CLASS
Learning event

30 April 2014

Museum of Science and Industry, Manchester

LCN Fund
Low Carbon Networks

electricity north west
Bringing energy to your door

CLASS
welcome and introduction

Steve Cox
Head of Future Networks

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Housekeeping

Fire alarms	xx:xx
Break	11:15
Presentations	xx:xx
Lunch	12:15
Presentations	13:00

Our objectives for today

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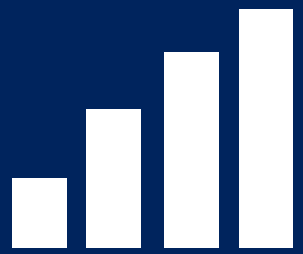
CLASS		
Introduction	Project status	Share learning, challenges and outcomes

	Questions & Answers
Next steps	Engage project team

Agenda

- Welcome and context-setting
- Project manager's update
- CLASS technology overview
- CLASS customer engagement approach
- Approach for conducting CLASS trials
- Potential benefits of CLASS to National Grid
- Overview of the autonomous substation controllers
- Opportunities for exploiting the relationship between voltage and demand
- Wrap up and close

Who are we?

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£8 billion of network assets

6 million

2.4 million

25 gigawatts

The key challenges and context for CLASS

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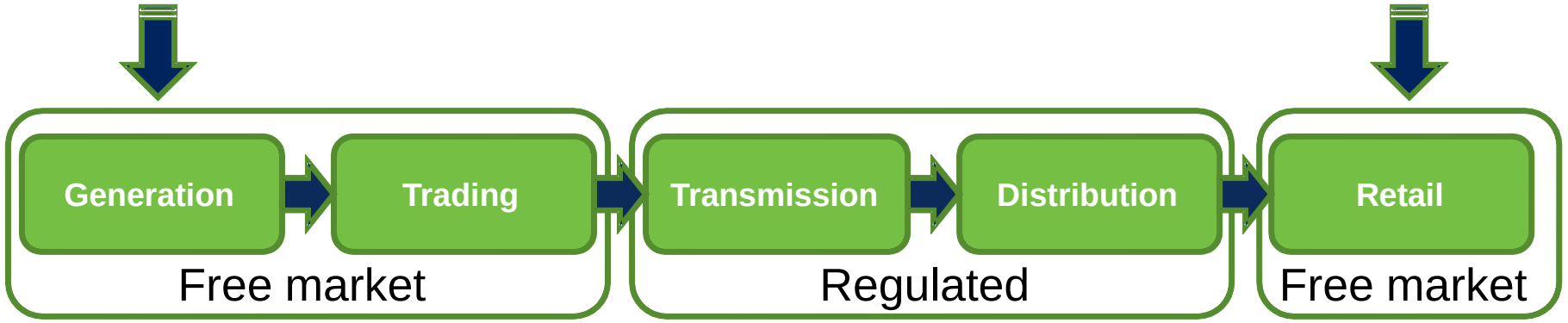
The GB energy market

Fuel capital
environmental

Affordability
consumption



> “Some 7.8 million people could not afford their energy bills in 2009. This is due to rise to 8.5 million by 2016”

Professor John Hills,

Interim Report on Fuel Poverty, March 2012

Network businesses are the only price throttle available

The challenges for DNOs

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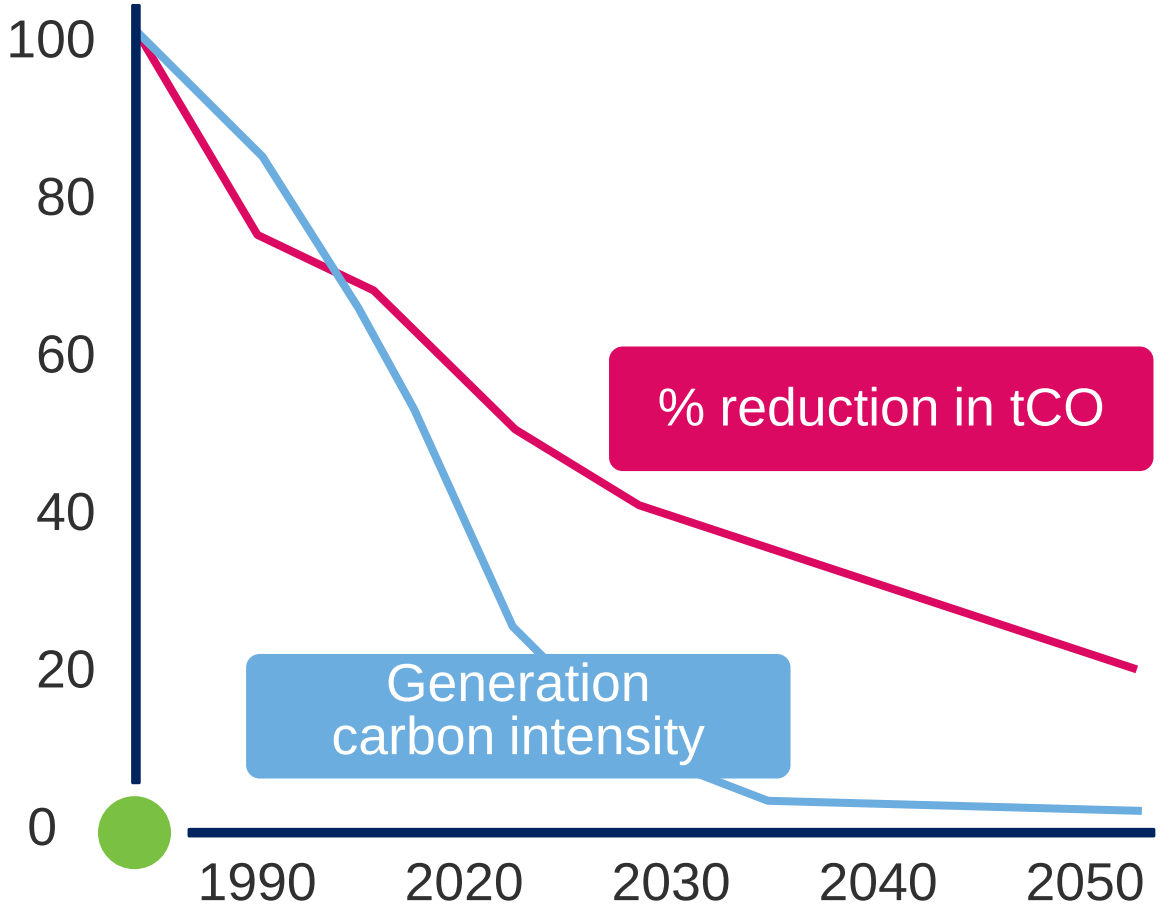
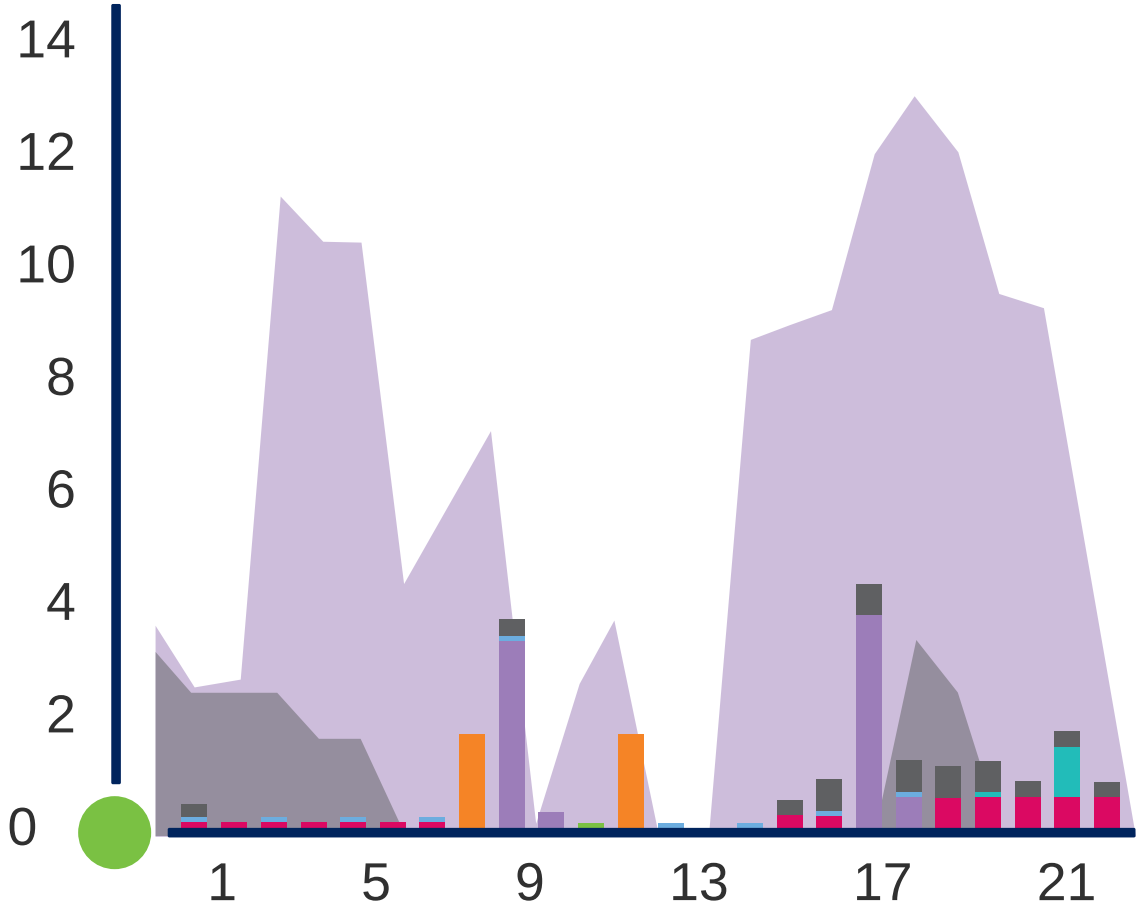
UK government emission targets 1990 base



Domestic demand profile 2012



Electricity North West's innovation strategy

Our smart grid development

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Leading work on developing smart solutions

Deliver value from existing assets

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£30 million

Three flagship products

C2C
Capacity to Customers

SMART STREET

CLASS
Customer Load Active System Services

Project Overview/Update

Herb Castillo
Project Manager, CLASS

LCN Fund
Low Carbon Networks

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Voltage and demand

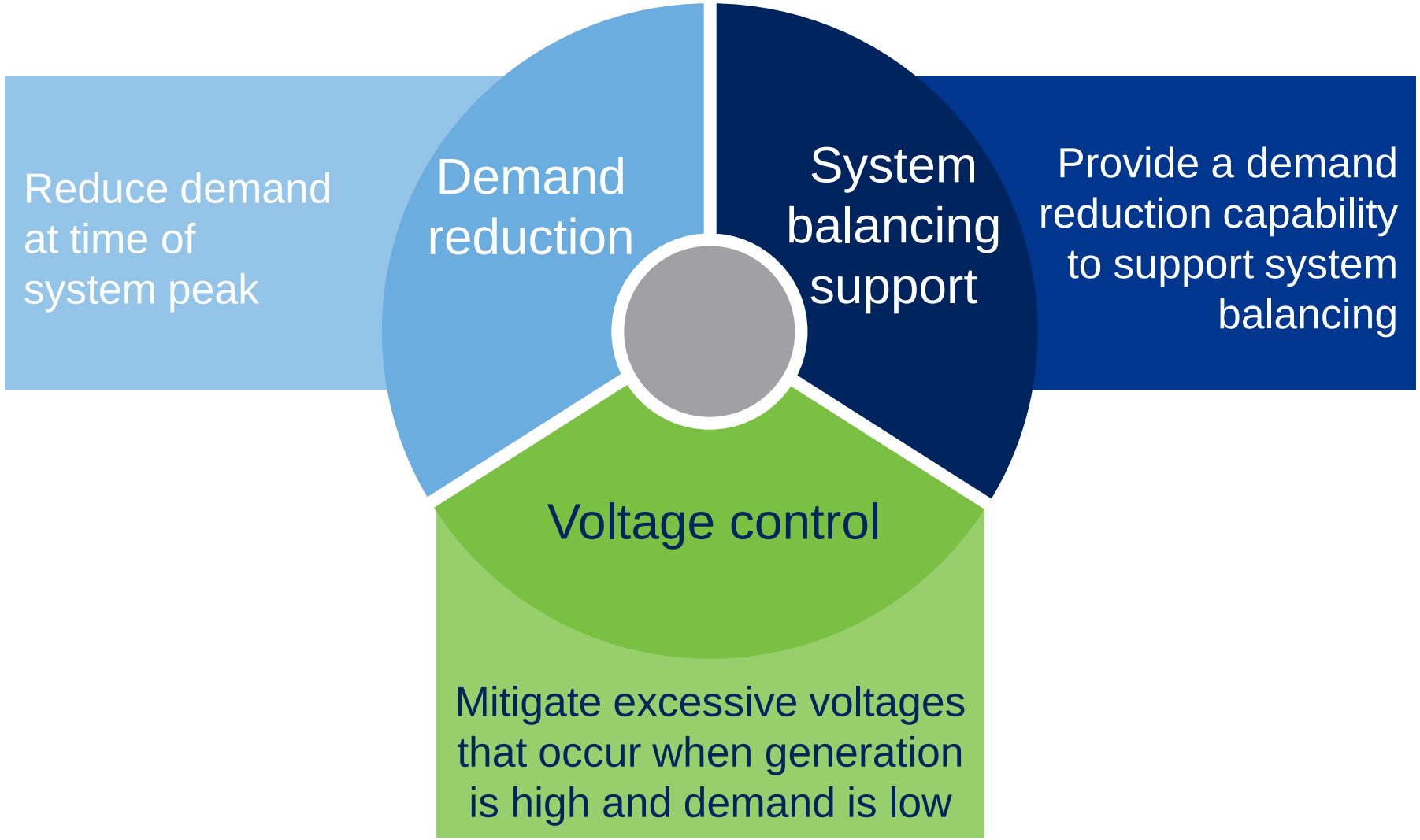
Can this relationship be used in a smart way to benefit customers?

Is seeking to demonstrate that electricity demand can be managed by controlling voltage…

…without any discernible impacts on customers

Customer Load Active Systems Services

Elements of CLASS



Key hypotheses

Creates a demand response capability	Creates a reactive absorption capability	Customers will not observe any discernible impact	Defers/ optimises reinforcement and reduces carbon intensity	Has no detrimental effects on asset health
Demand reduction	Voltage control	Customers	Efficiency	Asset health

Projected benefits

If rolled out GB-wide, CLASS has potential to defer £90 million in traditional reinforcement costs and 22,000 tCO_2eq

Will better exploit existing assets, thus cost-effective and quickly implemented	Reducing peak demand at a primary can delay the need for reinforcement	Provides DNOs with valuable time to conduct analyses and assess how best to intervene	Can defer reinforcement costs and the time taken to complete the associated works	Minimises carbon-intensive infrastructure
Rapidly deployable solution	Reinforcement deferral	Provides time for assessment	Cost deferral	Carbon reduction

Our structure and partners

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SIEMENS

PB PARSONS BRINCKERHOFF

nationalgrid

GE

MANCHESTER 1824

Tyndall Centre for Climate Change Research

Chiltern Power

nationalgrid

Impact Research

Technology build

Trials and research

Customer engagement

Learning and dissemination

The Electricity North West project team

CLASS Project Steering Group

Herb Castillo
CLASS Project Manager

Paul Turner
Future Network Technology Lead

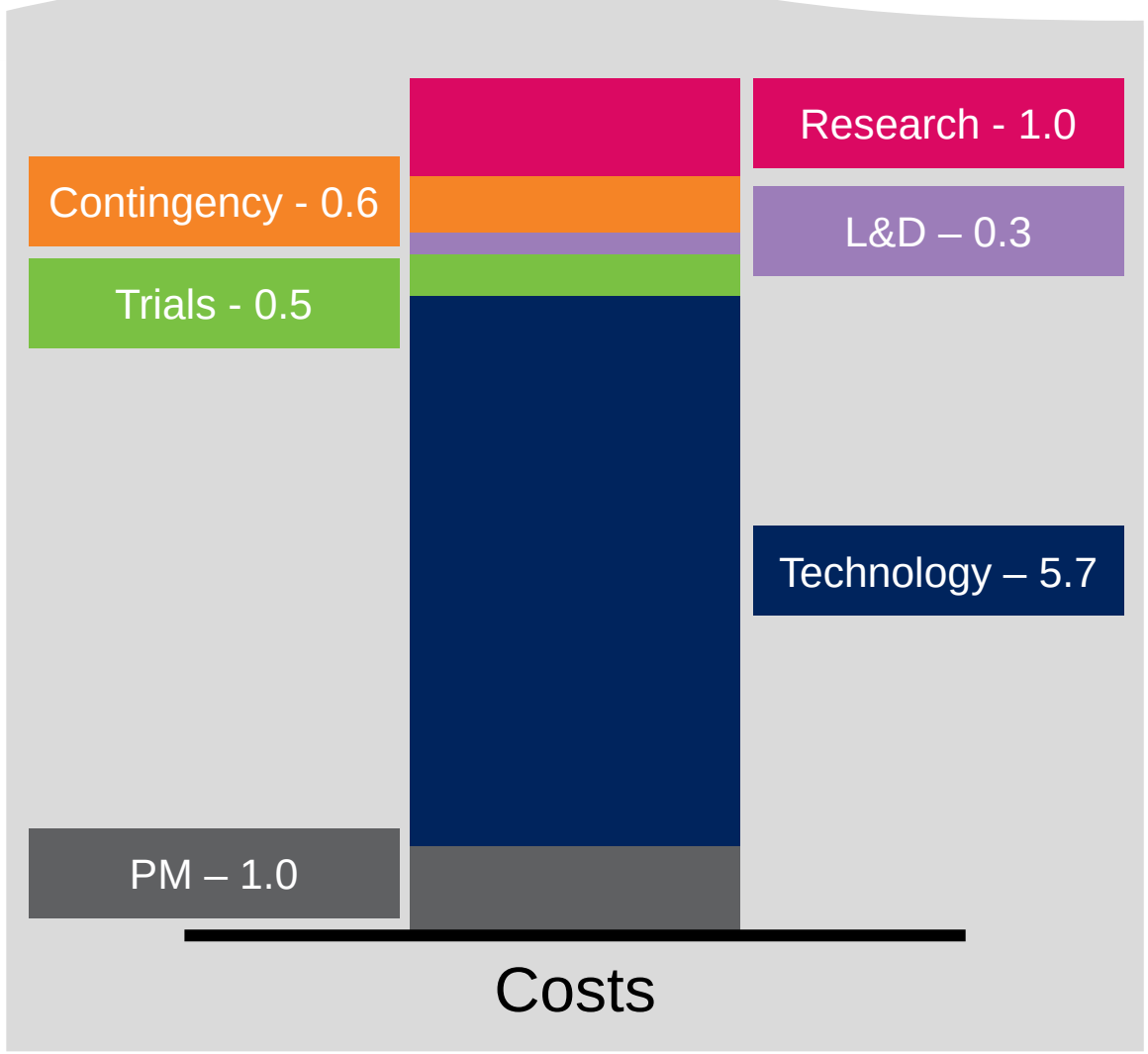
Kate Quigley
Future Networks Customer Lead

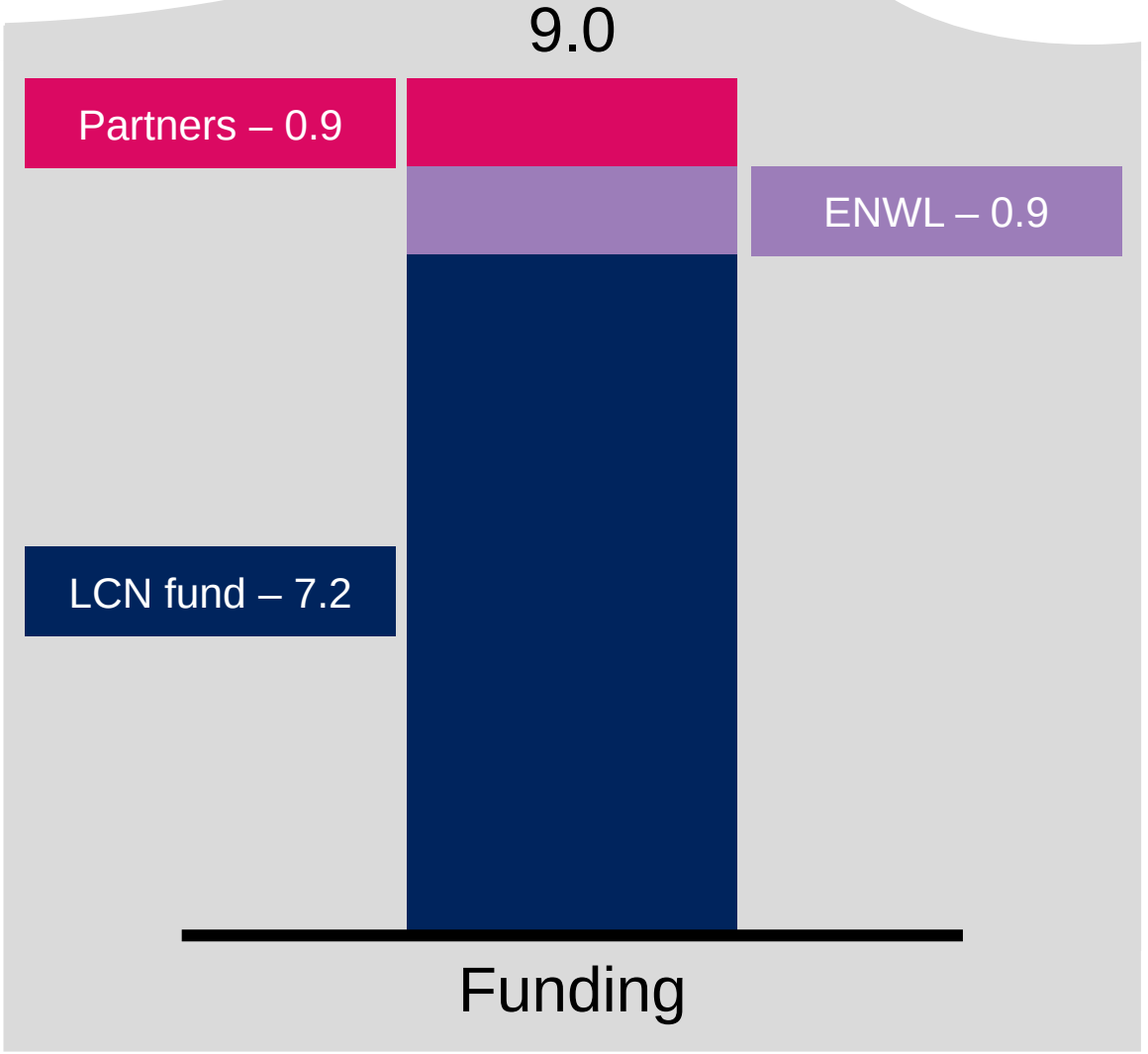
Damien Coyle
Assistant CLASS Project Manager

Victoria Turnham
CLASS Research Engineer

Steve Stott
CLASS Research Engineer

CLASS financial overview





Project costs segments and funding breakdown £m

Key activities to date

Jan 2013

April 2014

Site Selection	Design and installation of CLASS technologies	Build data link with National Grid	Design the trials and test regime	Engage customers and develop survey material
60 primaries selected which define the CLASS trial area	CLASS solution designed; hardware and software installed	Real-time data link to National Grid developed	The methodology and schedule for the CLASS trials developed	Engaged customer panels convened to elicit customer views

Knowledge sharing and dissemination

What's next for CLASS?

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May 2014

Sep. 2015

Trials	Data collection	Customer surveys	Analyses	Publish reports
Series of CLASS trials to commence in summer 2014	Automatic collection of data and associated monitoring	Surveys of customers in the trial area to assess perception and impact	Analyses of technical data and customer survey outcomes	Write-up and publish trial outcomes

Knowledge sharing and dissemination

Technology Overview

Paul Turner
Future Networks Technical Delivery Manager

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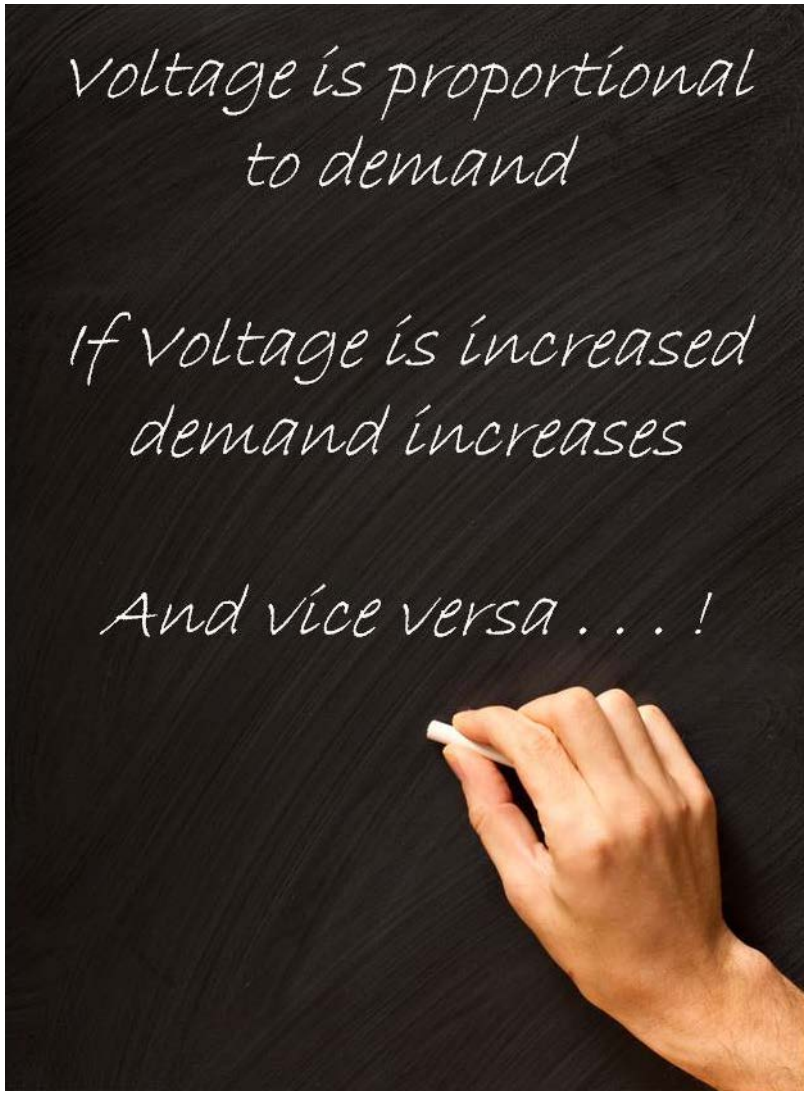
Back to school for a moment…

This fundamental relationship is at the heart of CLASS

But how will it change over time as customers adopt new devices?

How could we use this relationship in a smart way to benefit customers?



How does it work

00:03:00

2% ↑ 00:00:08 ↓ 2%

The cost £ to make your cup of tea is always the same!

"*A problem shared is a problem halved…*"

20,000 homes in a town

200,000 homes in a city

26 million across the GB

What problems could we solve ?

The CLASS functions

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	Objective	Technique
Load modelling	Establish voltage/demand relationship	Raise & lower tap position
Demand response	Demand response for peak reduction	Lower tap position
Frequency response	Primary response to reduce demand when frequency falls on the network	Switch out transformer
	Secondary response to reduce demand when frequency fails on the network	Lower tap position
Reactive power	Absorb high voltages that occur on the transmission network	Stagger tap position

CLASS project scale

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primary sites	60
Micro tap sites	52
Argus 8 sites	8
Primary Frequency Response sites	10

HV locations	10
45 New LV locations + 15 existing	60
Transformers	3

Complete CLASS system

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Control room

Substation

Algorithm

Soap

Dashboard

PoF NMS

ICCP Link

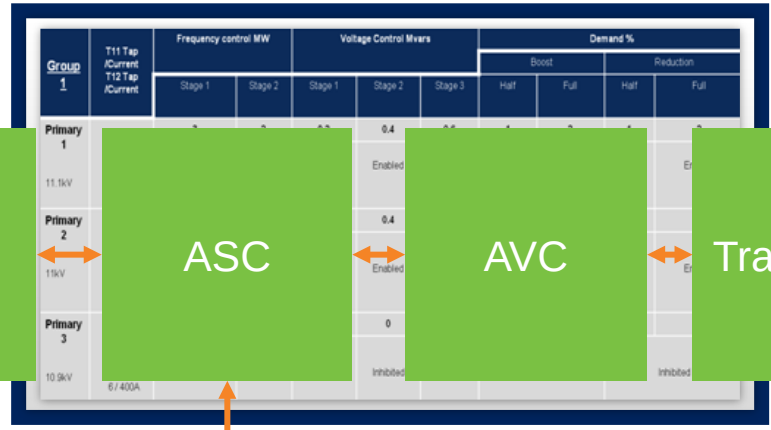
Dashboard

NG NMS

CRMS NMS

iHost

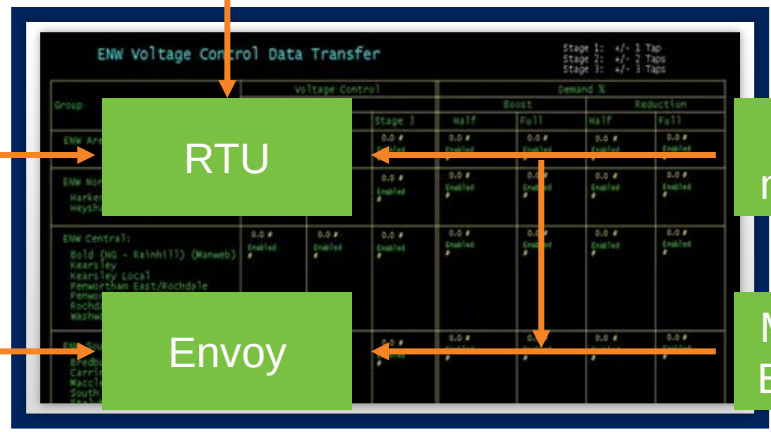
T11/T12 Circuit Breakers



ASC

AVC

Transformers



RTU

Primary monitoring

Envoy

Monitoring Equipment

Complete CLASS system

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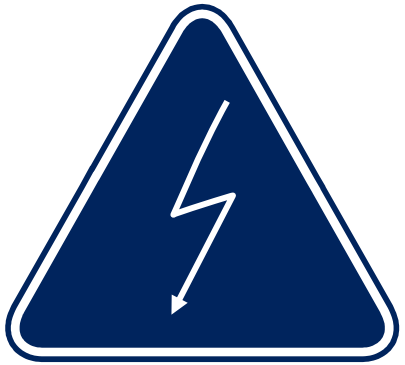
Group	T11 Tap/Current T12 Tap/Current	NRD	Frequency control MW		Voltage Control Mvars			Demand %			
								Boost		Reduction	
			Stage 1	Stage 2	Stage 1	Stage 2	Stage 3	Half	Full	Half	Full
South Manc		Disabled	6	0	0.4	0.8	0.6	2	4	2	4
			Enabled	Activated	Enabled	Enabled	Enabled	Enabled		Enabled	Enabled
Trafford 11.1kV	T11 6/400A T12 6/400A	Disabled	**3**	**0**	**0.2**	**0.4**	**0**	**1**	**2**	**1**	**2**
			Enabled	Activated	Enabled	Enabled	Disabled	Enabled		Enabled	Enabled
Monton 11kV	T11 6/400A T12 6/400A	Disabled	**3**	**0**	**0.2**	**0.4**	**0.6**	**1**	**2**	**1**	**2**
			Enabled	Activated	Enabled	Enabled	Enabled	Enabled		Enabled	Enabled
Mount st 10.9kV	T11 6/400A T12 6/400A	Disabled	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
			Inhibited	Inhibited	Inhibited	Inhibited	Inhibited	Inhibited		Inhibited	

ICCP (Inter control centre protocol)

DNO control centre

National grid control centre

Dashboard



Control call

Measures real time availability

Demand and voltage control call off

Schematic diagram - On site

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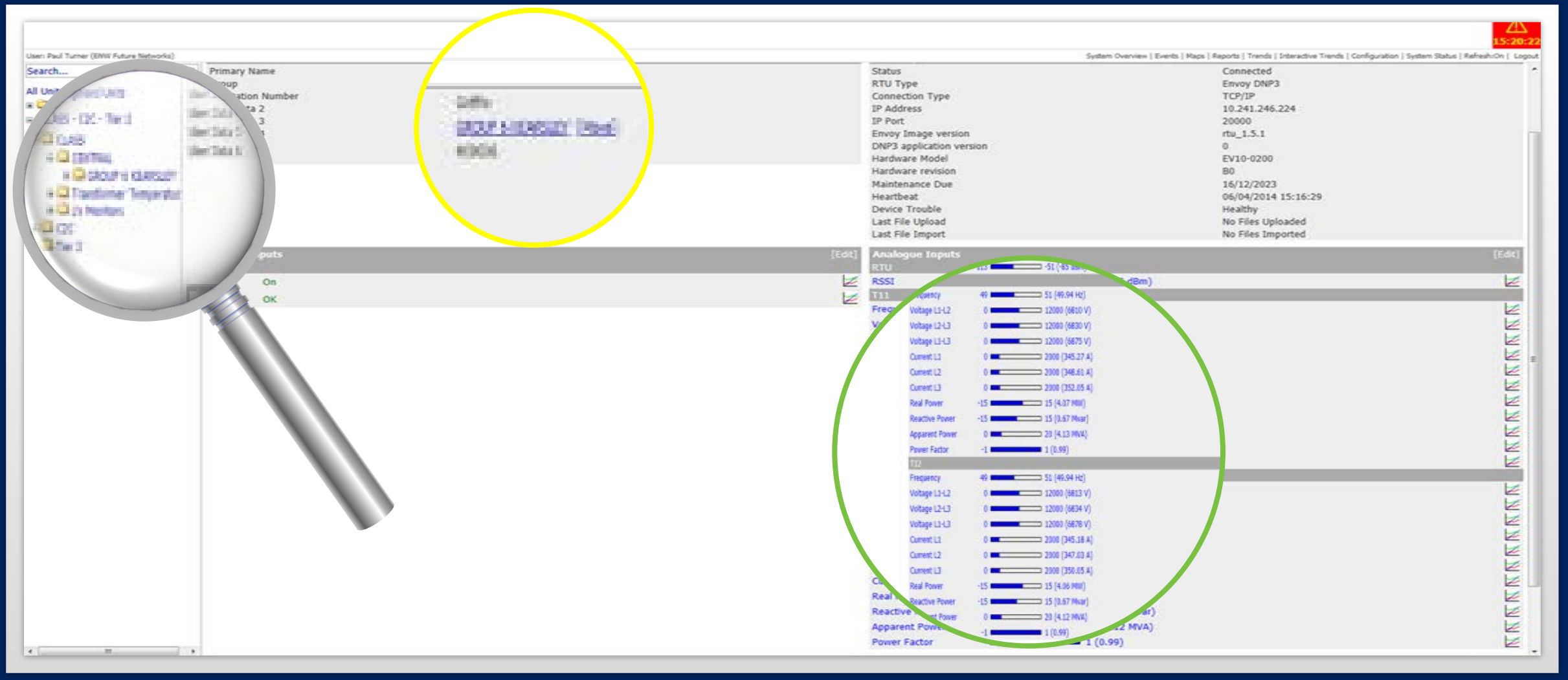
T11/T12 Circuit Breakers

Transformers

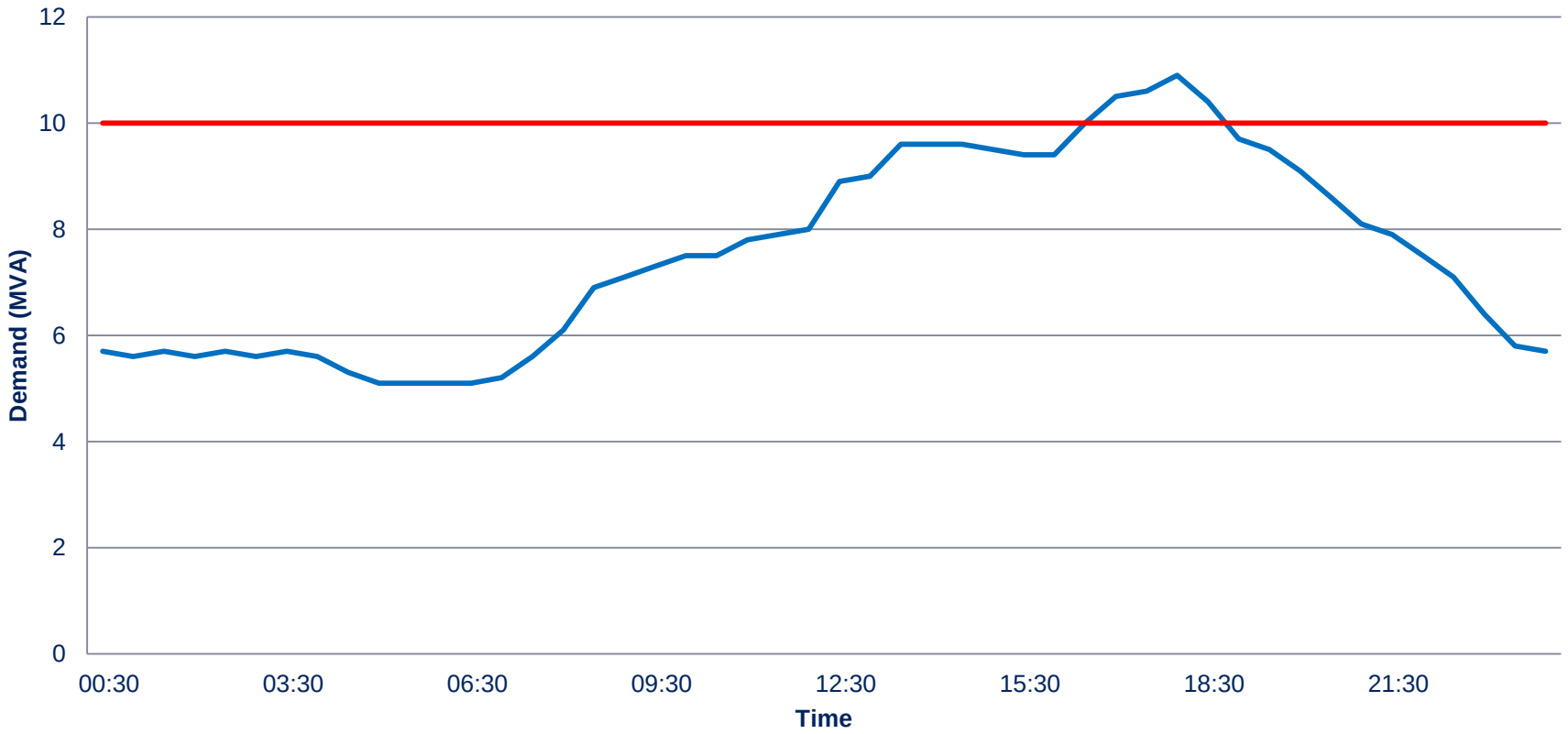
RTU

Envoy

CLASS monitoring



Network reinforcement deferral example - Trafford



Network reinforcement deferral example

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South Manc		Disabled	0	0	0	0	0	0	0	0	0
			Disabled	Disabled	Disabled	Disabled	Disabled	Disabled		Disabled	Disabled
Trafford 11.1kV	T11 6/400A T12 6/400A	Disabled	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
			Disabled	Disabled	Disabled	Disabled	Disabled	Disabled		Disabled	Disabled
Monton 11kV	T11 6/400A T12 6/400A	Disabled	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
			Disabled	Disabled	Disabled	Disabled	Disabled	Disabled		Disabled	Disabled
Mount st 10.9kV	T11 6/400A T12 6/400A	Disabled	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
			Disabled	Disabled	Disabled	Disabled	Disabled	Disabled		Disabled	

Network reinforcement deferral example

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Trafford 11.1kV	T11 6/400A T12 6/400A	Enabled	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
			Disabled	Disabled	Disabled	Disabled	Disabled	Disabled		Disabled	Disabled
Monton 11kV	T11 6/400A T12 6/400A	Disabled	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
			Disabled	Disabled	Disabled	Disabled	Disabled	Disabled		Disabled	Disabled
Mount st 10.9kV	T11 6/400A T12 6/400A	Disabled	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
			Disabled	Disabled	Disabled	Disabled	Disabled	Disabled		Disabled	

Network reinforcement deferral example

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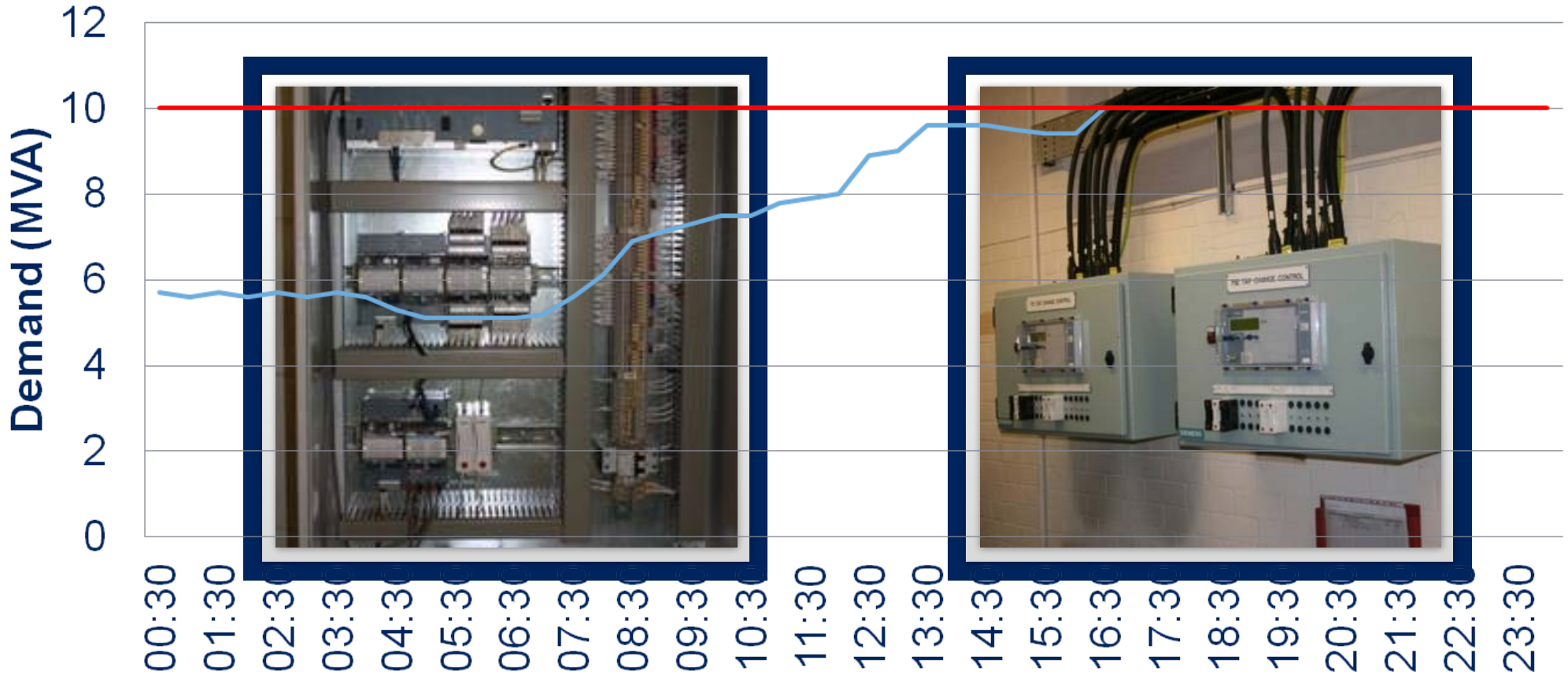
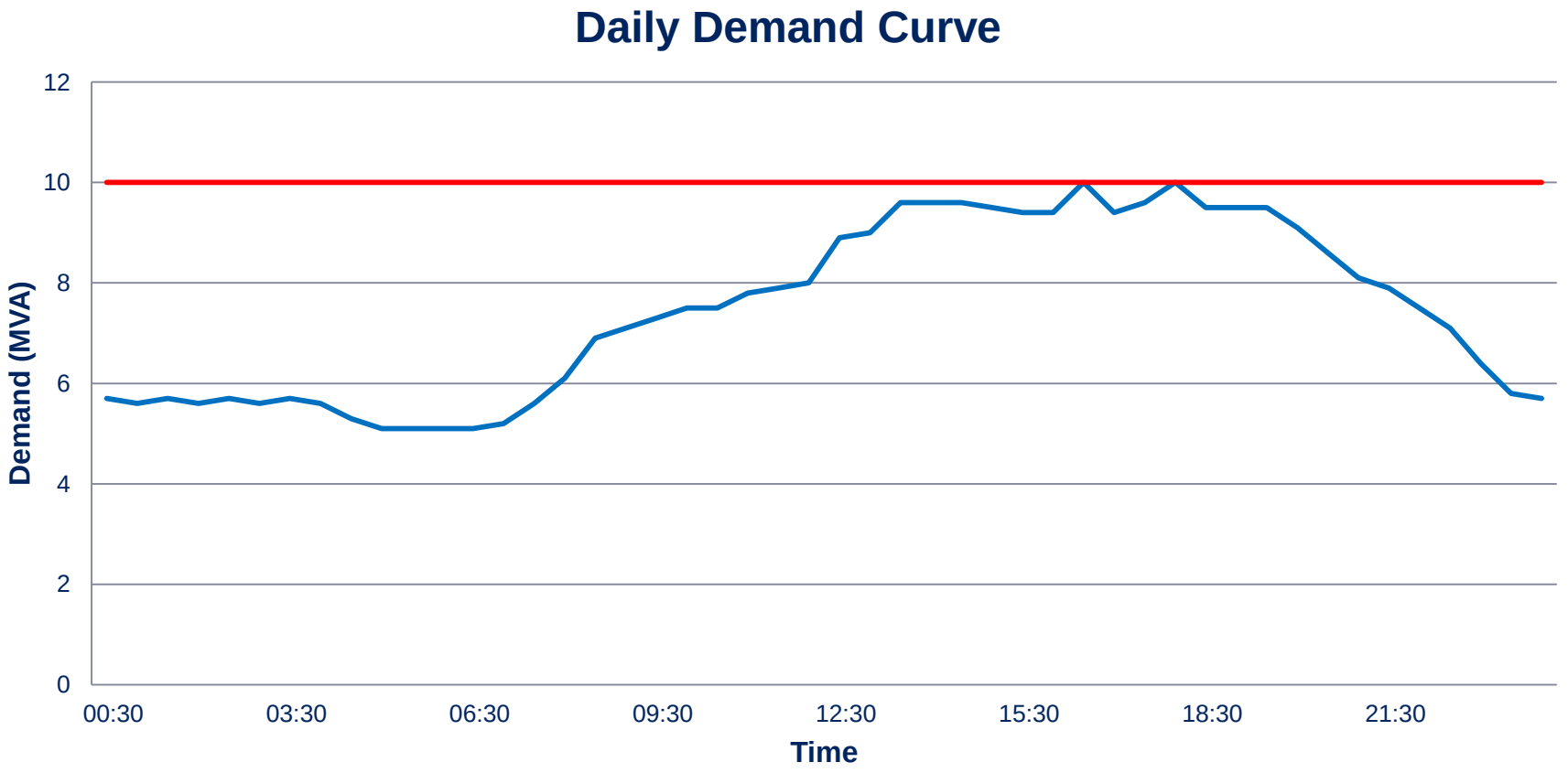
Daily Demand Curve



Network reinforcement deferral example



Project outcomes

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Voltage & demand

Network reinforcement deferral

Voltage control

Frequency ancillary services

CLASS Customer Engagement

Kate Quigley and David Pearmain

LCN Fund
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The customer challenge

“CLASS will be indiscernible to customers”

Customers will not see / observe / notice an impact on the supply quality when these innovative techniques are applied

Customer

Supply quality

Innovative techniques

Agenda

	Customer engagement	Research methodology	Engaged customer panel	Customer survey
Risks	Peer review	Engaged panel findings	Awareness campaign and survey registration	Next steps

Qualitative research summary

Formulate effective communication plans and materials in order to provide clear information for customers

Explain CLASS initiative

Develop and refine communications

Input to design of quantitative surveys

Engaged customer panel (ECP)

Engaged customer panel methodology

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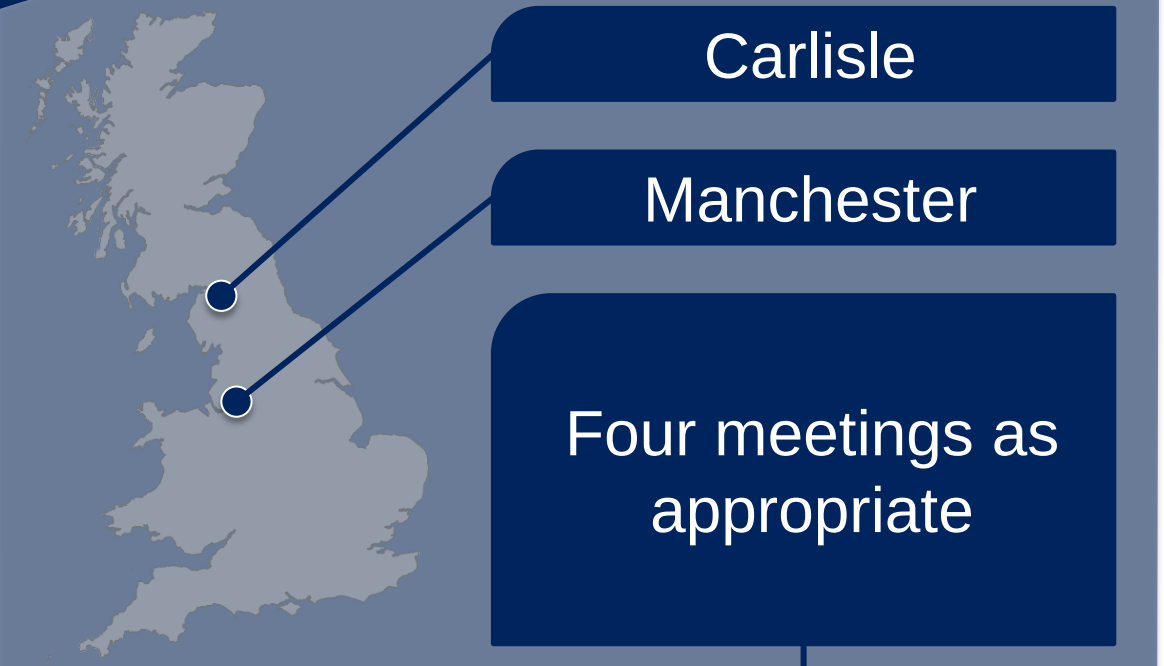


Carlisle

Manchester

Four meetings as appropriate

Cross section of customers

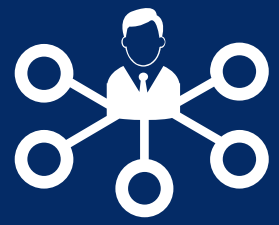
All I&C panellists had decision-making responsibilities

30 consumers were recruited

Customer research methodology

“CLASS will be indiscernible to customers”
Customers will not see / observe / notice an impact on the supply quality when these innovative techniques are applied

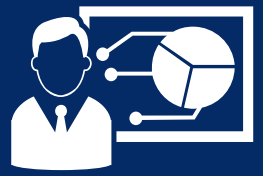
Qualitative



Formulate communications and materials

Customer research

Quantitative



Compare feedback trial vs control

Qualitative research (ECP)

Engaged customer panel methodology

ECP meeting	Date and time	Research objective
1	15 October (Carlisle) and 16 October (Manchester) 2013	Introduce CLASS and establish customer perceptions and understanding of the concept
2	5 November (Carlisle) and 6 November (Manchester) 2013	Establish the most effective way of communicating CLASS to customers (customers leaflet + other) and encouraging participation in the customer research
3	3 December (Carlisle) and 4 December (Manchester) 2013	1) Sign off the customer leaflet 2) Establish the most effective way of communicating about the CLASS survey to potential participants 3) Explore the use of social media
4	14 January (Carlisle) and 15 January (Manchester) 2014	Feedback on the draft customer survey

We developed the way the concept of CLASS is described

Input into the marketing materials

Quantitative research summary

A representative sample of 500 households and 200 businesses in the trial area, located over 60 primary substations

Recruit and interview customers

Regular re-contact to measure any perceived change in quality of electricity supply

Baseline survey
Surveys takes place
7 April –
28 April 14

Summer surveys
Test and control approach
Surveys takes place
14

Winter survey
Surveys takes place

Spring survey
Surveys takes place
2 March –
5 April 15

Measure when trial is occurring

Notify that trial could be occurring

Measure when trial is *not* occurring

Do not notify that trial could be occurring

Qualitative research (baseline and trial surveys)

How the trials will be covered

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Baseline survey	Summer surveys	Winter survey	Spring survey
Surveys takes place 7 April – 28 April 14	Surveys takes place 5 May – 31 August 14	Surveys takes place 1 Dec 14 – 1 March 15	Surveys takes place 2 March – 5 April 15

	Ref	Trial	Details	Baseline (April)	Up to four additional interviews per person over the year			
					Season 1	Season 2	Season 3	Season 4
Demand response	T2	Voltage reduction	13 LI5 primaries c. 100 tests	✓			✓	
Frequency response 2	T3a	Primary frequency response	10 primaries	✓	✓		✓	
	T3b	Secondary frequency response	41 primaries (Not involved in primary response)	✓	✓		✓	✓

Quantitative research (baseline survey)

Baseline survey (20 mins)

Baseline survey (20 mins)

- You/your business
- Your household/ business
- When you are in
- Your energy consumption
- Your current electricity supply

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Quantitative research (Trial surveys)

Trial surveys (5 mins)

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Three trial survey seasons will follow the baseline

Trial period

↓

1 year

↓

Contacted 4 times

↓

Following pattern of tests

Administered over the phone

5

minutes

Customer perception of power quality

£25

per interview

Trial surveys (5 mins)

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[illegible]
[illegible]
has this affected their perception of the service
offered by Electricity North West

- You/your business
- Your household/ business
- When were you in
- Energy consumption changed?
- Your current electricity supply

Quantitative research (Trial surveys)

Test and control methodology

Control group customers will

Half on a later day

d that they are up or that they e test group

Similar day/ hour before

Any ‘placebo effect’ from being told that a trial may take place will be examined by notifying half of the control group and half of the test group before any test takes place on selected electricity circuits

Quantitative research (Trial surveys)

Trial surveys (5 mins)

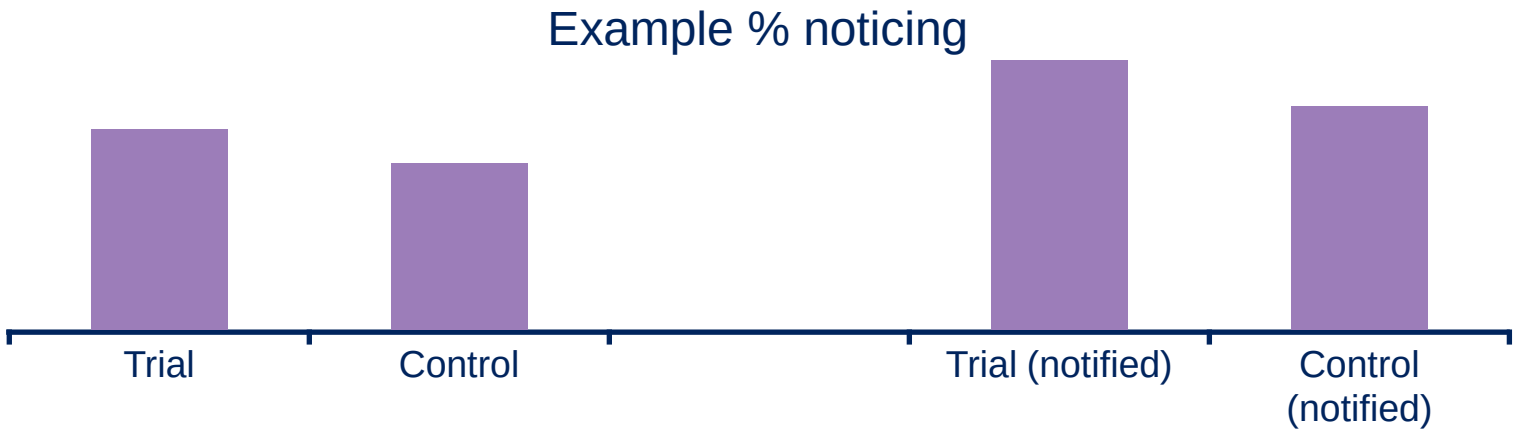
Notified 48 hours prior to trial	Control surveys prior to tests	17:00 - 19:00 Monday - Thursday	Test surveys	Control surveys after tests
50%	50%	3% x 3	Fri - Sun	50%

Trial:	2
Season:	3 wk/c 01/12/2014
GSP group:	4 (Harker/Hutton)
Trial primary:	Egremont

Quantitative research (Trial surveys)
Analysis

Have customers noticed any changes in the quality of their electricity supply?

If they noticed anything, how big a problem was it?



Further breakdowns by:
- Type of test (egT2, T3a and Tb)
- Season eg summer 2014 vs winter 2014
- Customer type (I&C vs domestic)
- Rural vs urban
- By pre notified vs not notified

Further sub-groups as data allows:
- Customer type by test vs control group
- Customer type by type of test
- Customer type by pre-notification
- Test vs control group by customer type
- Test vs control group by test
- Test vs control group by pre-notification

Priority service customers

Already registered

Project team

470,000 customers

Eligible for inclusion

Identify PSR customers and any special needs

Vulnerable customers reside at the property and/or if medical equipment affected

Power quality monitoring

Mitigating risks

Possible risk	Mitigation
Can we be sure to get enough people to participate?	- **Oversampling** from the start - **Full explanation** in face-to-face interview so respondents understand the nature of the study and the need for commitment - Financial **incentives**
What if research participates move house during the trial?	- We will ask whether they are intending to move within the next year, if yes, we will not recruit them - Should participants move house during the trial period, the **replacement household at the same address can still be invited** to opt in to future research because their answers regarding the benefit of the new technology to the property will be valid
What if a customer is hostile to the forced "opt-in" element of the trials?	- The trials will be taking place anyway and the research is not geared towards gaining their consent - In preparation for these cases - Information will be available to reassure customers - They will be able to phone the contact centre, use social media, write to or learn about it on Electricity North West website
What if a CLASS customer observes something or complains?	- We will investigate by cross-checking customer feedback against the monitoring data on the secondary network.

A dedicated and consistent team of experienced interviewers will be used to administer the surveys. They are highly trained and effective in engaging with customers on an ongoing basis

Peer review

Maintain standards

Improve performance

Provide creditability

The role of peer reviewer on this project will be carried out by **Professor Ken Willis**

Emeritus Professor of Economics of the Environment at the School of Architecture, Planning and Landscape, Newcastle University

Expert in environmental economics; consumer demand theory and customer preferences; environmental valuation and cost-benefit analysis (CBA)

His role in the project is to review the market research customer survey methodology, the analysis and interpretation of the findings (analysis plan, draft report)

In summary

LCNF fund available

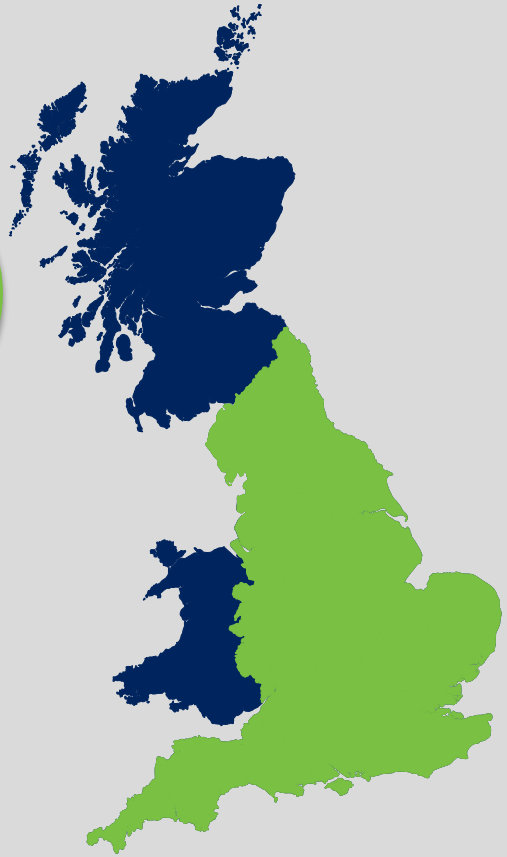
Viability in scaling CLASS

Customer engagement methodology

Test the key hypothesis

No noticeable effects on customers

Test whether this holds for a variety of customers



Engaged customer panel – objectives and approach

Aim	Research
Customer leaflet	Educate panel
Materials for survey recruitment	Inform of CLASS concept and trials
Survey instrument	Guide understanding of elements
	Anticipate any questions or issues

Formed in advance of awareness campaign and trial go-live

Engaged customer panel – materials

Which materials helped to effectively explain CLASS

- FAQ
- Video
- Concept board

2%⇩ 8 seconds slower

2%⇧ 8 seconds faster

£ Always the same

Engaged customer panel - concept

- ☑ Do customers understand?
- ☑ Do customers care?
- ☑ Will customers notice?

Initially concerned about more power cuts
and their equipment/appliances and if they would have to upgrade them

Engaged customer panel – leaflet

How customers get involved in the survey and get the cash reward

Engaged customer panel – leaflet

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Leaflet one (three pages)

Leaflet two (three pages)

FAQ page added to both leaflets

Frequently asked questions

Can I opt out if I live or have a business in the trial area?

You cannot opt out of the trials because the substations where we are installing the trial technology serve thousands of different customers. Please be assured you will continue to receive the same reliable service during the trials.

Am I likely to notice a difference in my electricity supply?

It is unlikely that you will notice any difference in your electricity supply as a result of the trials taking place. Nor will we turn off your electricity supply at any point because of the trials. Occasionally you may experience a power cut because of a fault on our network. If this happens please call our 24 hour helpline on 0800 195 4141.

What changes are you making to my electricity supply?

We will adjust the voltage at the substation serving your home so we can manage peak demand for electricity. To give you an example of how voltage control may affect you – if a kettle takes three minutes to boil, a two per cent decrease in voltage would mean it boils eight seconds slower and a two per cent increase in voltage would mean it boils eight seconds faster. It's a bit like the temporary fluctuations

Why are you telling me this – is it a legislative requirement?

Our industry regulator Ofgem expects us to communicate this information to you. Ofgem has set up the Low Carbon Network Fund to support local electricity operators like Electricity North West to develop innovative solutions to meet the predicted huge increase in electricity usage. It's our responsibility to make you aware of any action we are taking to prepare your local electricity network for a sustainable future and how that might affect you.

I rely on electricity for special medical needs - will I be affected by the trials?

The trials will not directly affect you but you may want to consider joining our priority service register. We have set up this service for our more vulnerable customers who may need additional specialised help from us during a power cut. As part of our priority service we work in partnership with the British Red Cross who can help you with practical necessities when things go wrong.

To register, call us on 0800 195 4141 or complete the form on our website at: www.enwl.co.uk

Two additional versions were tested. Key changes included the removal of the ‘what to do if there’s a power cut’ section and the inclusion of a detailed FAQ

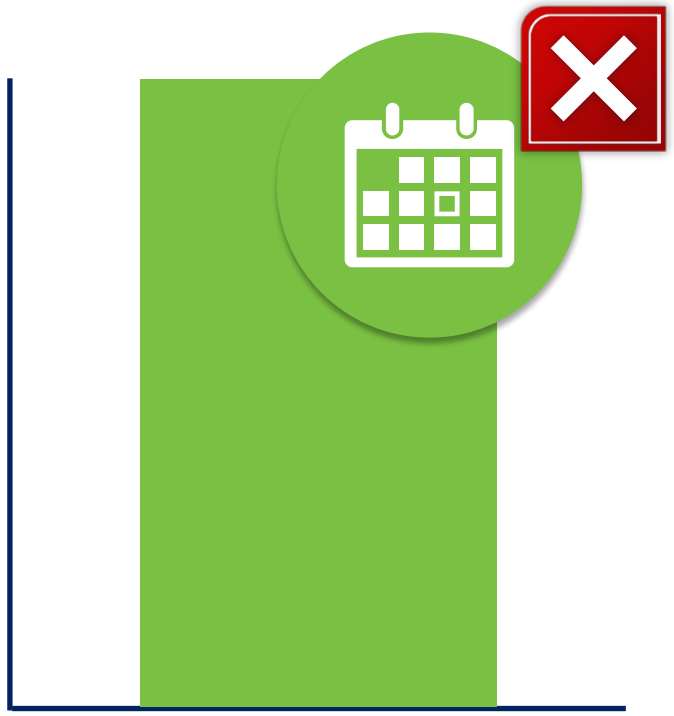
Vulnerable customers

electricity north west
Bringing energy to your door

FAQ

I rely on electricity for special medical needs – will I be affected by the trials?
The trials will not directly affect you but you may want to consider joining our priority services register. We have set up this service for our more vulnerable customers who may need additional specialised help from us during a power cut. As part of our priority services we work in partnership with the British Red Cross who can help you with practical necessities when things go wrong.

How to register



Availability of leaflets

Frequently asked questions

Am I likely to notice a difference in my electricity supply?
It is unlikely that you will notice any difference in your electricity supply as a result of the trials taking place. Nor will we turn off your electricity supply at any point because of the trials. Occasionally you may experience a power cut because of a fault on our network. If this happens please call our 24 hour helpline on 0800 195 4141.

What changes are you making to my electricity supply?
We will adjust the voltage at the substation serving your home so we can manage peak demand for electricity. To give you an example of how voltage control may affect you – if a kettle takes three minutes to boil, a two per cent decrease in voltage would mean it boils eight seconds slower and a two per cent increase in voltage would mean it boils eight seconds faster. It's a bit like the temporary fluctuations in speed of your broadband service. The amount you pay for your electricity is the same regardless of the voltage level.

Will there be any other effects on my appliances or local infrastructure?
The changes in voltage will be within statutory safe limits so appliances such as house alarms, televisions and computers will not stop working or need to be re-set. The trials will not affect local infrastructure such as street lights and traffic lights.

Can I opt out if I live or have a business in the trial area?
Although you do not have to take part in our surveys, you cannot opt out of the trials because the substations where we are installing the trial technology serve thousands of different customers. Please be assured you will continue to receive the same reliable service during the trials.

Why are you telling me this – is it a legislative requirement?
Our industry regulator Ofgem expects us to communicate this information to you. Ofgem has set up the Low Carbon Network Fund to support local electricity operators like Electricity North West to develop innovative solutions to meet the predicted huge increase in electricity usage. It's our responsibility to make you aware of any action we are taking to prepare your local electricity network for a sustainable future and how that might affect you.

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To register, call us on **0800 195 4141**
or complete the form on our website at:
www.enwl.co.uk/priority

This leaflet is also available in Braille, large print and a number of different languages on request.

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Electricity North West Limited
304 Bridgewater Place, Birchwood Park, Warrington, WA3 6XG
01925 846 999

5

Engaged customer panel – leaflet findings

- What were the likes and dislikes of both leaflet options?
- What did the group think about the final version leaflet?
- Which method of communication should be used?

A leaflet with the logo, correct image and appropriate message was eye-catching and a personally addressed communication was appreciated. Cannot look like junk mail or a big sell

Engaged customer panel – survey findings

- What was the general feedback on the survey?
- What issues did they have?
- What did the group think about the reward on offer?
- What did the group think about the method of survey completion?

Happy to register online, ask respondents for preferred day/time to survey, appreciate reminders of imminent survey if possible, very interested in progress/results

Engaged customer panel – emerging lessons

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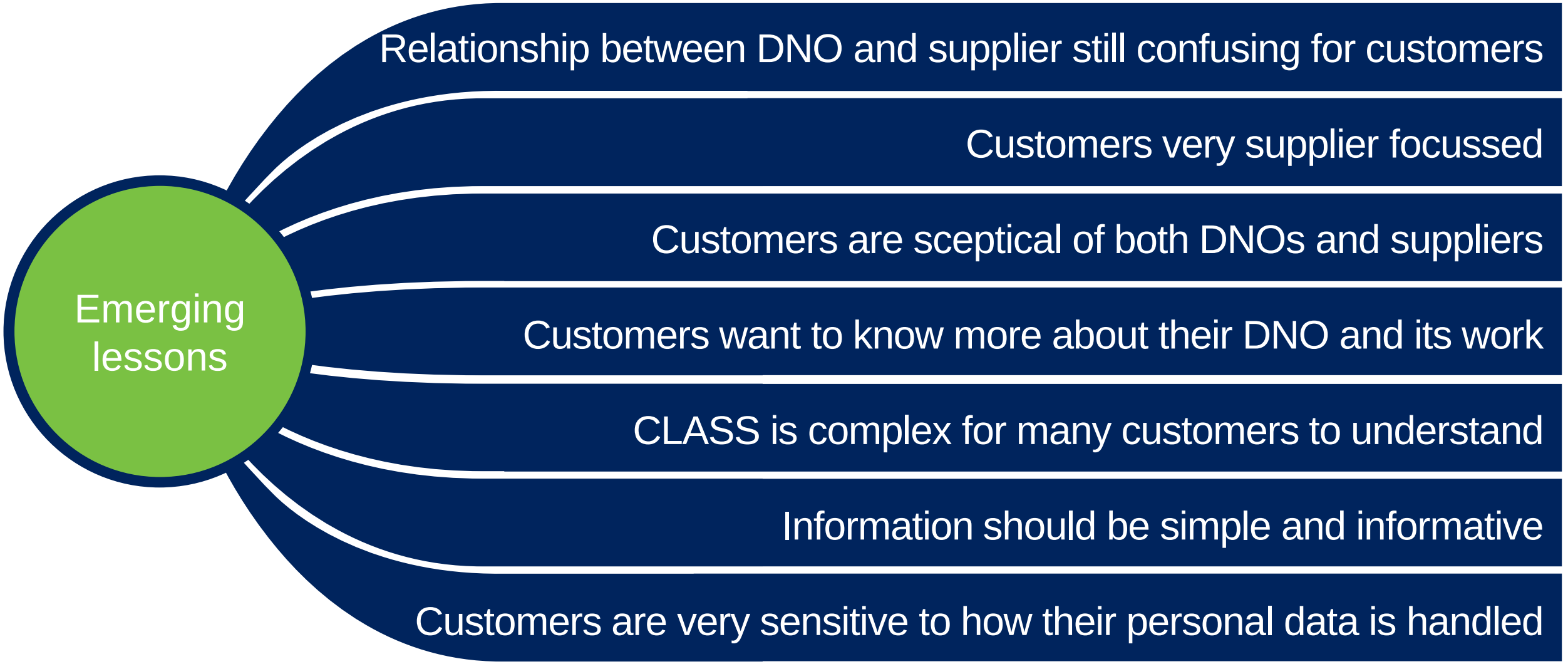

Customer leaflet and survey registration

Sign off December 2013

Hand delivered to 471,000 domestic and I&C customers

Class website where customers could register

Data sent to Impact Research

Customer leaflet and survey registration

3551 registrations 22 February – 3 March

354

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3317 online

www.

CLASS website

‘Due to overwhelming response, registration for the CLASS trial surveys is now closed’

Impact Research

Recruitment of 700 participants
of a representative mix of customers

Stakeholder engagement

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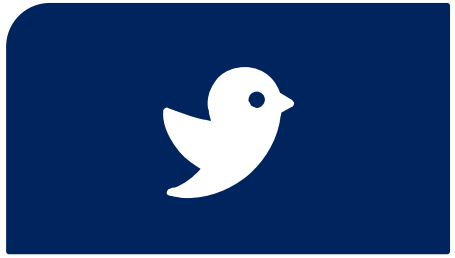
CLASS website



Social media

Supplier engagement

Webinars

Podcasts

Trade magazine

CLASS newsletter

Internal briefing

Next steps

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- **April 2014**
  - Agree process for dealing with customer enquiries
  - Additional face to face recruitment as appropriate
- **May 2014**
  - Brief customer facing employees
  - Baseline survey completed
- **August 2014**
  - First seasonal survey (summer)
- **September 2014**
  - Findings published

Our approach to conducting the CLASS trials

Victoria Turnham

LCN Fund
Low Carbon Networks

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Overview

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Objectives	Reduction of peak demand	Frequency response and voltage support	Voltage and demand relationship	No effect on customers
When	April to March 2015			
Outcome	**CLASS** Evaluate solution	Deliver results and learning	Transferrable to UK DNOs	

Considerations in designing the trials

Testing the CLASS enabling technology

Key components to trial design

Evaluating customer perception

Assessing the potential capability of CLASS

Project partners

Requirements adequately met

Key stakeholders

CLASS trials overview

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CLASS trials period

Trial 1: Load modelling

Trial 2:
Peak demand reduction

Trial 3:
Frequency response

Trial 3:
Frequency response

Trial 4:
Reactive power absorption

April 2014 | May | July | Sep | Nov | Jan 2015 | March

Trial 1 – Developing our understanding of the voltage/demand relationship

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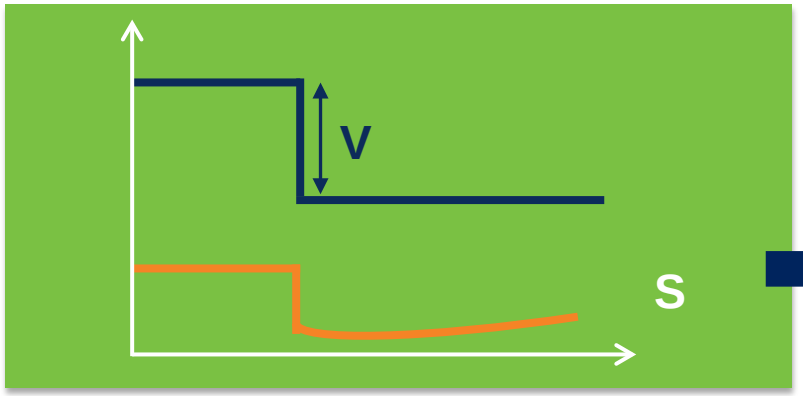
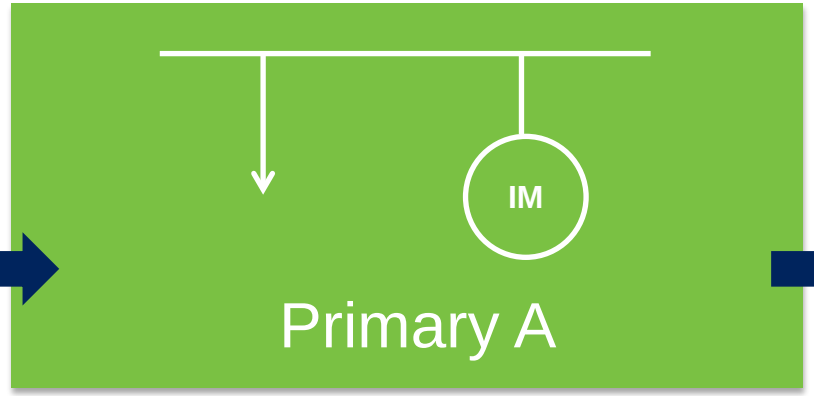
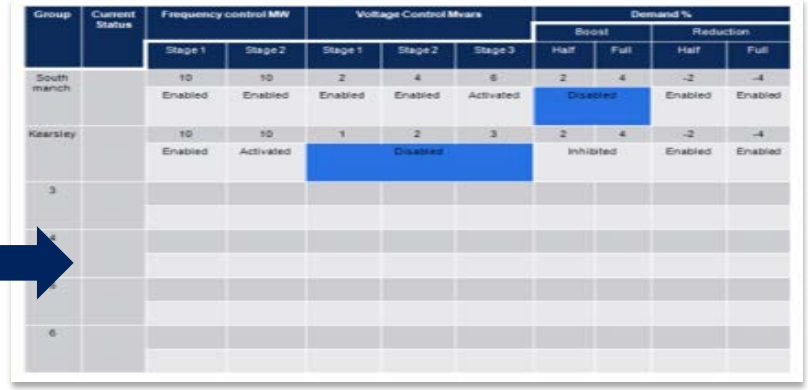
V ∝ Demand?



Response of demand



Load model



Group	Current Status	Frequency control MW		Voltage Control Mvars			Demand %			
							Boost		Reduction	
		Stage 1	Stage 2	Stage 1	Stage 2	Stage 3	Half	Full	Half	Full
South march		10	10	2	4	6	2	4	-2	-4
		Enabled	Enabled	Enabled	Enabled	Activated	Disabled		Enabled	Enabled
Kearsley		10	10	1	2	3	2	4	-2	-4
		Enabled	Activated	Disabled			Inhibited		Enabled	Enabled
3										
4										
5										
6										

Voltage/demand matrix

Trial 1 – Site selection

Methodology developed

Ratio of CDCM profile classes at substation peak demand

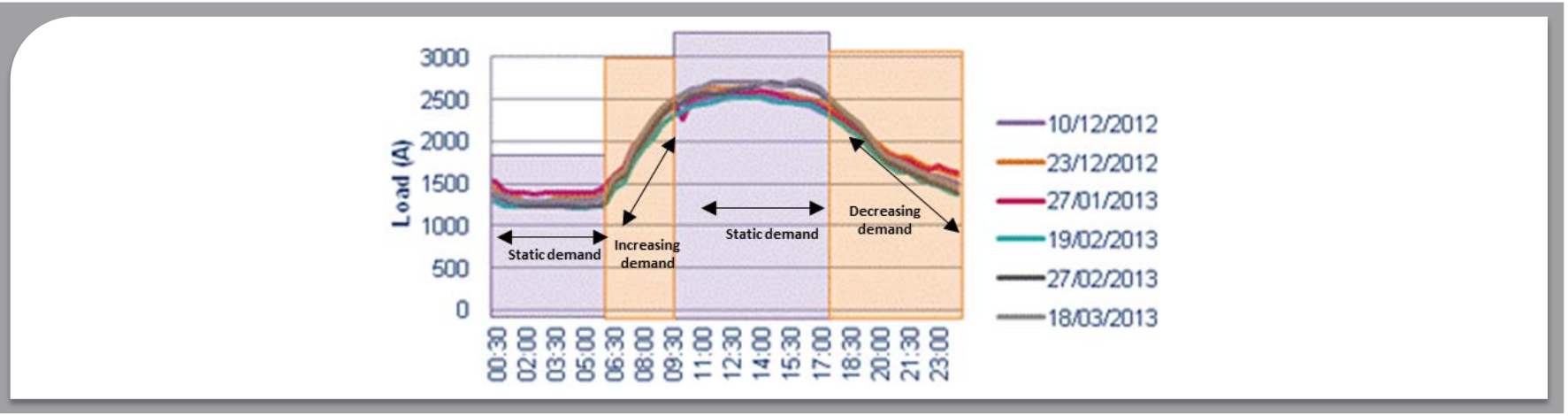
Category A	Category B	Category C
Largely industrial and commercial	Largely domestic	Mixed

Consideration of additional factors such as geography, socio-economic activity, type of processes for significant I&C customers

Trial 1 – Determining the test schedule

Typically primary substation demand shows regularity across a day or a season

Example daily profile



Tests can be conducted in representative periods

Quantify the demand/voltage relationship for every half hour across the annual cycle

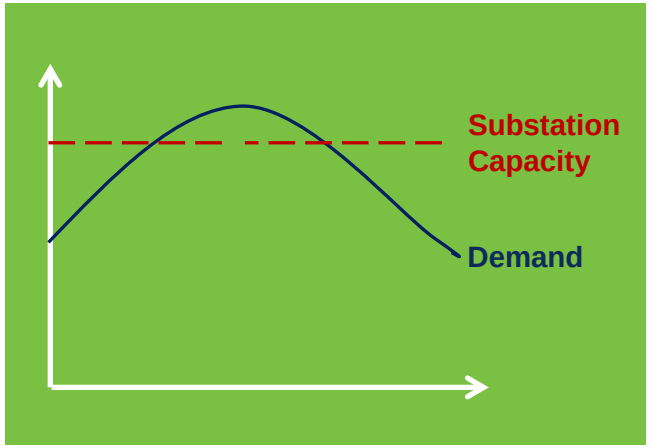
The planned voltage decrement and increment tests will supplement BAU tap change activity

Trial 2 – Reduction in peak demand

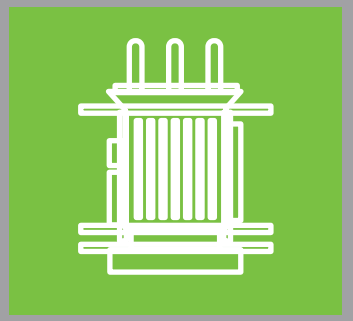
Demonstrate CLASS solution actively reduce peak demands on networks

Avoid or defer network reinforcement

CLASS is a low cost and quickly deployable solution where there is uncertainty in demand forecast



Maximum apparent power reduction that can be sustained



V

3%, 5%

Incremental levels of voltage reduction

Historic peak times

60 minute duration

Evaluating customer perception and testing technology

&

Trial 2 – Implementing the peak demand reduction

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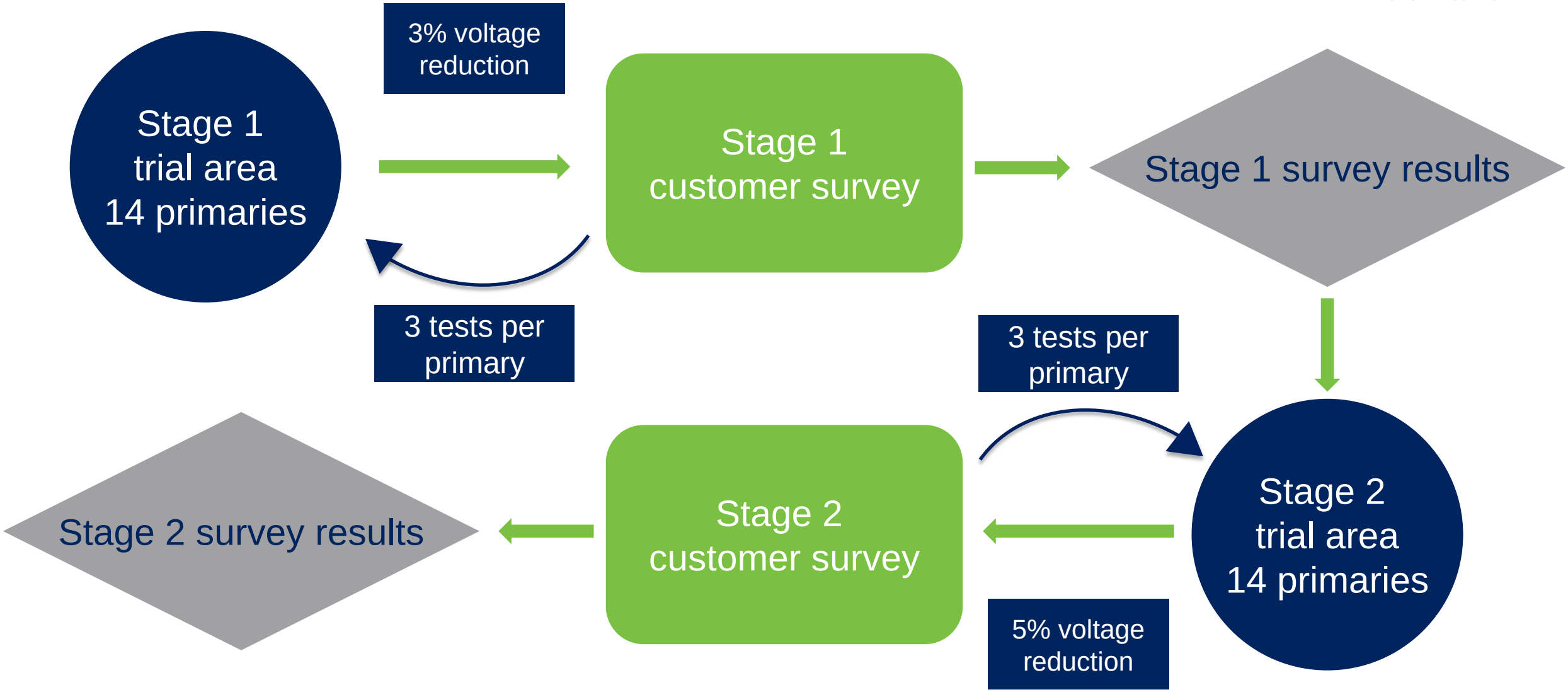
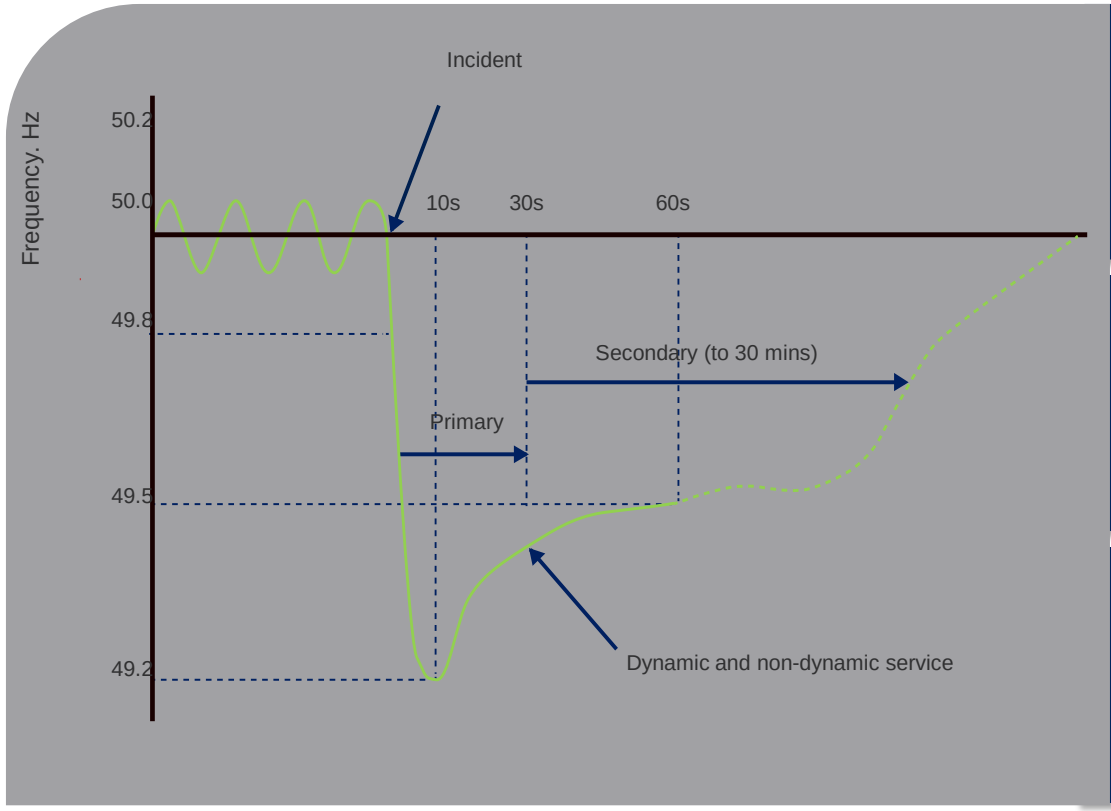


Trial 3 – Frequency response



Demonstrate CLASS can be a new mechanism for managing system frequency

Existing reserve services attract a high financial and carbon cost

CLASS has the potential to be a cost effective and flexible solution

Trial 3 – Utilising our assets

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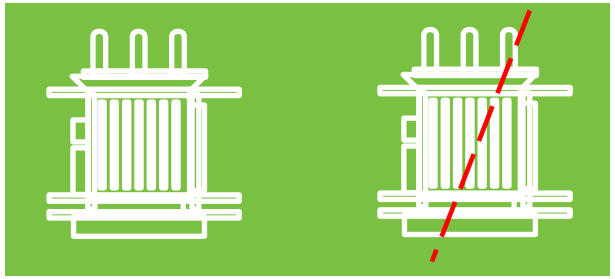
Stage 1



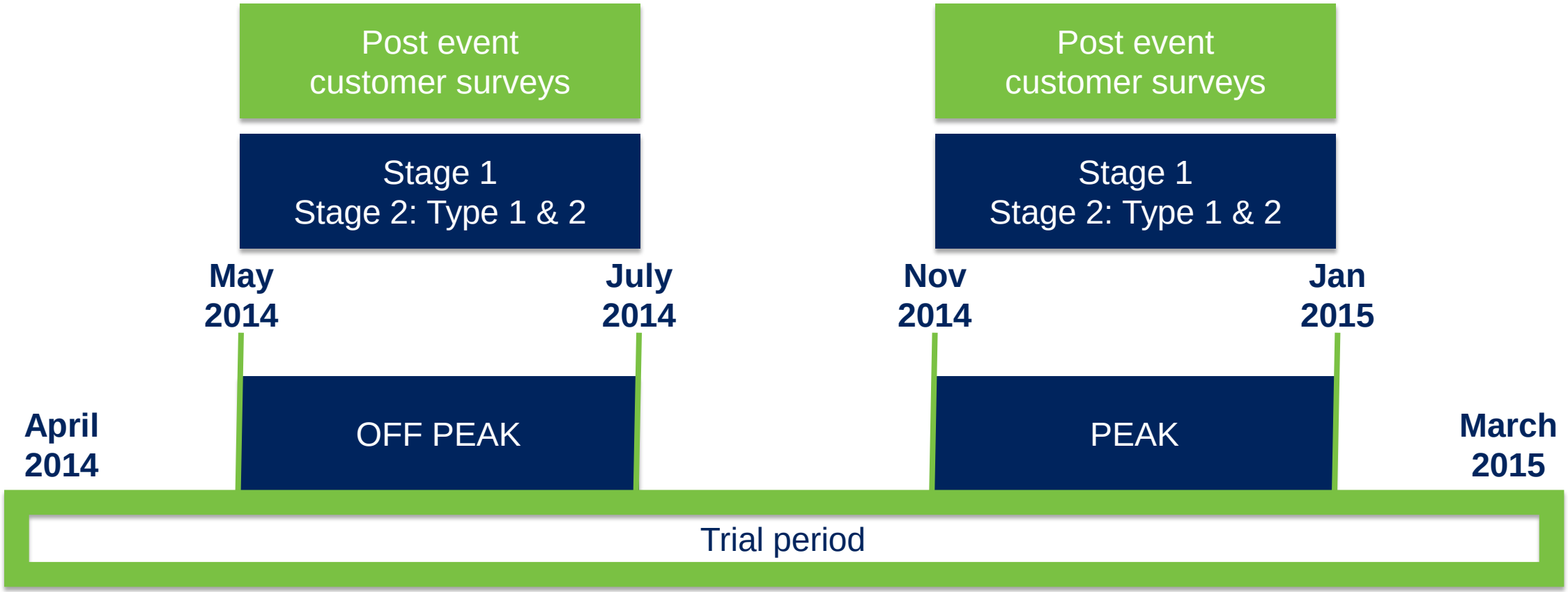
- Detection of a low frequency threshold
- Tripping one of a pair of parallel primary transformer
- Instantaneous change in voltage
- Response time ~ 2 sec
- Duration – 30 minutes

Stage 2

Tap position

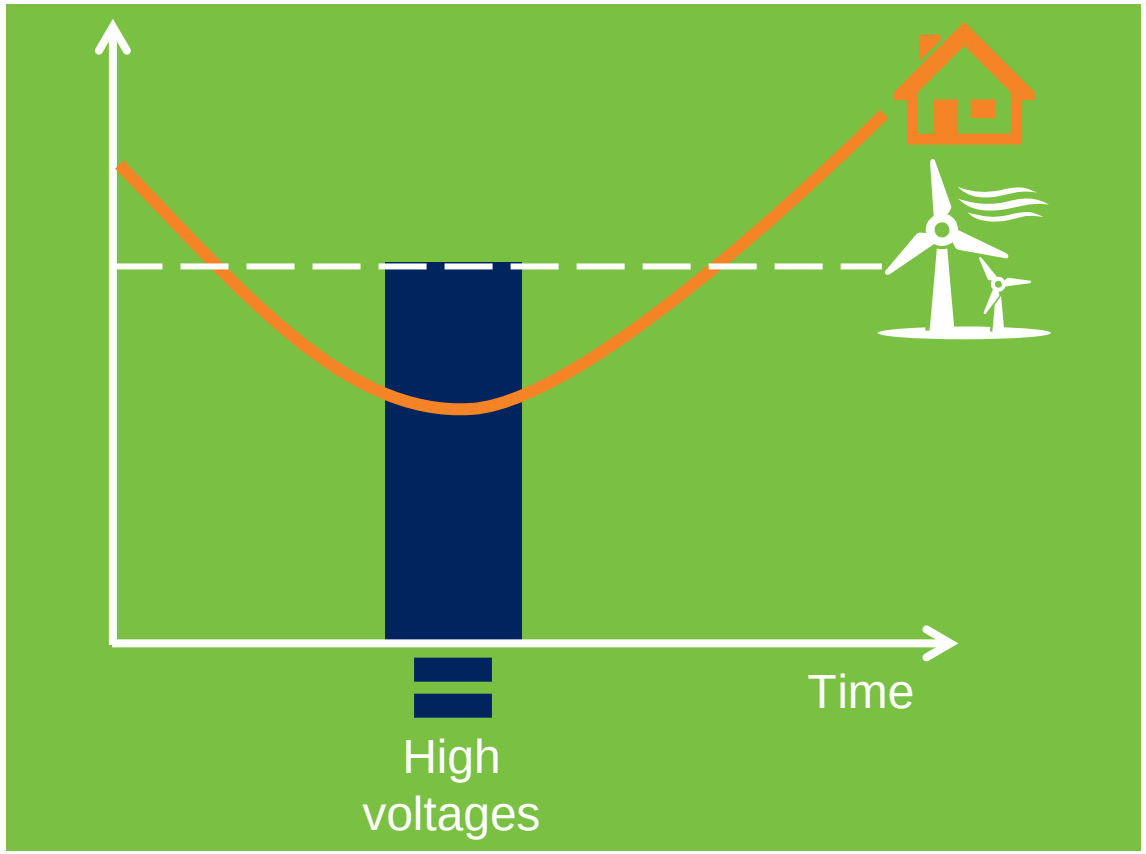
- Initiated from dashboard or detection of a low frequency threshold
- Reduction in HV voltage through change in tap position
- Response time – 30 sec to 2 minutes
- Duration – 30 minutes

Trial 3 – Testing approach

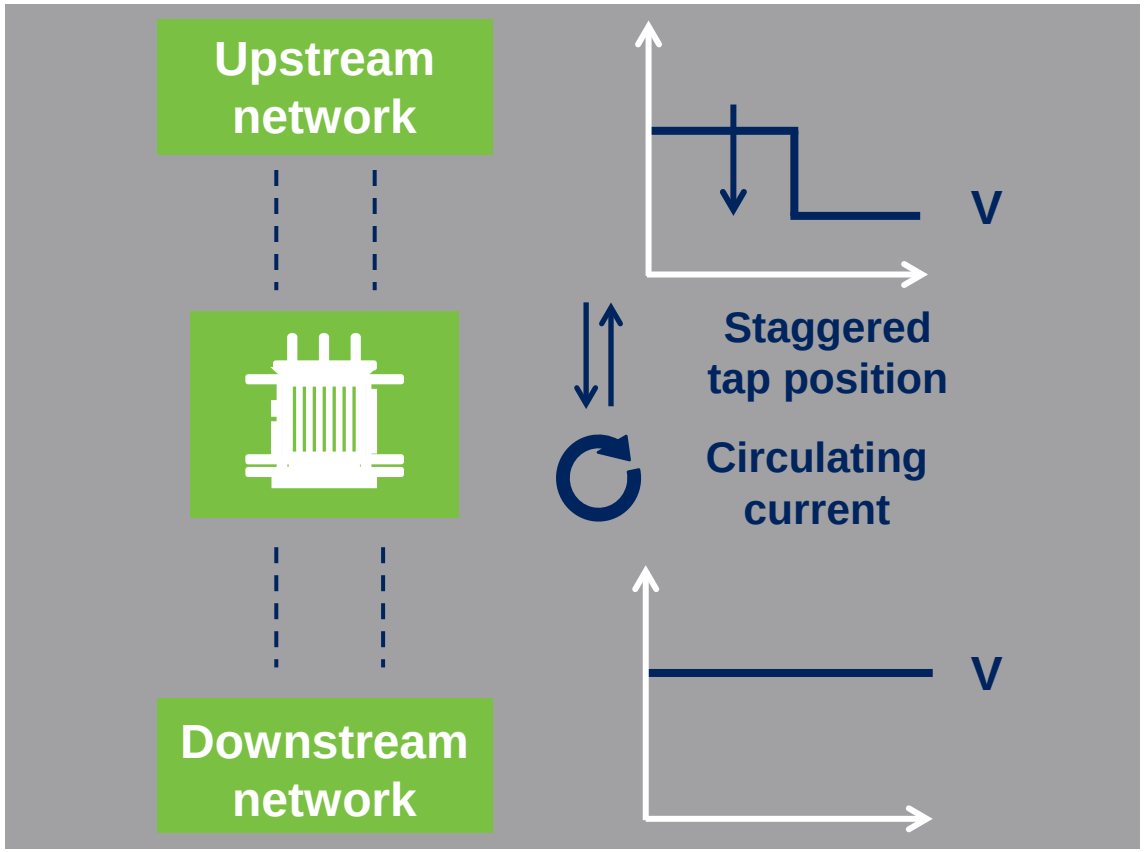


Trial 4 – Reactive power absorption

Demonstrate CLASS can be used to manage excessive system voltage typically at times of high generation output but low demand



Method of implementation



Trial 4 – Approach to testing

Three levels of reactive power absorption capability

NGT period high

voltage period 2-6 am

ENWL period high

Voltage period 10pm – 7 am

Concluding comments

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First set of trial results available August 2014

Learning from every season

Detailed trial schedule

http://www.enwl.co.uk/docs/default-source/class-documents/

Potential benefits of CLASS to National Grid

Alice Etheridge
Balancing & Markets Manager

LCN Fund
Low Carbon Networks

nationalgrid

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Transmission UK - Electricity

nationalgrid

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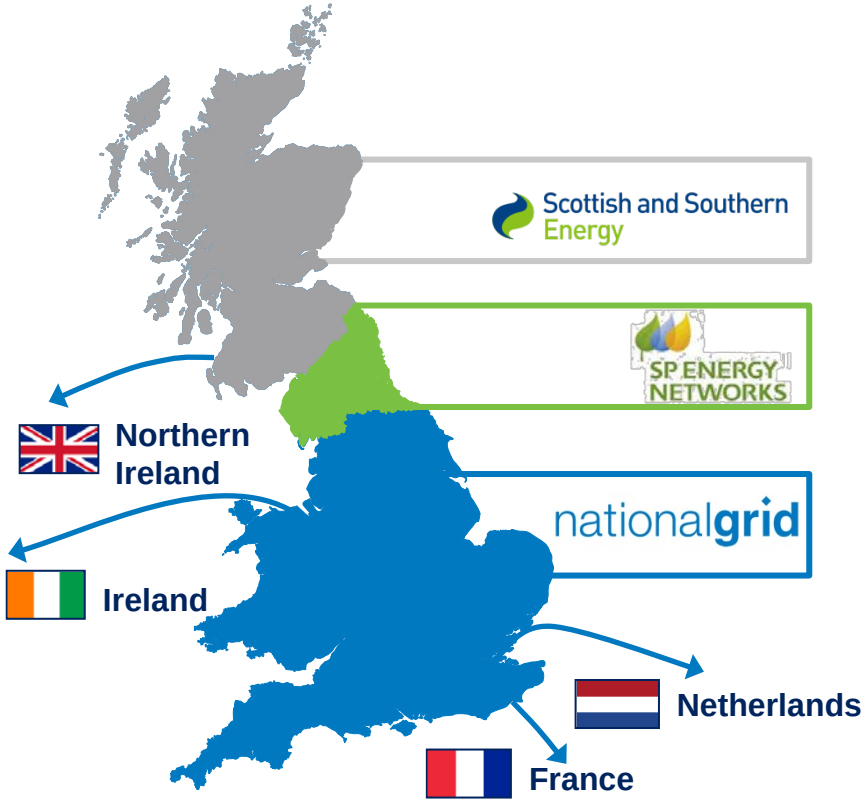

Multiple TOs

SHET

SPTL

OFTOs

NGET

One NETSO

National Electricity Transmission System Operator

National Grid Electricity Transmission

System operation: key responsibilities

nationalgrid

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System operator

Balance generation and demand	Ensure transmission constraints are managed
Over each settlement period On a second by second basis Procure sufficient reserve volumes	Ensure voltage is kept within strict limits Ensure thermal and stability limits are not breached

The royal wedding gives an idea of what we need to manage

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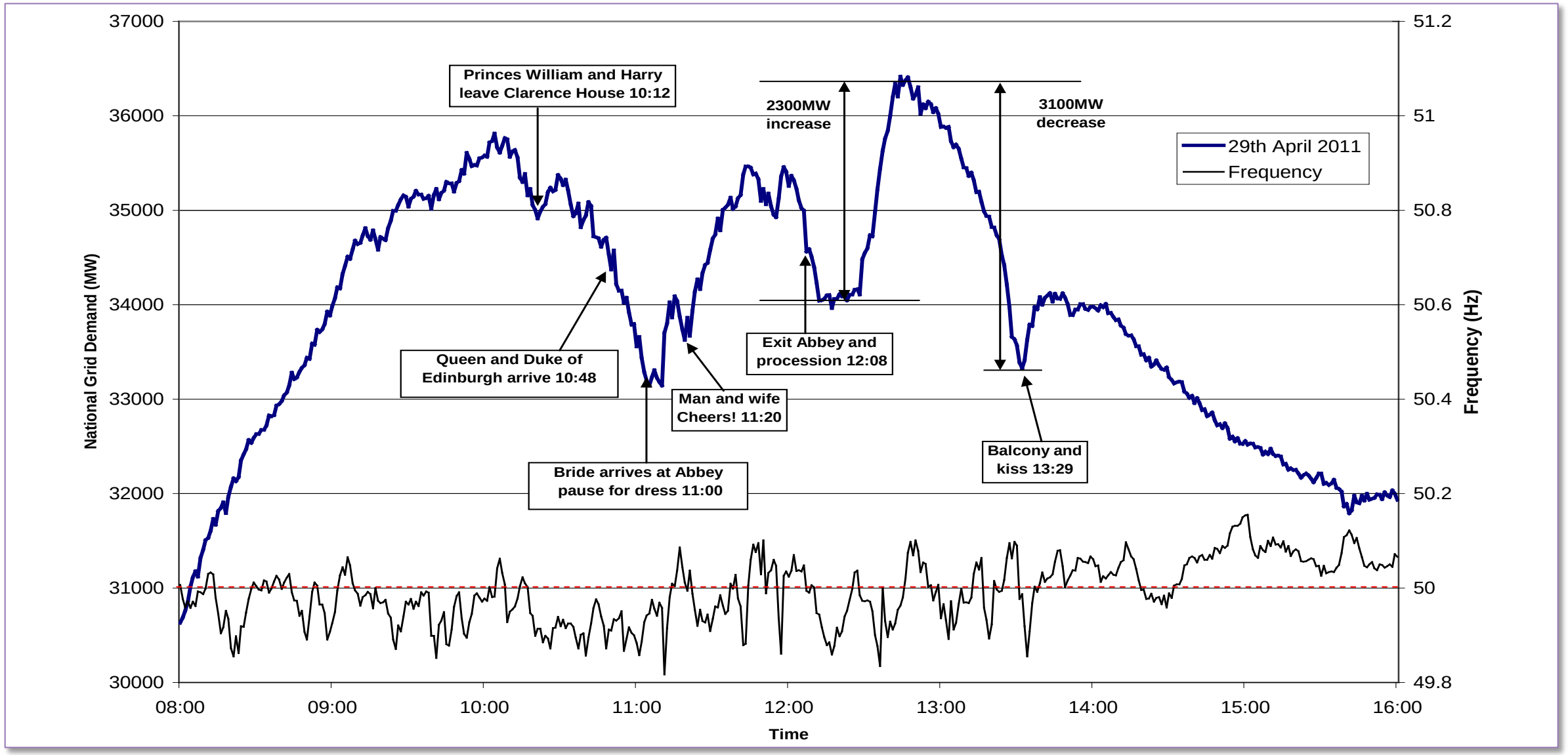
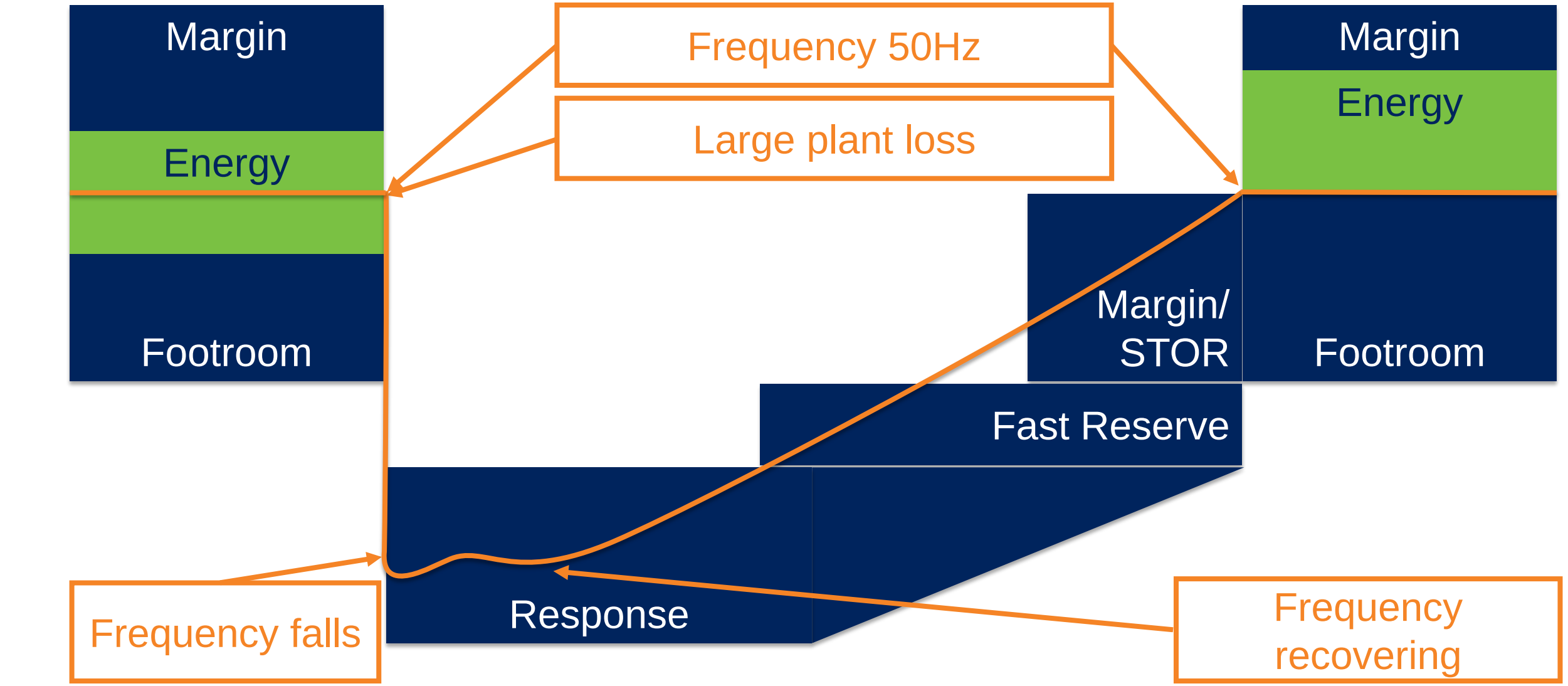


We use balancing services to help manage the frequency



Our generation and demand are changing over the coming years

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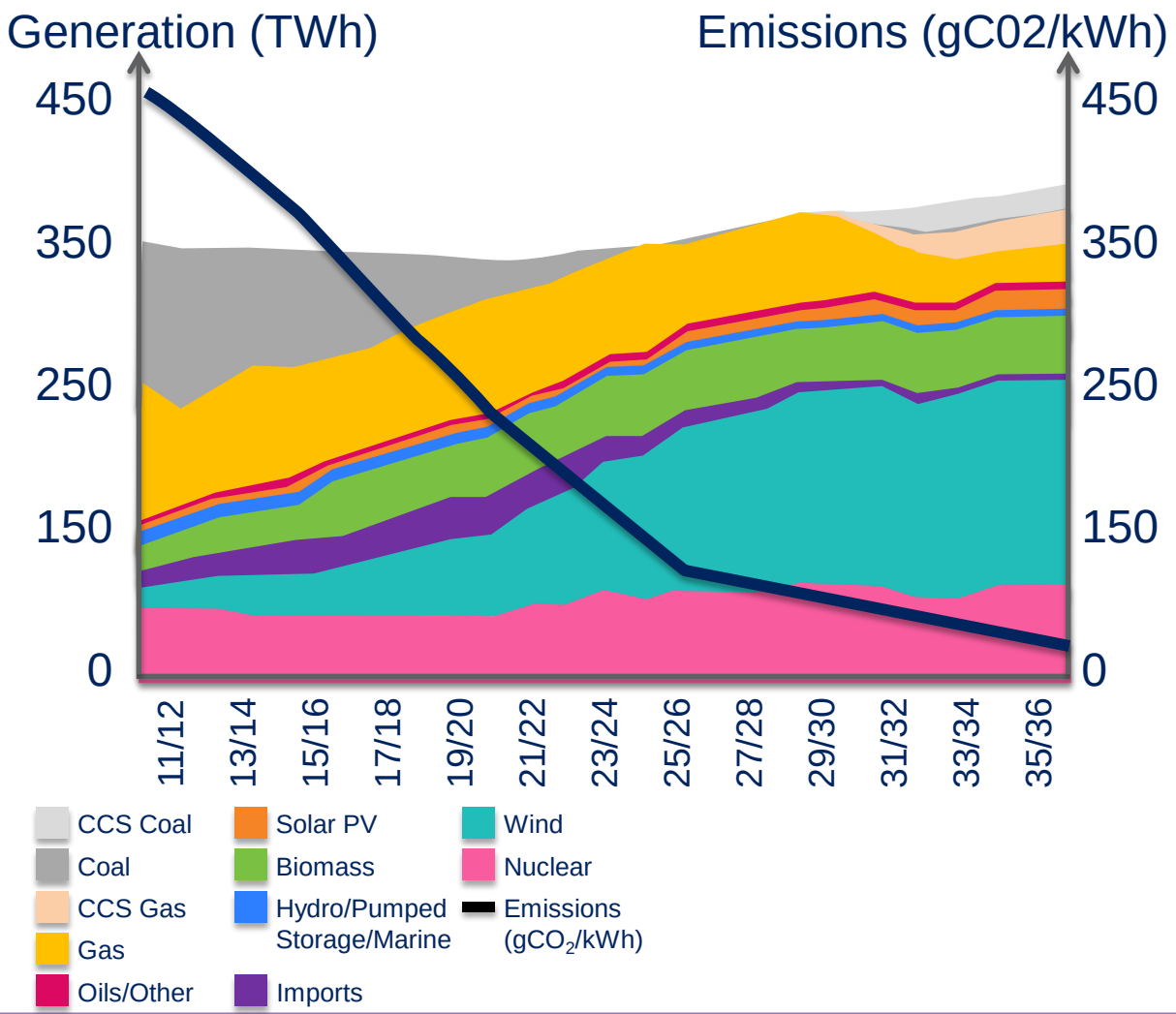
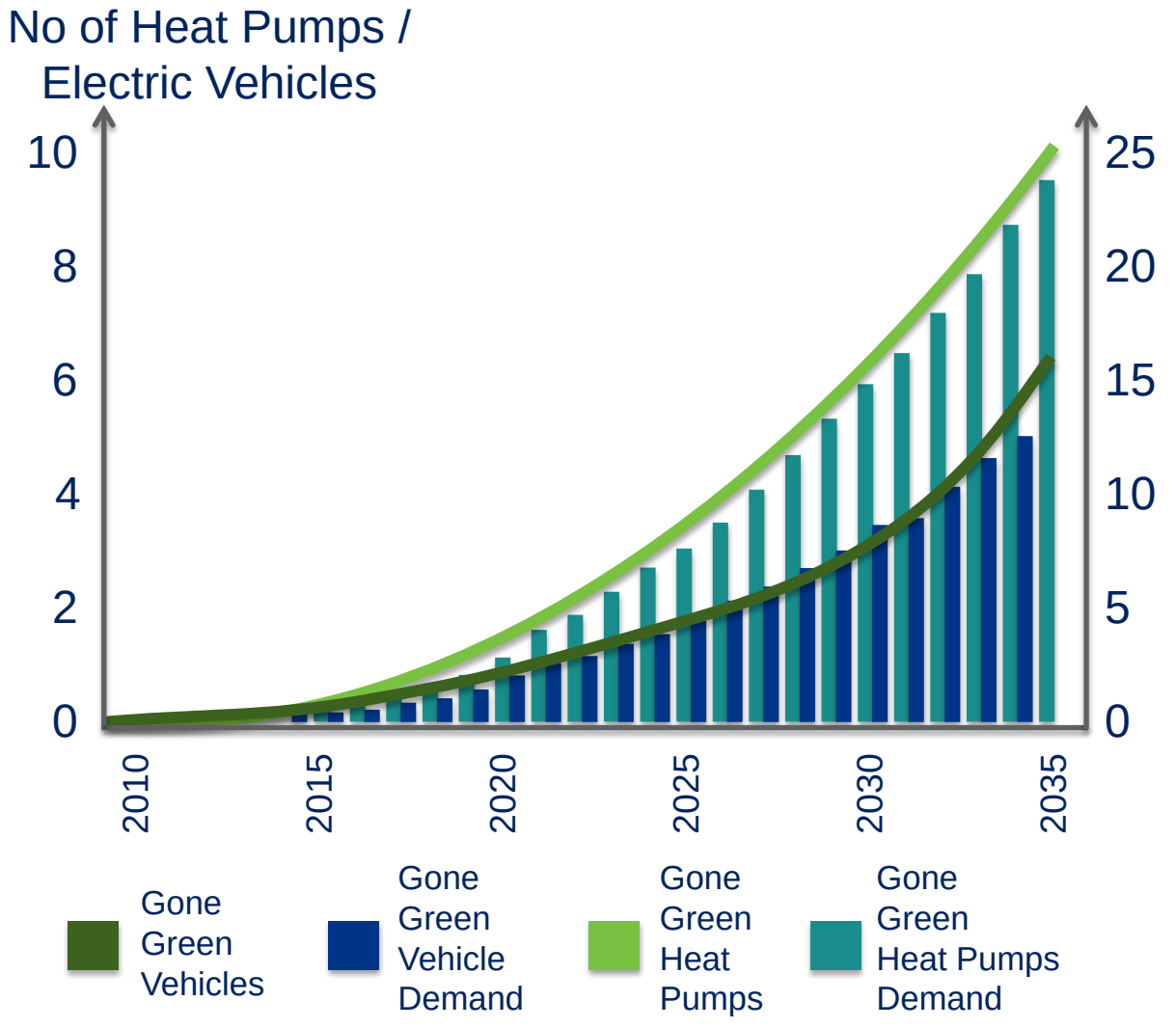
GB generation by fuel type – Gone Green



Cumulative numbers & associated load (TWh)



These changes are likely to bring new challenges and opportunities to managing supply and demand

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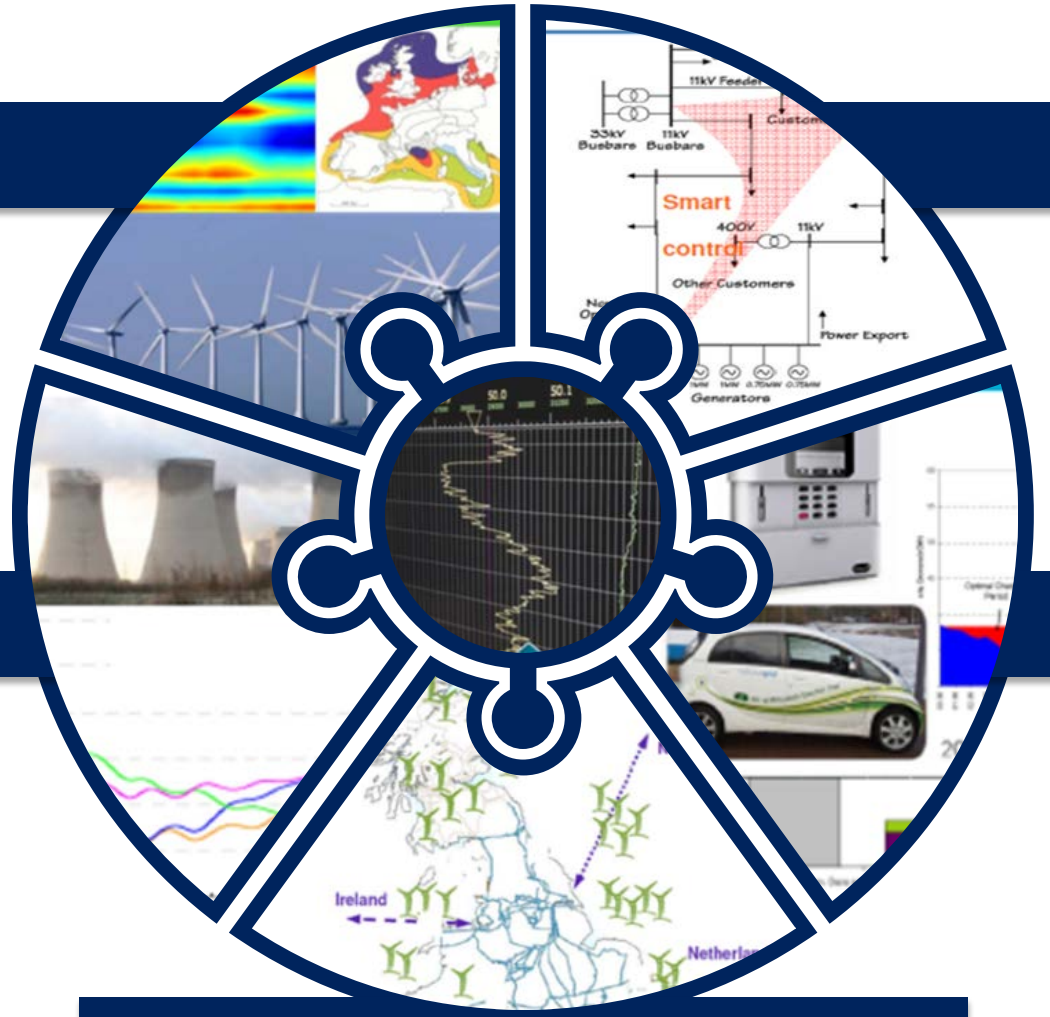
Variable generation

Active distribution



Large generation

Active demand

Greater interconnection

Innovative approaches such as CLASS have the potential to help us manage the challenges more cost effectively

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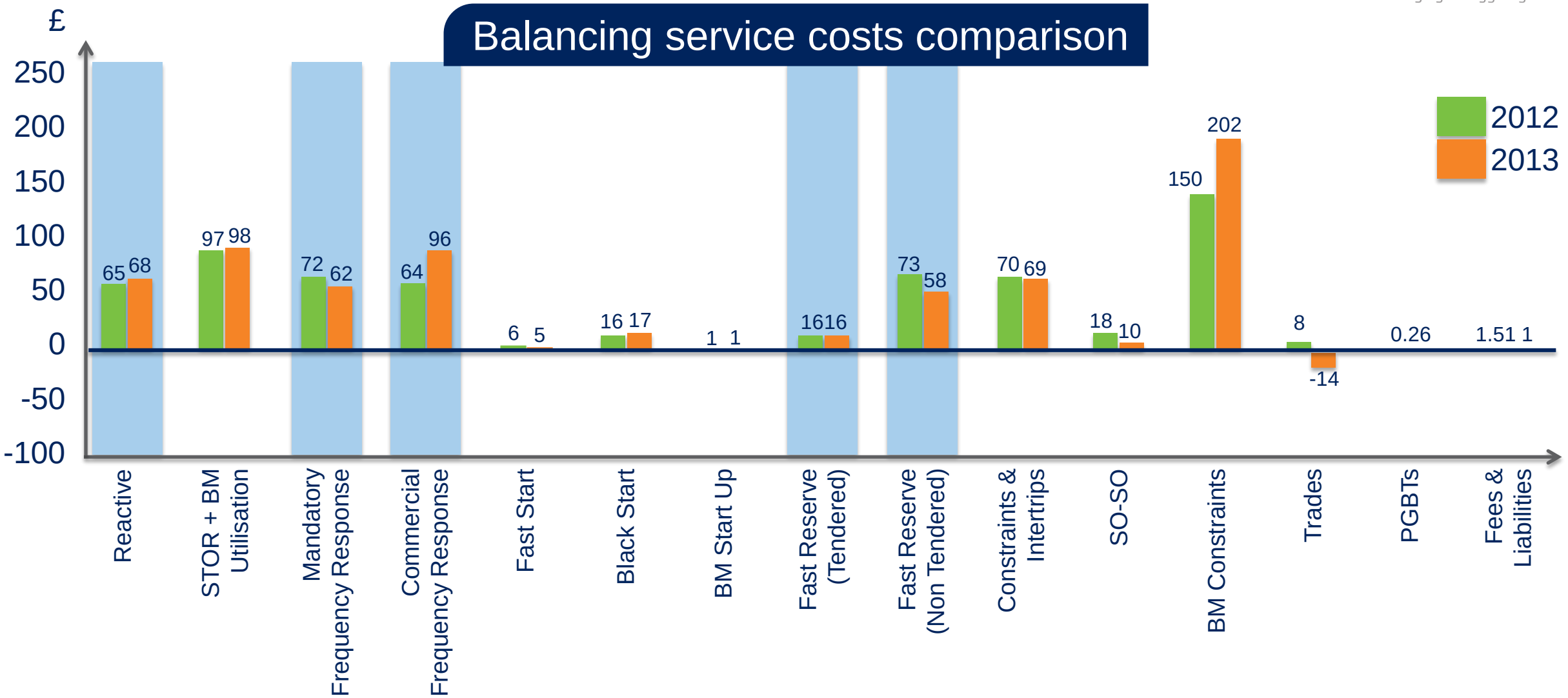
Balancing service costs comparison



And contribute to a smart energy system, integrating transmission and distribution

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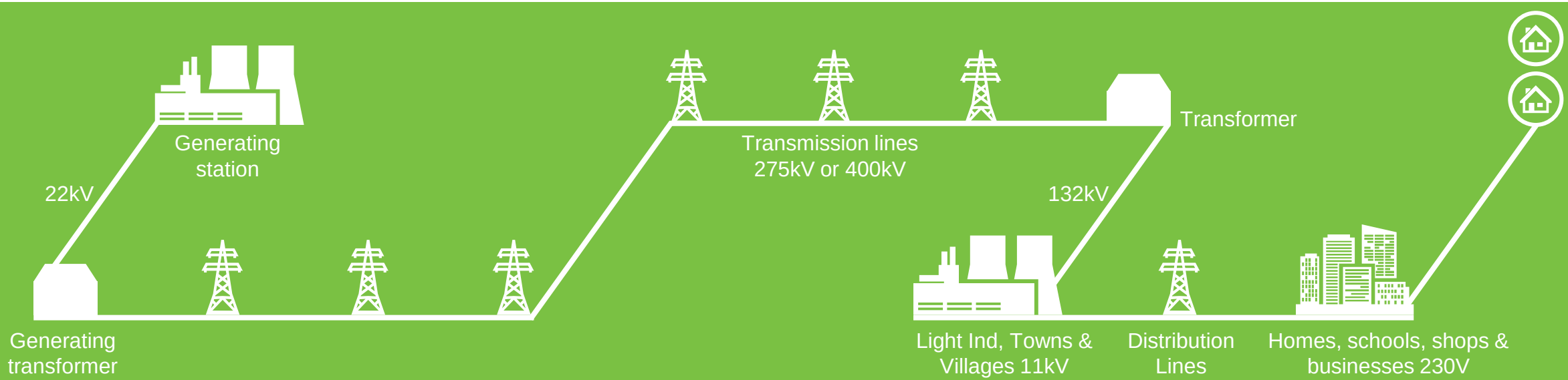
Transmission

Distribution



HVDC
Humber Smart Zone
Optimised Quad Boosters

CLASS (ENW)
Smarter Network Storage (UKPN)

Design, installation and commissioning of Autonomous Substation Controllers (ASC)

Julian Nash
Project Manager, Siemens

LCN Fund
Low Carbon Networks

SIEMENS

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The role of Siemens on CLASS

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SIEMENS

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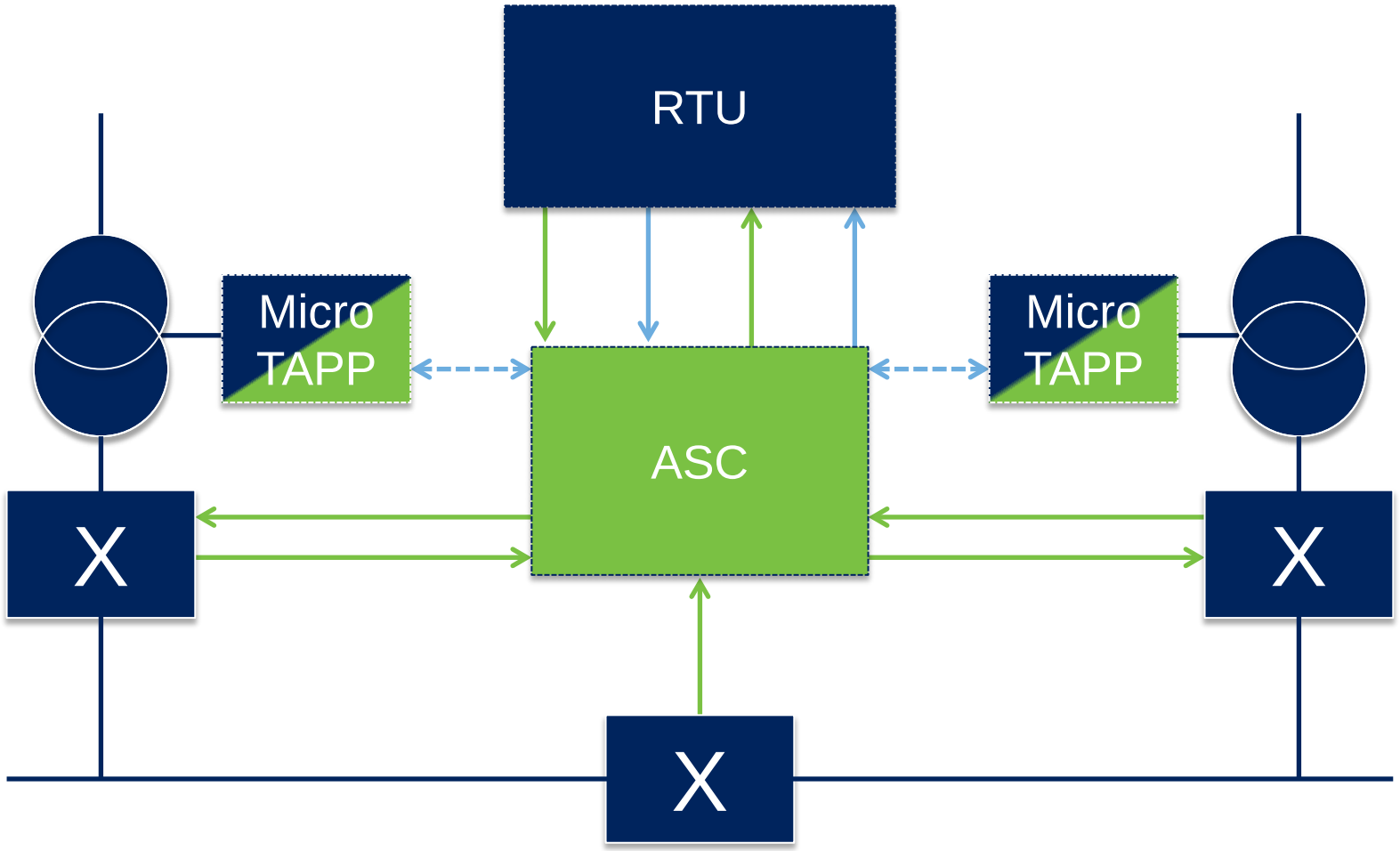
Design	Manufacture	Test	Install	Commission
Autonomous Substation Controller (ASC)	New Microtapp AVC's		Argus 8 interface to existing AVC	
60 sites	30 of 60 sites		10 of 60 sites	

How it all fits together....



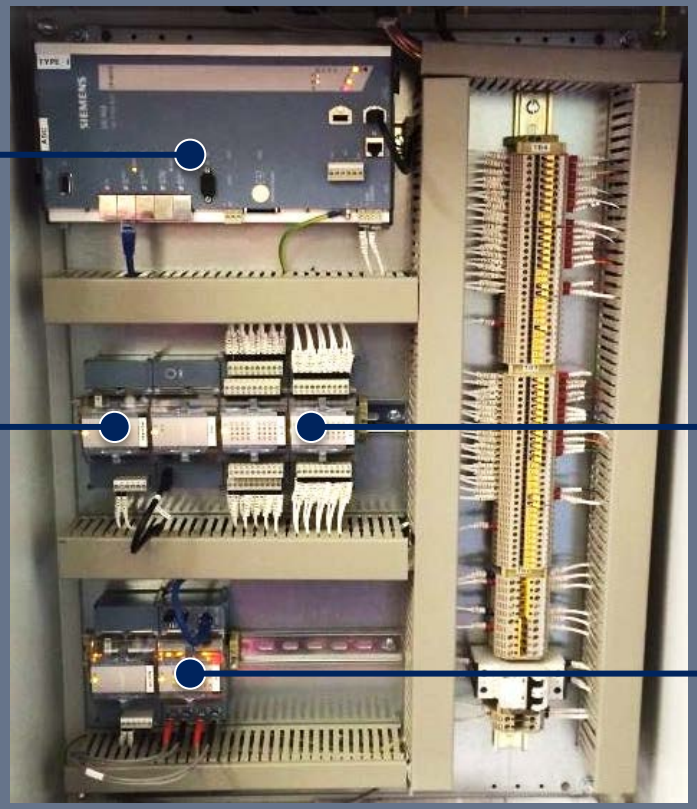
CLASS installed equipment

Existing equipment

TM1703 ACP hardware

Master control unit

Power supply units



Input / output units

Fibre optic converter unit

What is the ASC?....

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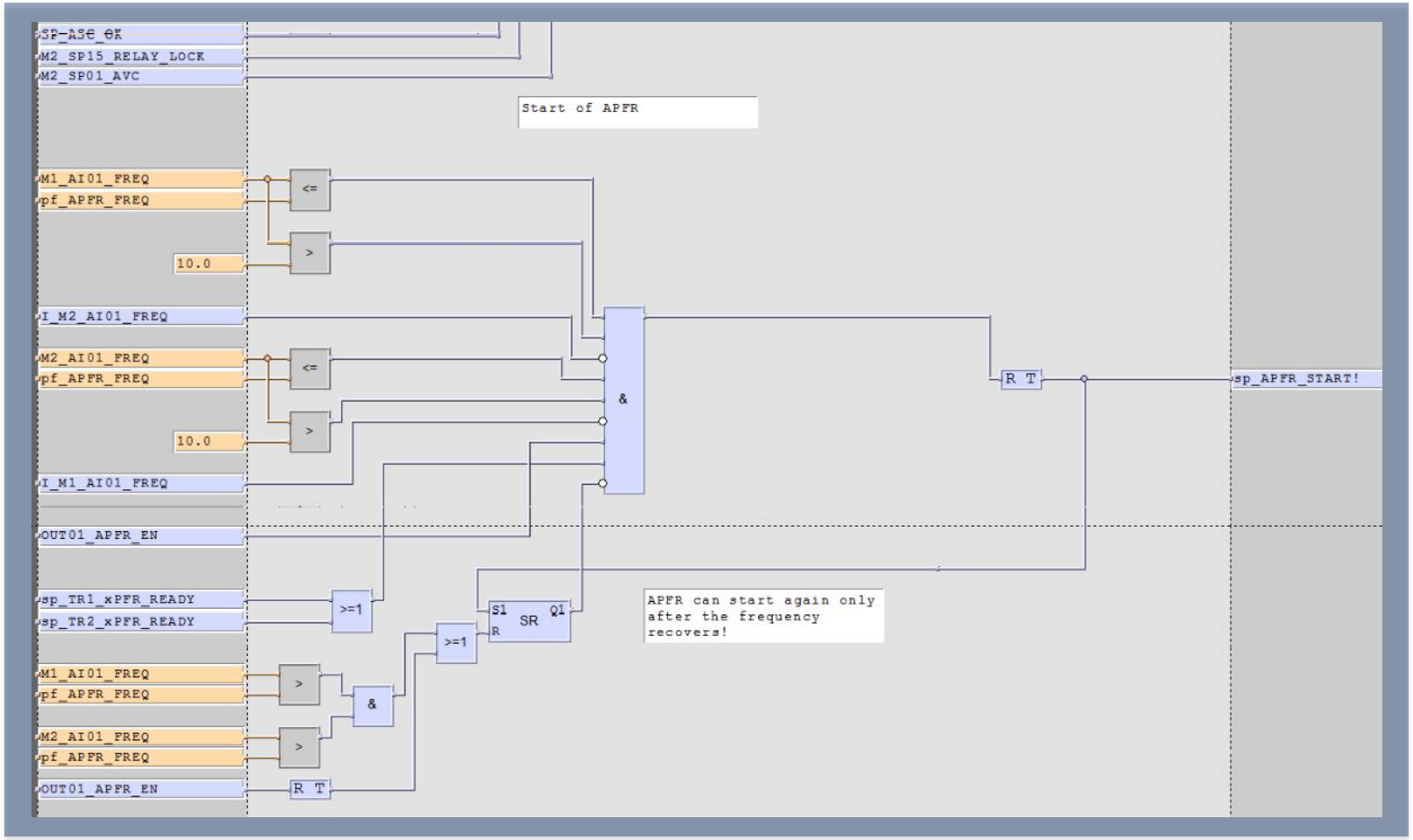
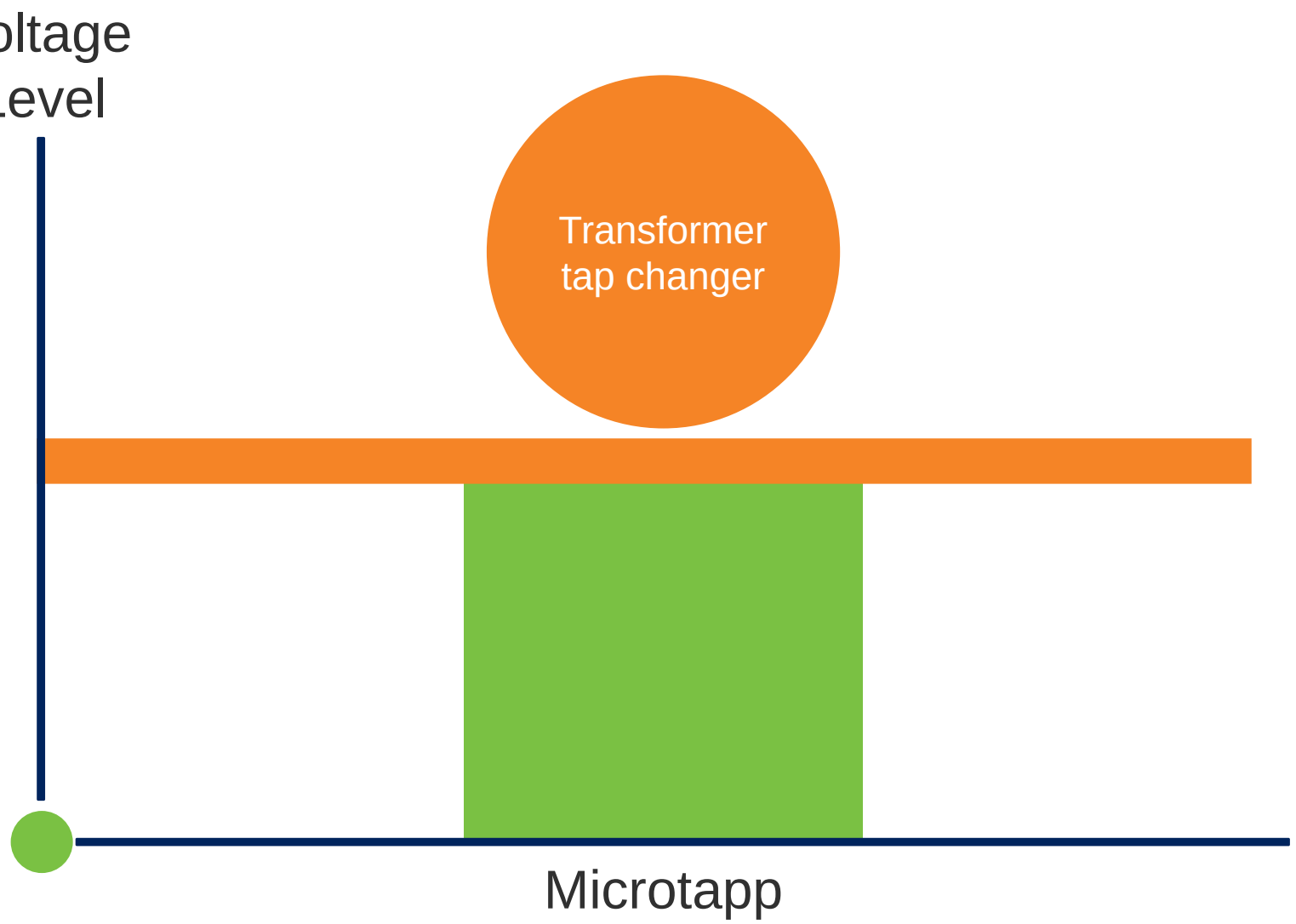
“Toolbox” software



What is a Microtapp?...

AVC

Automatic Voltage Controller (AVC)



What is a Microtapp?....

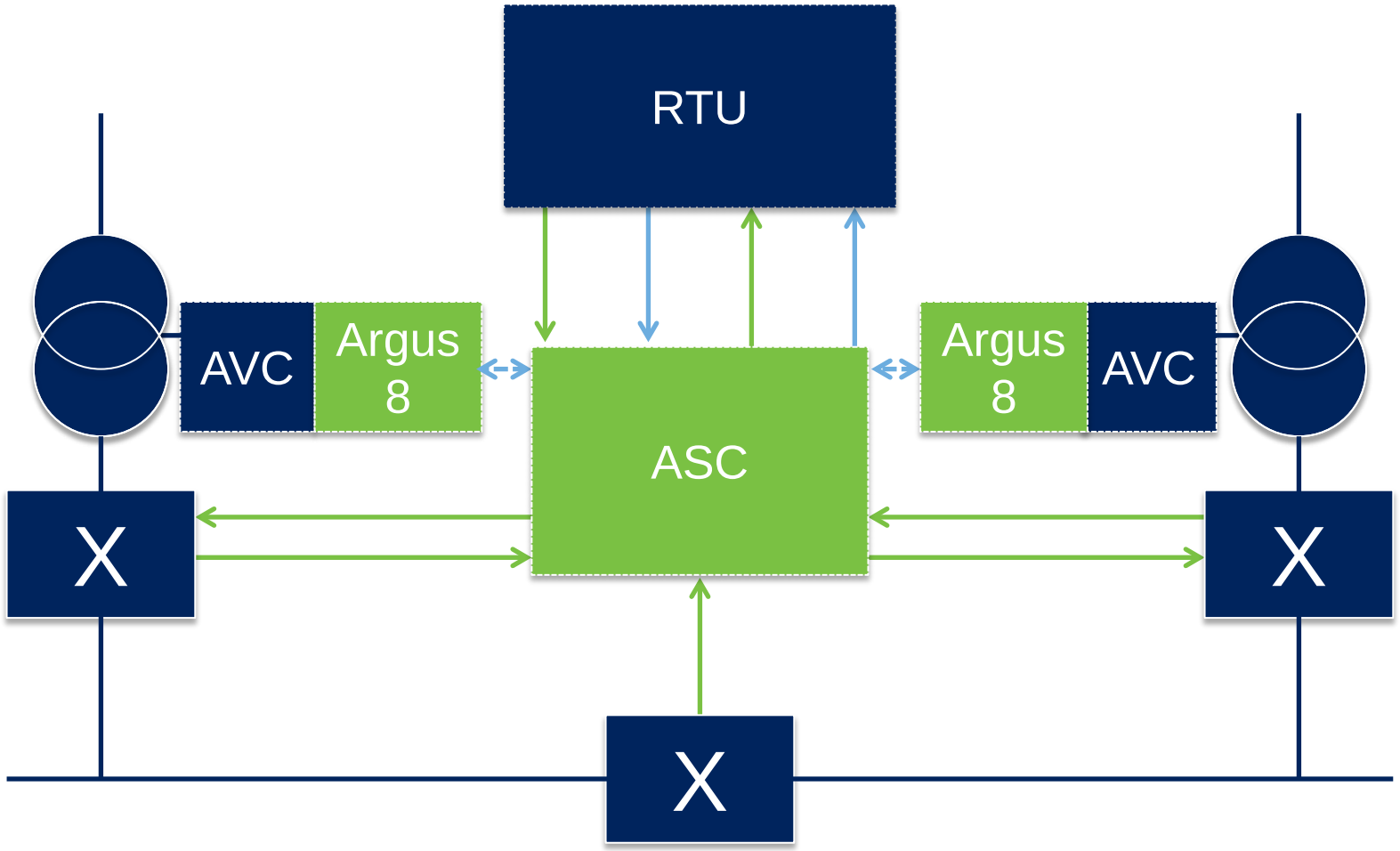
Do we have to use Microtapps on CLASS?

The answer to the above question is NO

We have devised an interface solution which allows an ASC to control an older (non-computerised / non-Microtapp) type of AVC

This solution is actually cheaper, but it cannot carry out as many functions as the Microtapp solution (ie no tap stagger)

CLASS – Substation overview with Argus 8 interface to existing AVC



CLASS installed equipment

Existing equipment

CLASS – Argus 8 AVC interface

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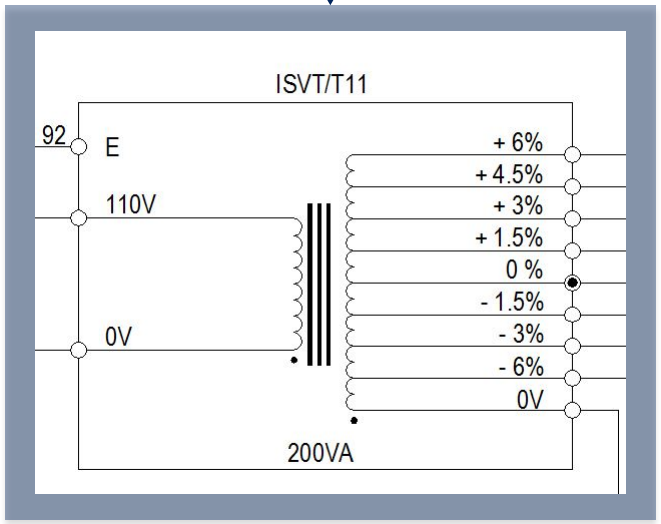
Argus 8 - standard SIEMENS product custom made stepped VT



The full on-site solution with Microtapps...

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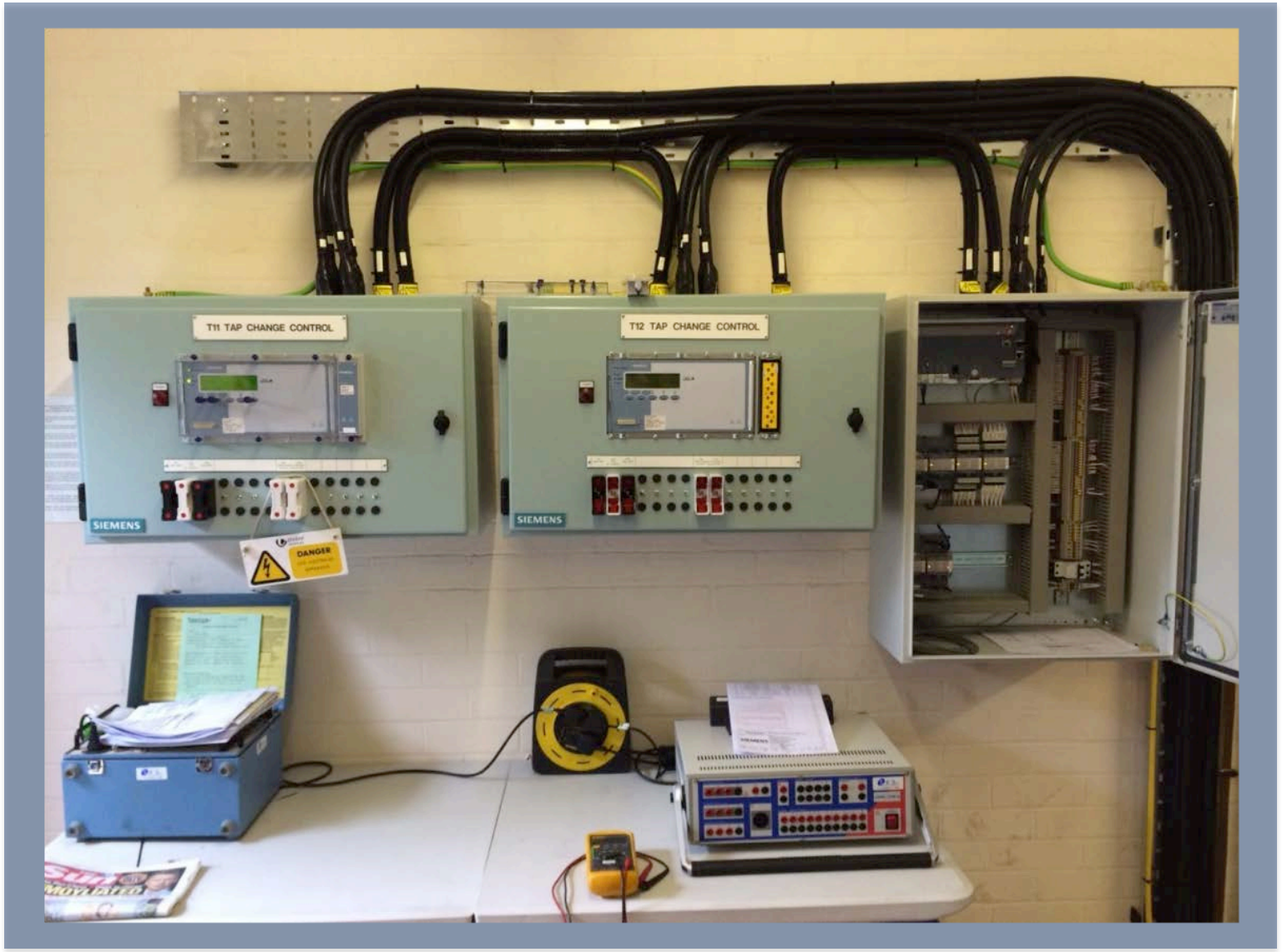

What does the ASC do?...

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CLASS Functions

Voltage Management
Demand Boost Function (DBF)
Demand Reduction Function (DRF)
Automatic Demand Reduction Function (ADRF)

Frequency Management
Manual Primary Frequency Response (MPFR)
Automatic Primary Frequency Response (APFR)
Automatic Secondary Frequency Response (ASFR)

Reactive Power Management
Tap Stagger Function (TSF)

Lessons learnt

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Replacing old AVCs with new Microtapps is the most time consuming activity

Configurations in ASC and Microtapps cannot be changed remotely

Poor power flow quality causes complications

Outage limitations require careful planning and scheduling

ASC functions limited to 16 inputs on DI module

System design ahead of functional design

Argus 8 not the optimal relay for the job

What next for the ASC?...

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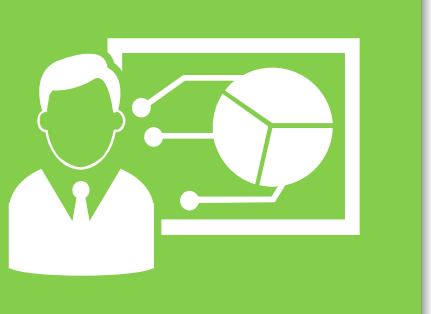
Functionality could be expanded

Argus

Replace Argus 8 with Argus C or ASC

Remote communications with ASC



Monitor and evaluate performance

Nationwide rollout

The voltage-demand relationship

Can it be better exploited?

Dr Luis (Nando) Ochoa

LCN Fund
Low Carbon Networks

MANCHESTER 1824

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Outline

Future electricity systems

Voltage-demand relationship

CLASS

How CLASS will affect customers?

Aggregated demand response

Key remarks

Future electricity systems

Load will continue to grow

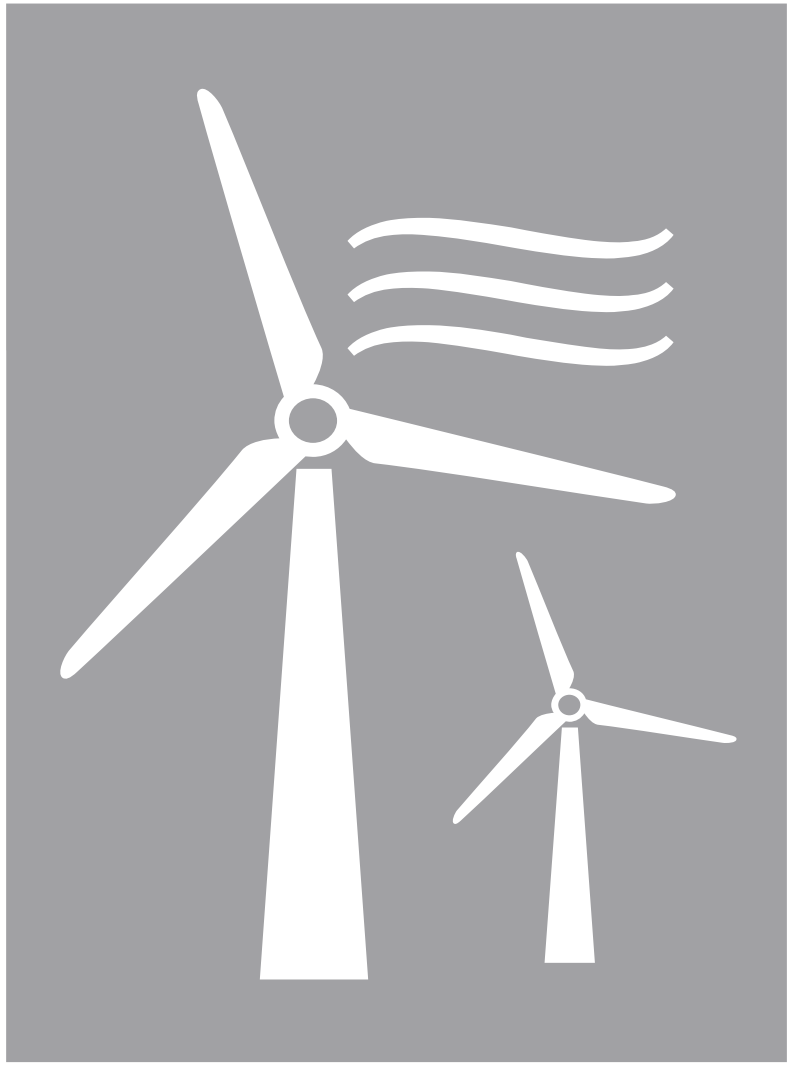
Reinforcements (more local and regional substations) will be required

More large-scale renewables

Conventional generation will have to be used to cover for periods without renewables

CLASS

Peak demand reduction to defer reinforcements
Peak demand reduction to help renewables

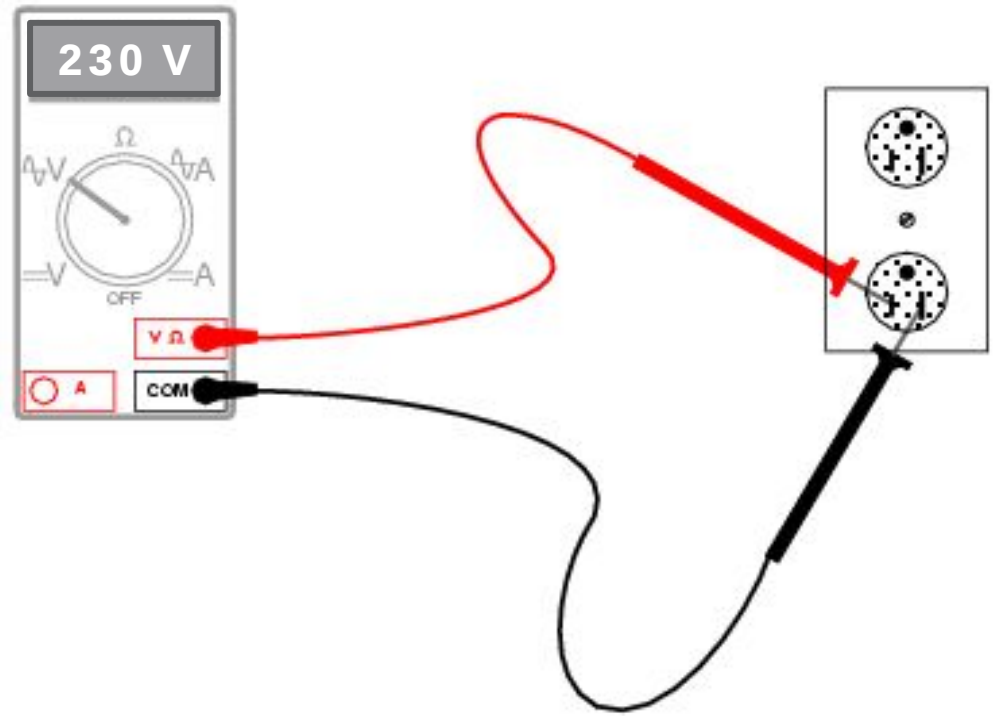


Voltage-demand relationship

How long does it take for water to boil?

Voltage-demand relationship

4 minutes



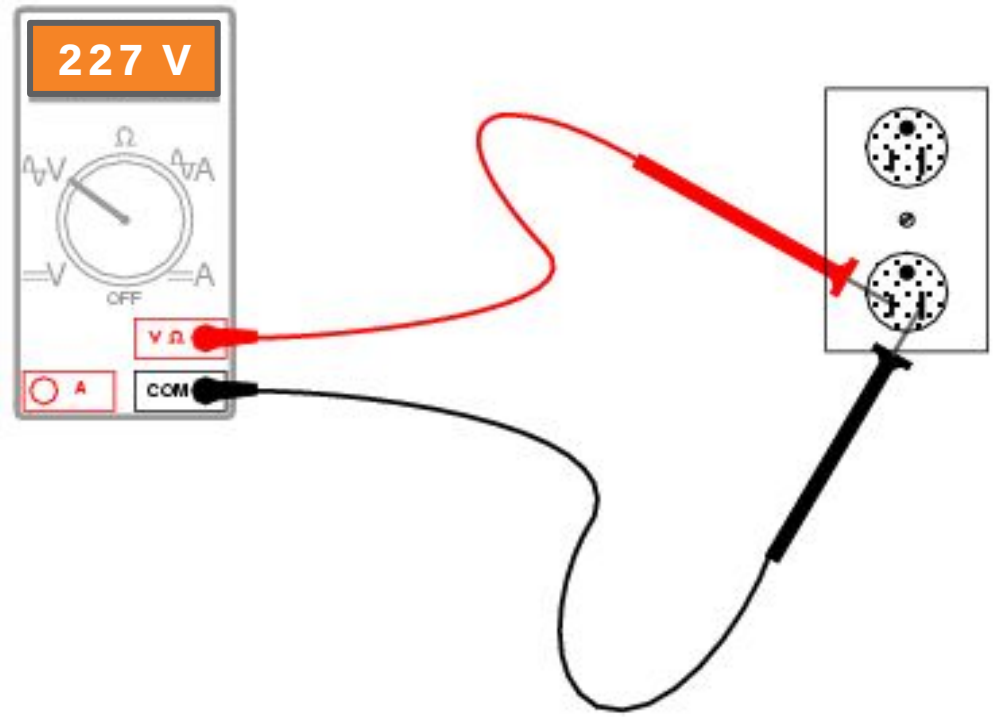
V=230 V

P=2000 W

Voltage-demand relationship

4 minutes

+8 seconds

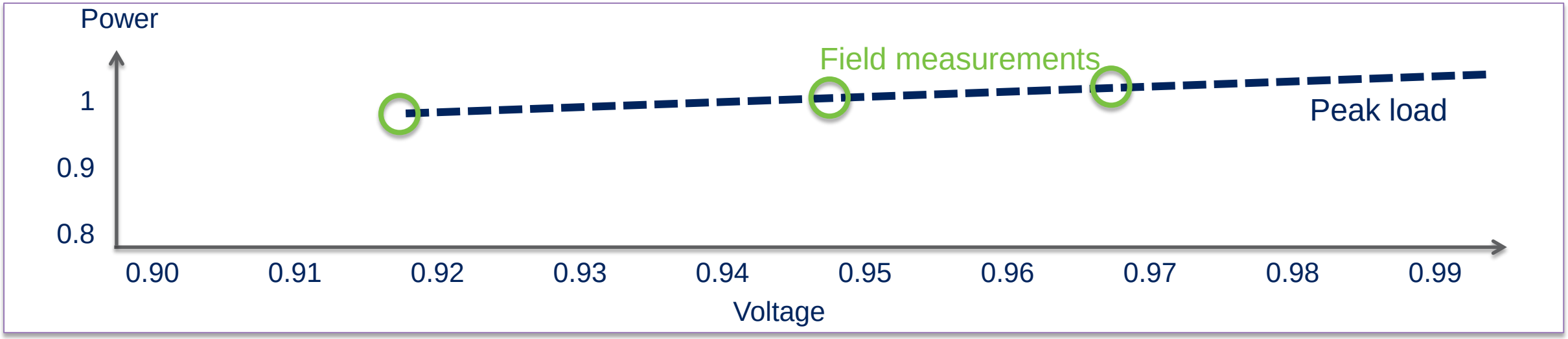


V=227 V
P=1940 W

Voltage-demand relationship

Field tests in New York, 2013

M. Diaz-Aguilo et al., “Field-validated load model for the analysis of CVR in distribution secondary networks: Energy conservation,” IEEE Trans. on power delivery, 28, 4, 2428-2436, 2013

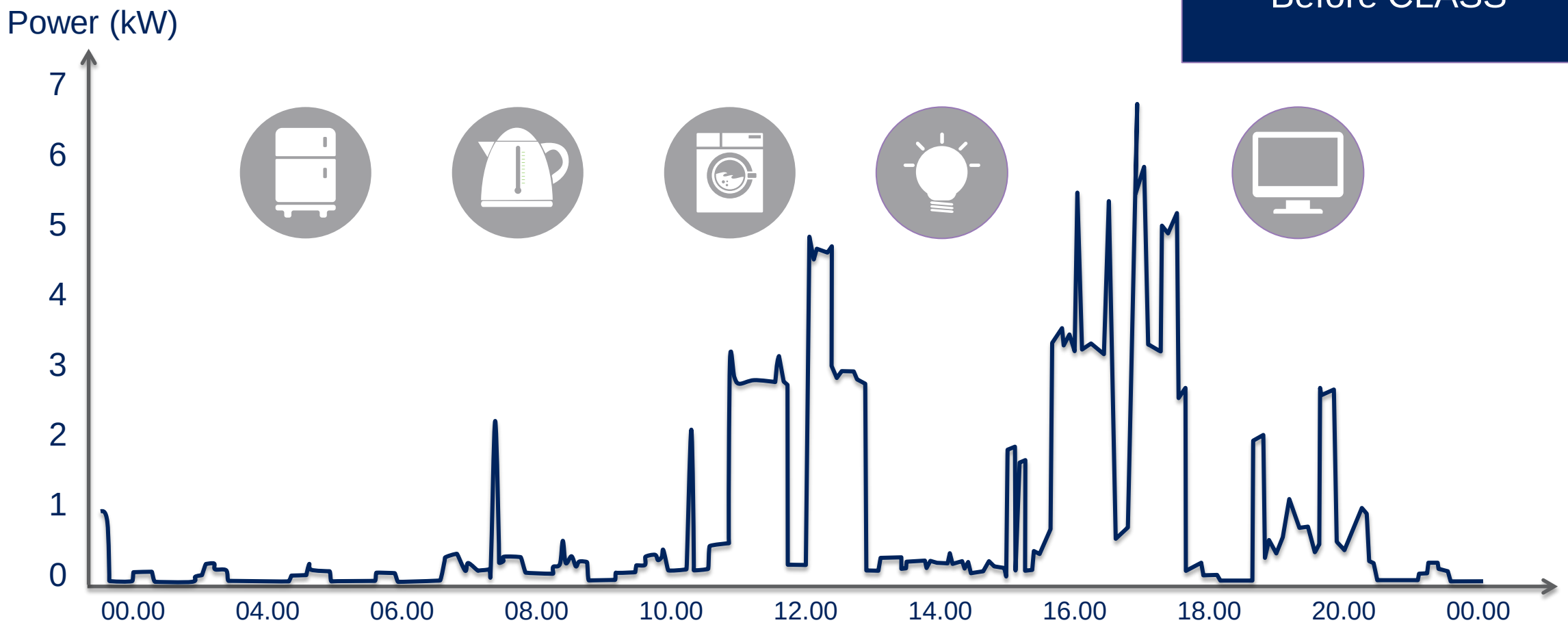


Voltage down ⊙ Power down

Voltage up ⊙ Power up

How CLASS will affect customers? *Example*

Before CLASS



How CLASS will affect customers? *Example*

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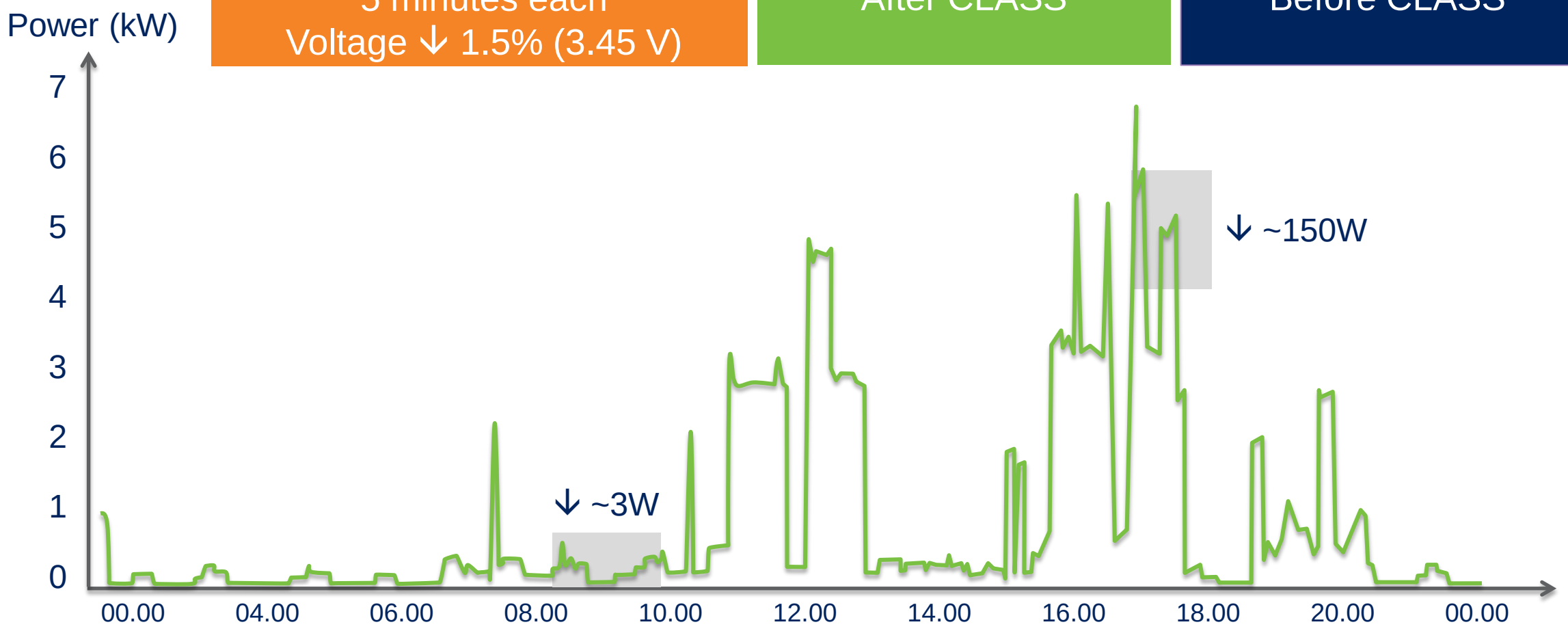
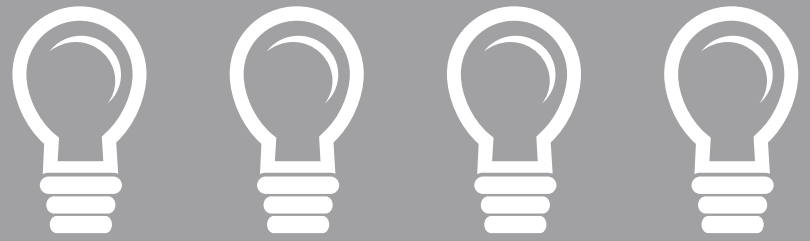
Two actions
5 minutes each
Voltage ↓ 1.5% (3.45 V)

After CLASS

Before CLASS



How CLASS will affect customers? *Example*

DAILY Max power reduction ~150 W	DAILY Energy reduction ~0.015 kWh
	
2.5 light bulbs	0.7 tea mug

How CLASS will affect customers? *Voltages*

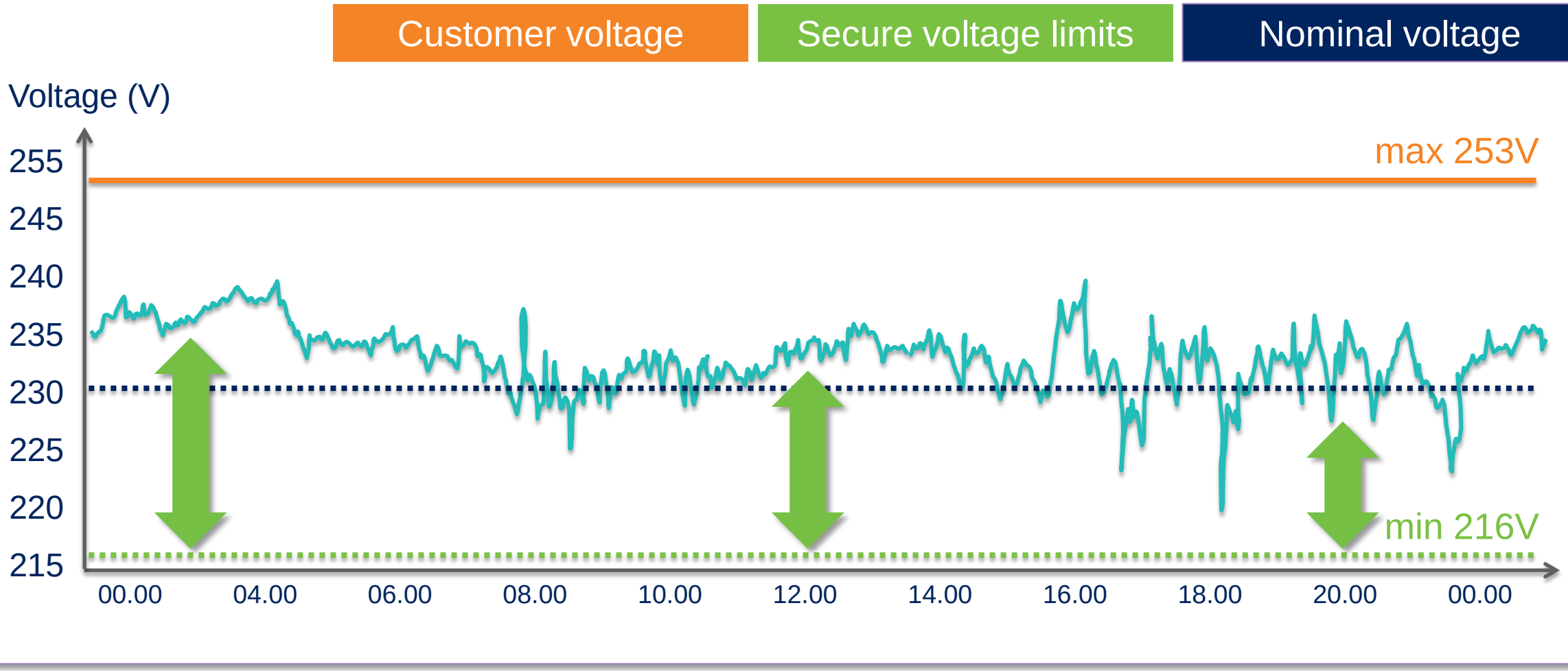
Are the voltage changes OK for our appliances?

Voltage variations are normal throughout the day

Most appliances are designed to work with these variations

How CLASS will affect customers? *Voltages*

Headroom for safe voltage variation



Aggregated demand response

Demand changes at customer level are almost unnoticeable
but when aggregated it could be significant

V ↓ 3%, winter

Power reduction ~600 houses

Active power response

Aggregated demand response

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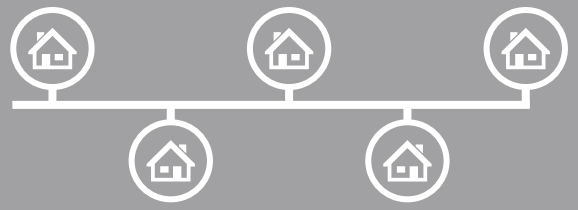
ENWL area (~2 million domestic customers)

First estimation:
140 MW peak reduction



Can we quantify this
in real time?

Key remarks

CLASS

Exploit the relationship between demand / voltage

Avoid/defer network investments

Host more renewables without the extra costs

Quantifying the responsiveness

of demand and voltage headroom

throughout the day

Challenge

QUESTIONS & ANSWERS

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Wrap up & Close

Steve Cox
Head of Future Networks

LCN Fund
Low Carbon Networks

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Summary

CLASS is seeking to exploit the relationship between voltage and demand

Lessons have been learned during the installation phase, that can be integrated into any future ‘roll out’

The trials will confirm the efficacy of CLASS and will illuminate further lessons and learning for future ‘roll out’

We will continue to keep you informed throughout

What's next for CLASS?

May 2014

Sep. 2015

Trials	Data collection	Customer surveys	Analyses	Publish reports
Series of CLASS trials to commence in summer 2014	Automatic collection of data and associated monitoring	Surveys of customers in the trial area to assess perception and impact	Analyses of technical data and customer survey outcomes	Write-up and publish trial outcomes

Knowledge sharing and dissemination

Finding out more

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Future events

Thank you

very much

for attending

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