CLASS workshop

Thursday 9 July 2015

LCN Fund
Low Carbon Networks

electricity north west
Bringing energy to your door

Introduction

Steve Cox

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Agenda

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CLASS
Customer Load Active System Services

Introduction	CLASS structure and technology	Demonstration
Lunch		
Customer engagement	Academic research	Closedown activities

Introducing Electricity North West

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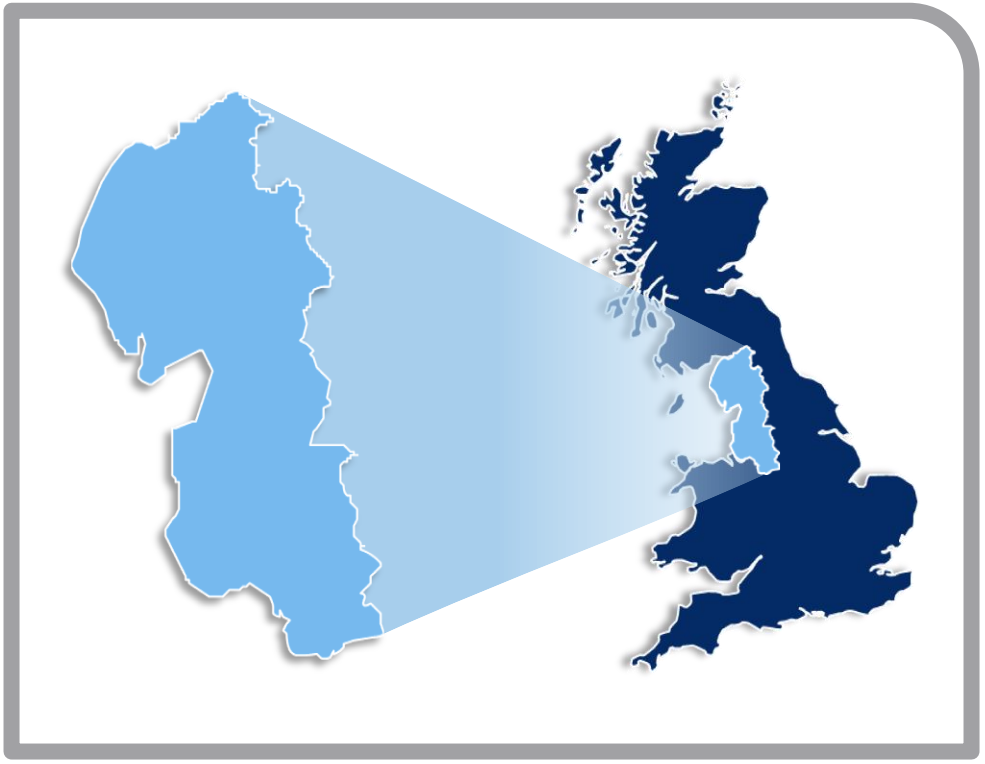
4.9 million

2.4 million

25 terawatt hours



£12 billion of network assets

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

Our innovation strategy

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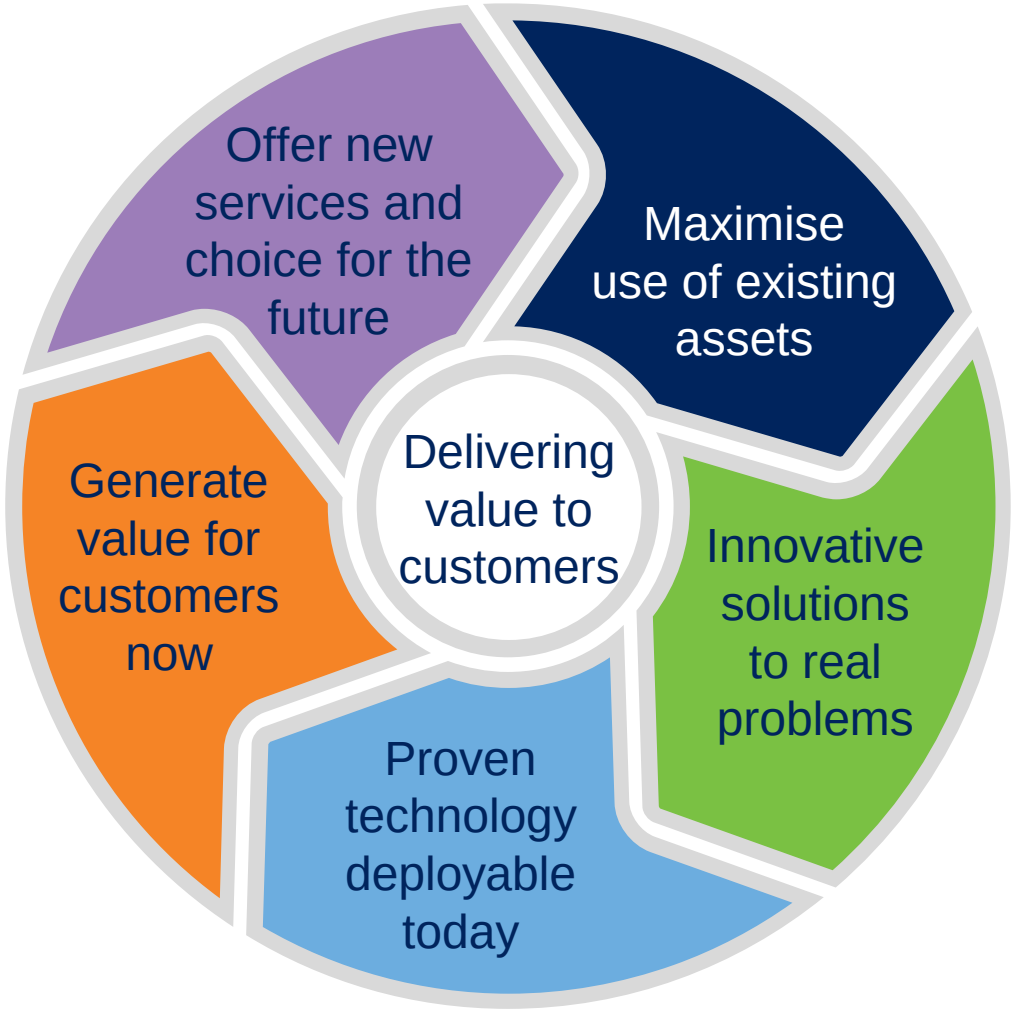

Our smart grid development

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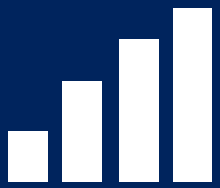
Leading work on developing smart solutions



Deliver value from existing assets

Customer choice

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Four flagship products (second tier) £36 million

C2C
Capacity to Customers

CLASS

SMART STREET

RESPOND

CLASS

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

…without any discernible impacts on customers

Customer Load Active Systems Services

Back to school for a moment…

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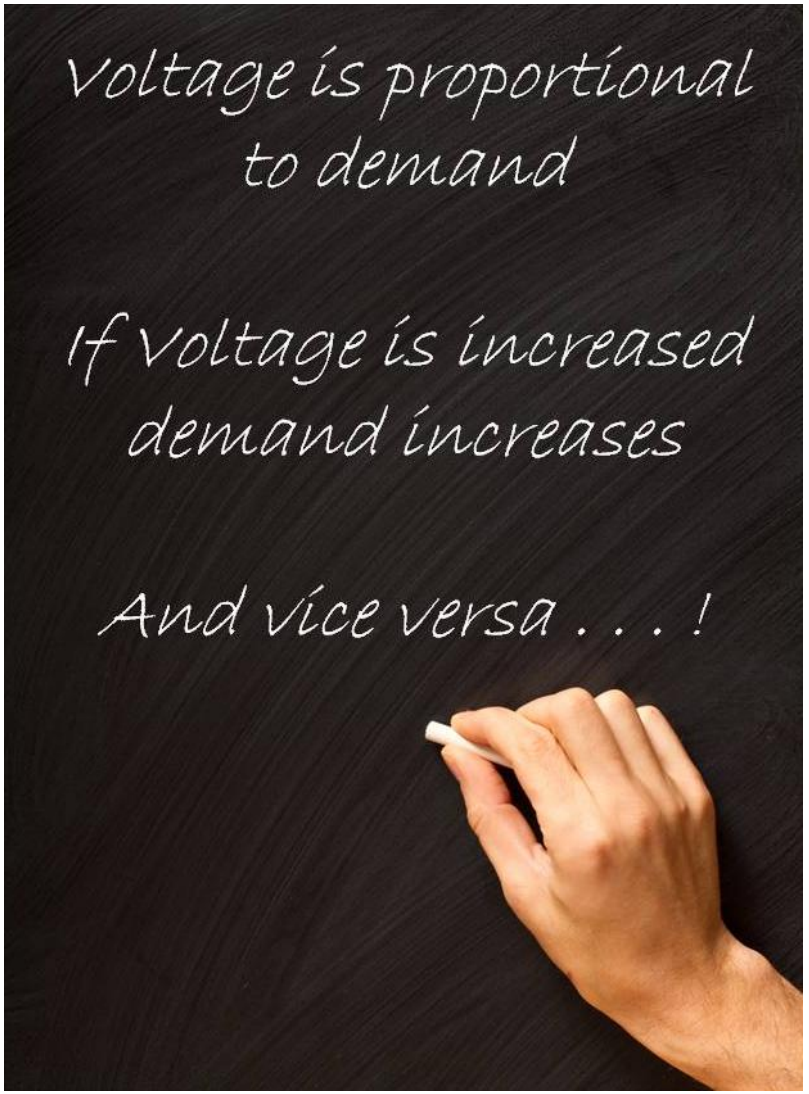
This fundamental relationship is at the heart of CLASS

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?

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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 ?

CLASS aims to harness thousands of tiny changes at just the right time

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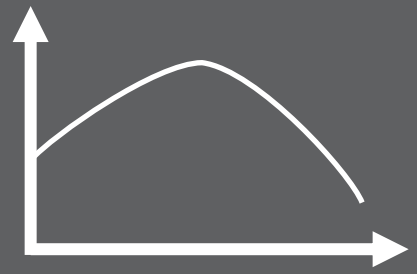
Today	Tomorrow	Future
High peak demand	Respond and reserve	Wind following
		
Lower network costs Faster connections	Lower balancing costs Reduced carbon	Lower energy costs

Our structure and partners

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Technology build	Trials and research	Customer engagement
SIEMENS PB PARSONS BRINCKERHOFF nationalgrid GE	MANCHESTER 1824 Tyndall Centre for Climate Change Research Chiltern Power nationalgrid	Impact Research

Learning and dissemination

Projected benefits

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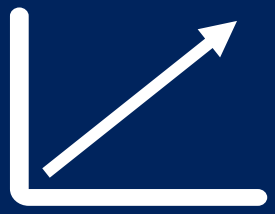
If rolled out GB-wide, CLASS has potential to defer reinforcement costs

Rapidly deployable solution	Reinforcement deferral	Provides time for assessment	Cost deferral	Carbon reduction
				
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

Structure and technical overview

Steve Stott

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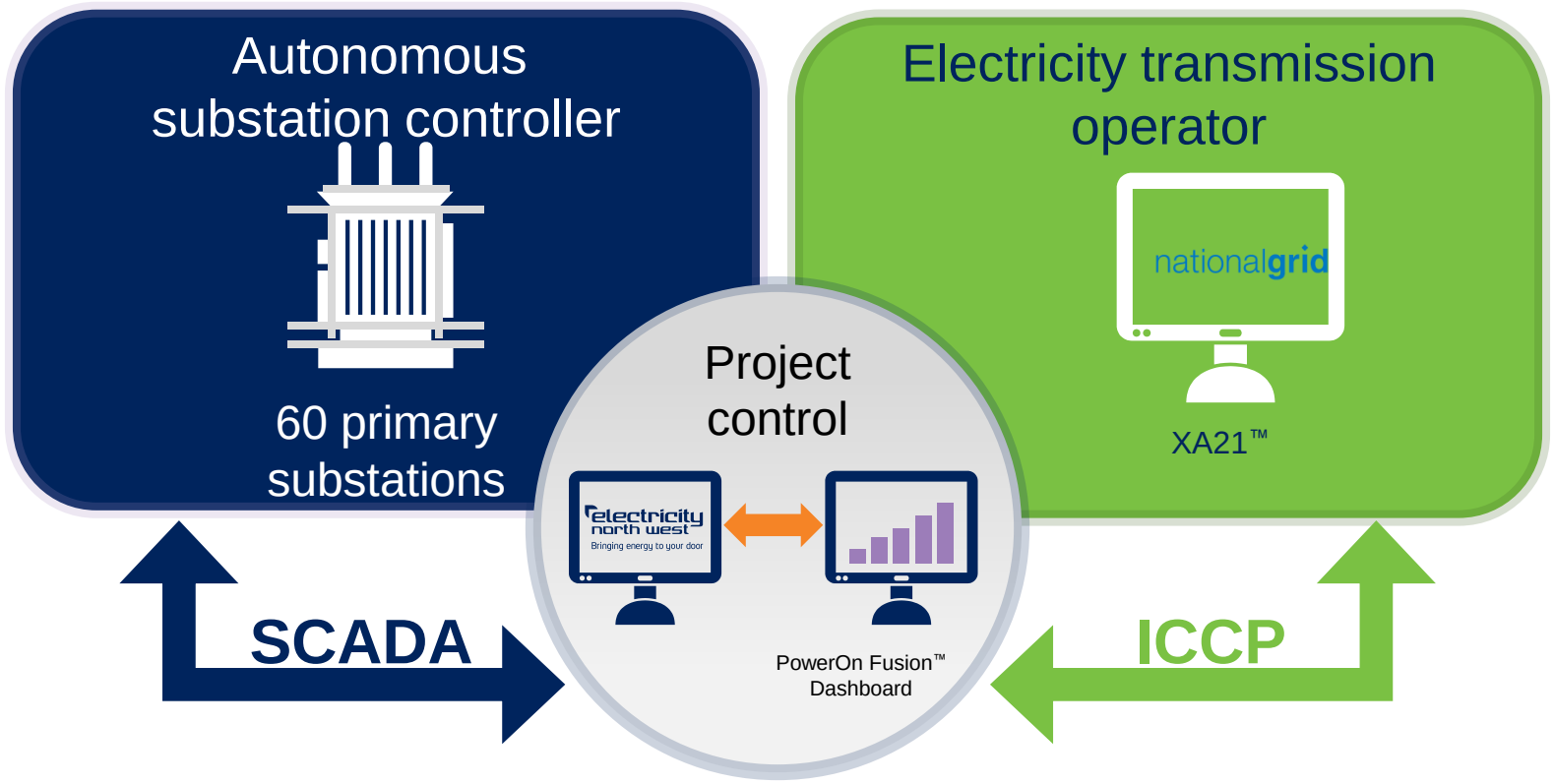
CLASS system overview



Complete CLASS system

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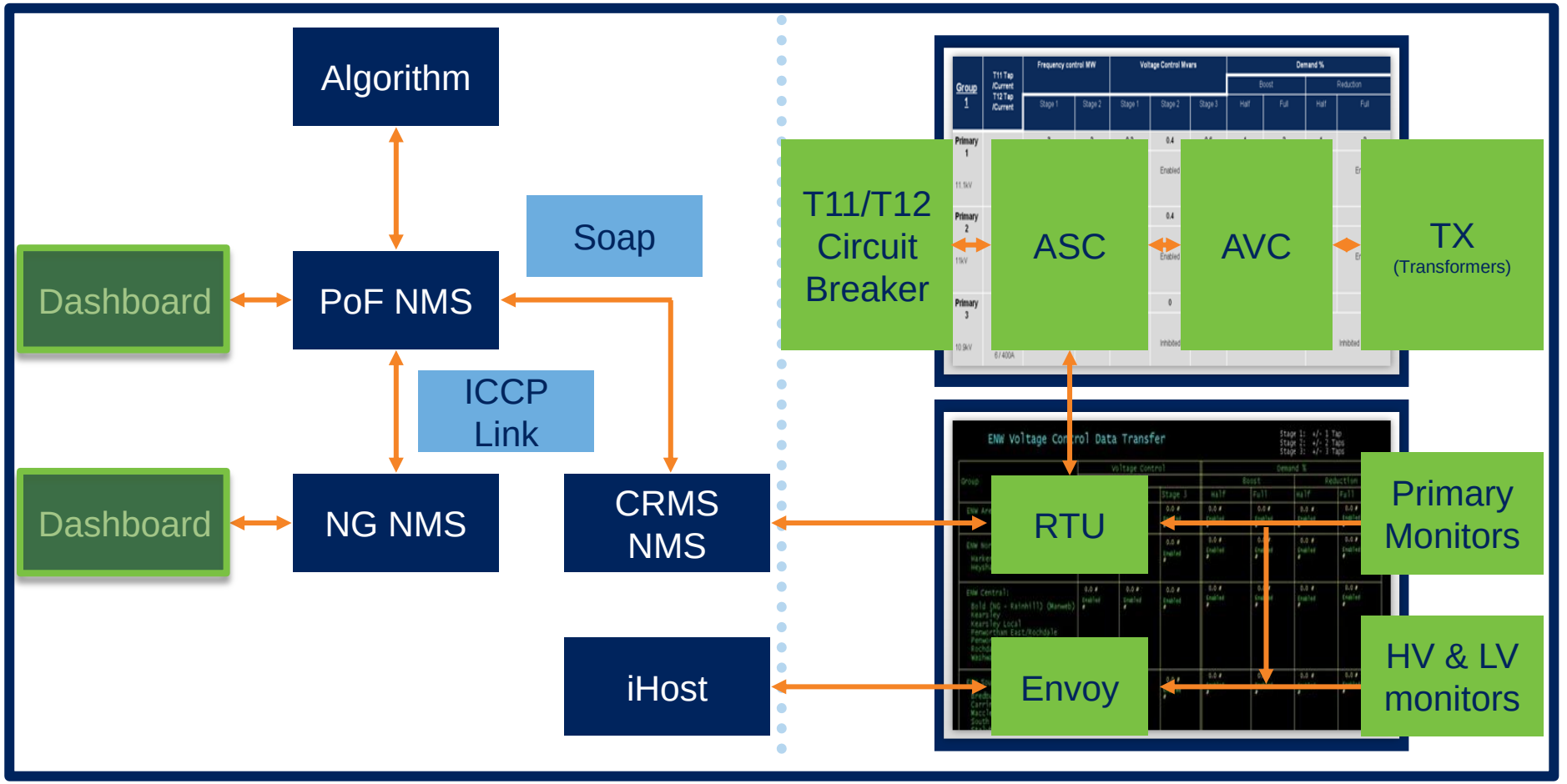
Control room

Substation



What is an ICCP link?

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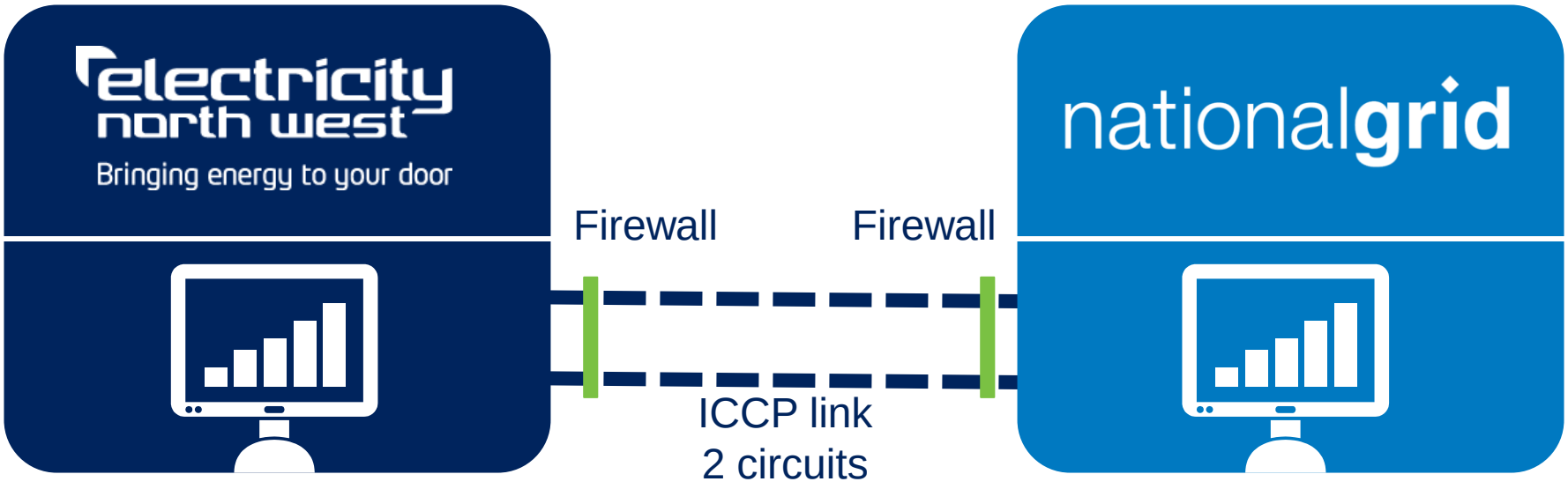
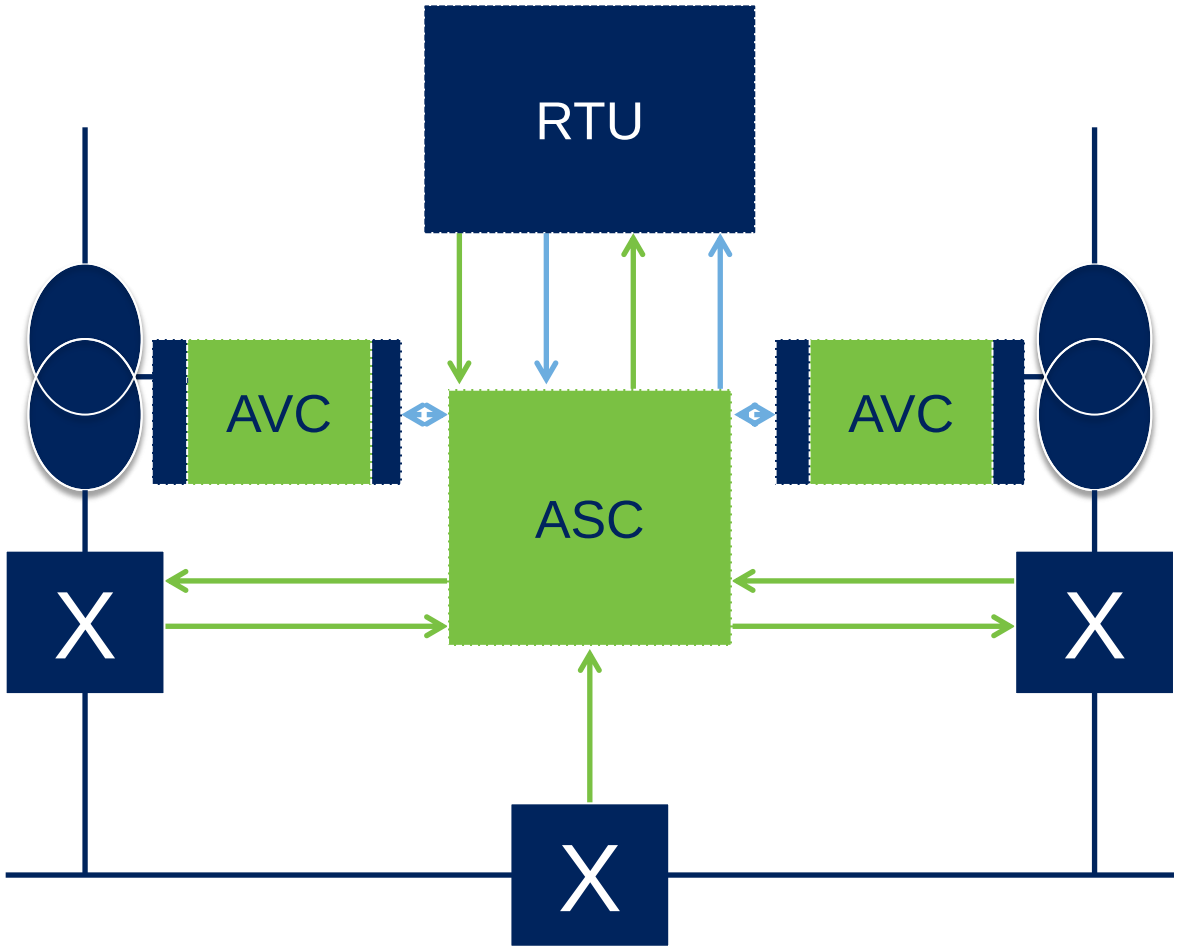


Secure Inter Control Centre Protocol is the industry standard

Direct fibre optic connection

Enables data exchange between energy management systems

CLASS substation overview



CLASS installed equipment

Existing equipment

Existing or CLASS installed/ enhanced equipment

What does the ASC do?

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CLASS functions

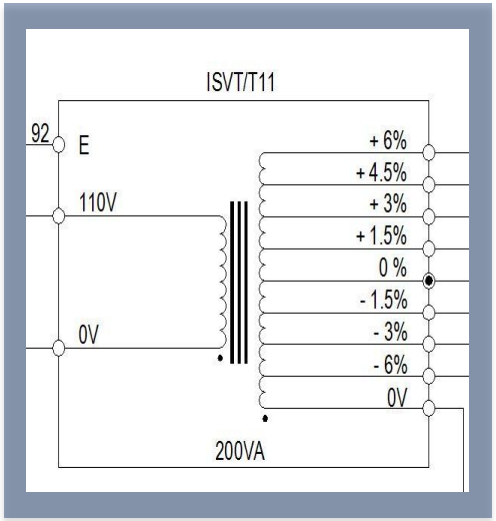
Voltage management
Demand boost function (DBF)
Demand reduction function (DRF)
Automatic demand reduction function (ADRF)

Frequency management
Manual primary frequency response (MPFR)
Automatic primary frequency response (APFR)
Automatic secondary frequency response (ASFR)

Reactive power management
Tap stagger function (TSF)

CLASS – Argus 8 AVC interface

Argus 8 – standard product +
custom made stepped VT



Demonstration

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Lunch

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CLASS Customer Engagement

Kate Quigley/Impact Research

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CLASS project overview

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Objectives	Reduction of peak demand	Frequency response and voltage support	Voltage and demand relationship	No effect on customers
What?	Baseline measure: Spring 2014 Monitoring waves: Summer 2014 to Spring 2015 **696** customers recruited at **baseline** **1,357 monitoring** interviews to measure changes to power quality			
Customer hypothesis	**"CLASS will be indiscernible to customers"** Customers will not see / observe / notice an impact on their supply quality when these innovative techniques are applied			

Summary of the Trial surveys

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Monitoring Trial surveys

Type of trials

Trial 2: 3%, 5%
Trial 3a:
Stage 1 Auto Enable
Trial 3:
Stage 2 type 2

Interviews spilt between test and control

Questionnaire

Administered over the phone

5
minutes

QUALITY

Had customer noticed any discernable differences in the quality of their supply?

£25
reward per interview

Test and control methodology

Half on a day a week later than real test

Customers were not informed that they were the test or control group

Half on a day a week earlier than real test

Any ‘placebo effect’ from being told that a trial may take place was accounted for by notifying half of the control group and half of the test group before any test or dummy test took place on selected electricity circuits

What have customers noticed?

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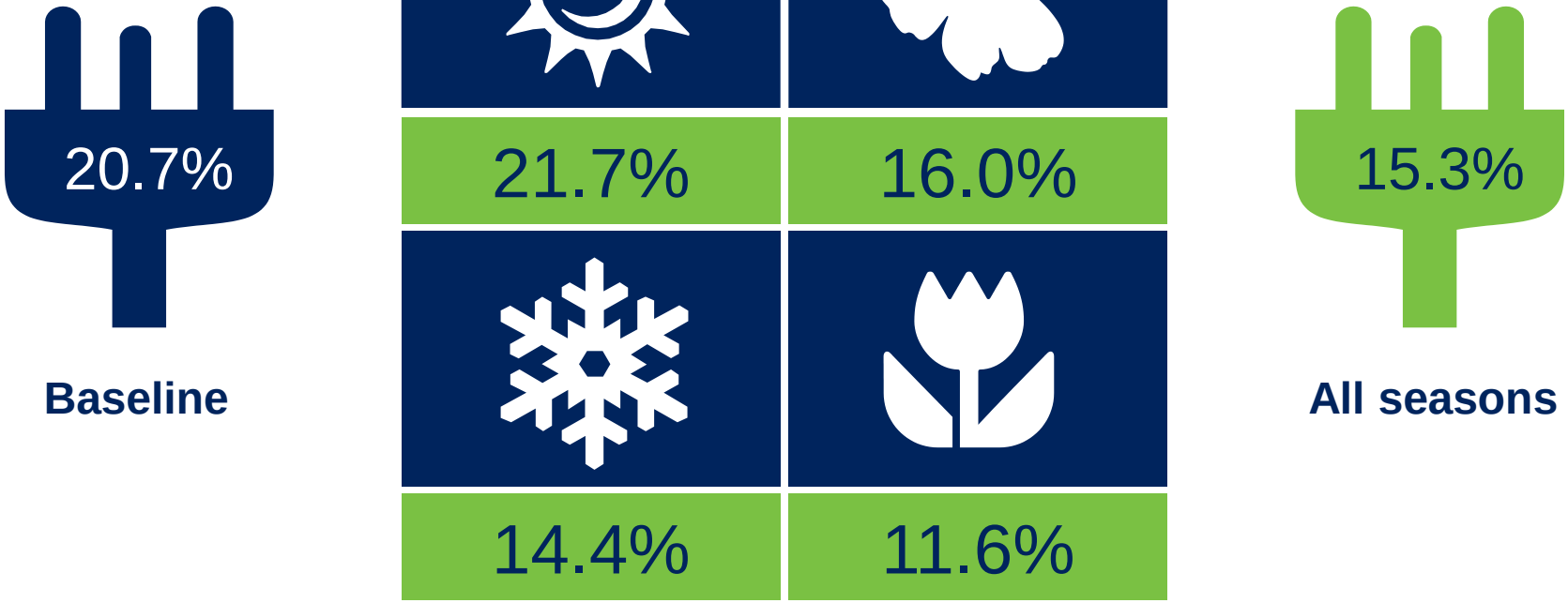
No differences by customer type, trial type, region, vulnerable customers, survey season

No complaints from customers about power quality that could be attributed to CLASS

Customers did ***not*** notice the CLASS tests

The hypothesis has been proven

Changes to appliances or lighting



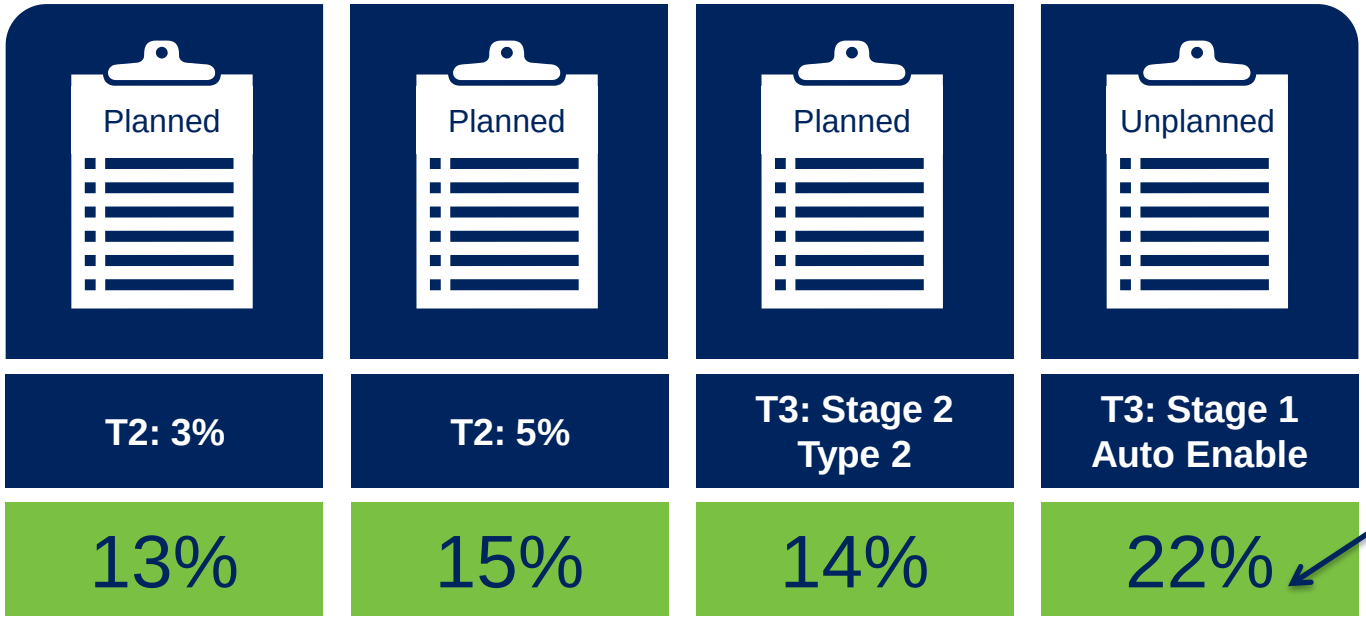
Customers who said they noticed a change in performance to at least one appliance or to their lighting in the last 7 days was **significantly lower than the baseline**

Test v control

	NOTIFIED	NOT NOTIFIED
CONTROL	5%	4%
TEST	3% ↓	3% ↓

The test sample were **less likely** to have noticed a change in performance than the control sample

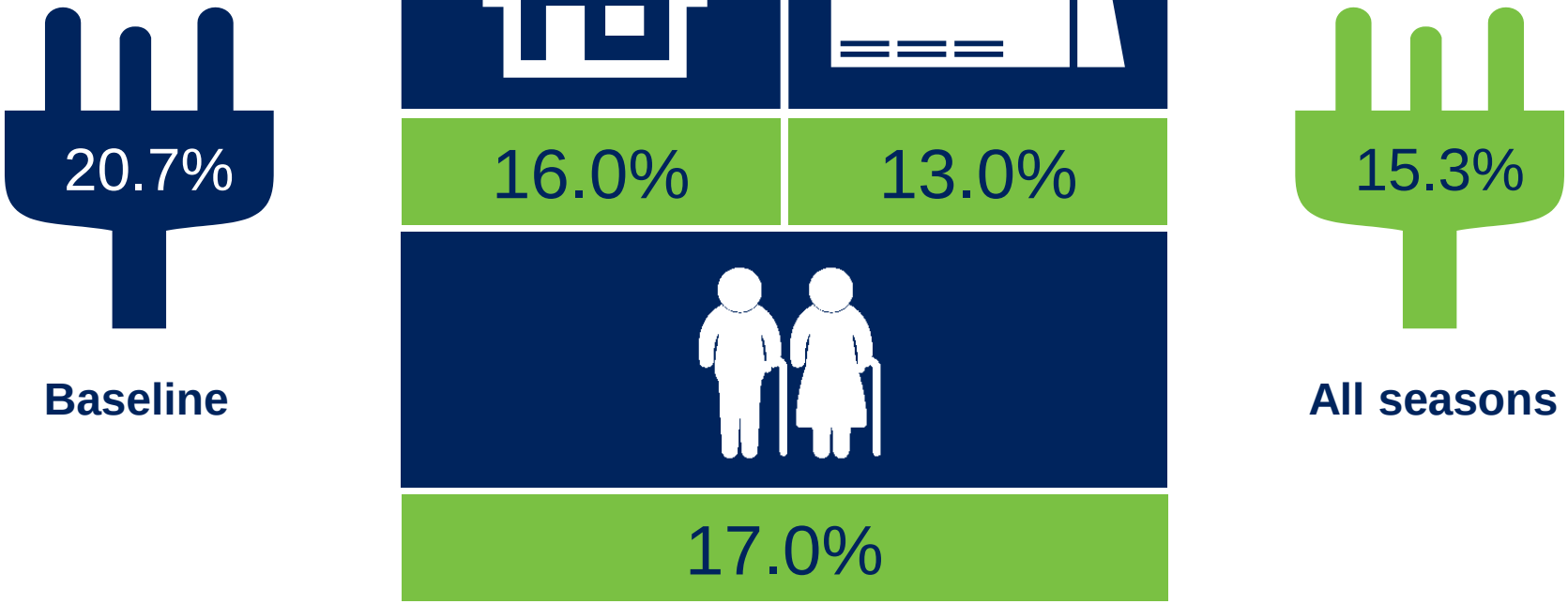
Trial type



19% amongst "test" respondents (N=101) and not significantly different from all season average.

Type of test was not an influencing factor on likelihood to notice a change to power quality

Customer type



Even **vulnerable** customers who may be more dependent on a constant electricity supply than other customers were no more likely to notice changes than other groups

Changes that could be due to CLASS

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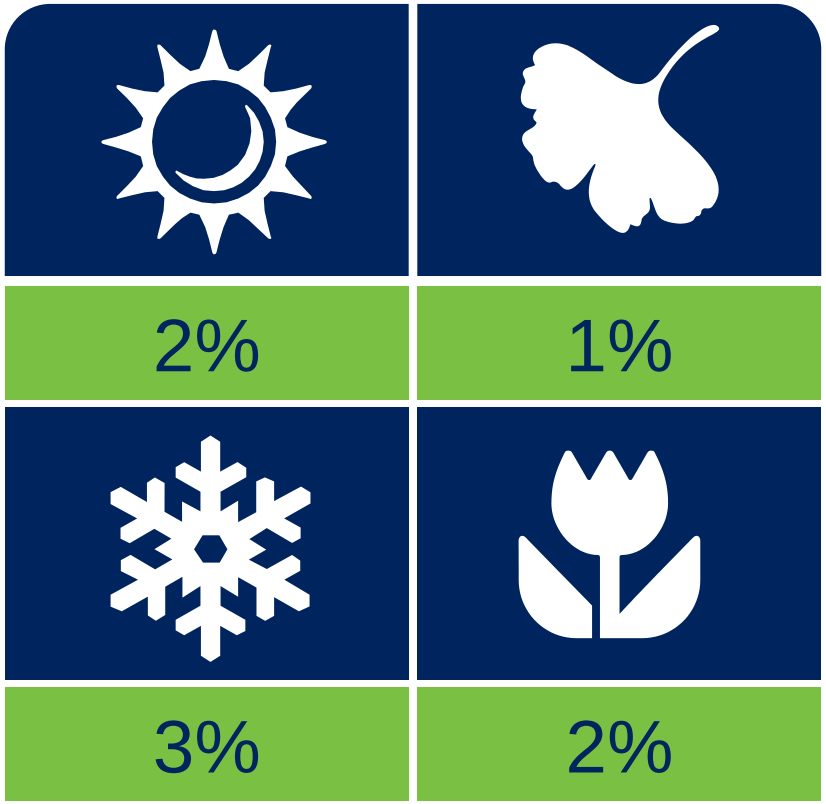
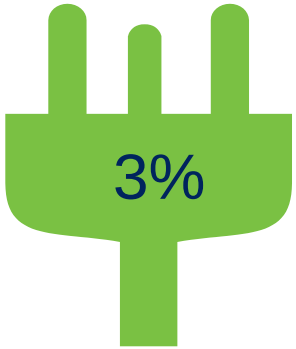


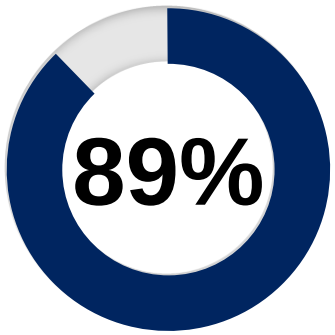


Seasonal average

Changes to power quality that **could be due to CLASS** were less than 3% on average

Customer satisfaction with service

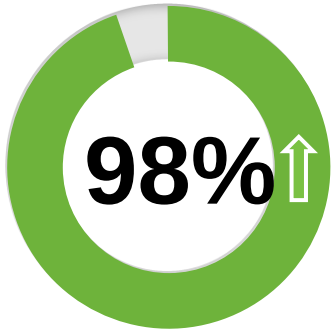
Baseline



73%

Of those that **noticed a change** to their appliances or lighting were satisfied

All seasons



95%

Of those that **noticed a change** to their appliances or lighting were satisfied

Good news → Overall satisfaction improved since the baseline, and also improved amongst those who noticed a change to their power quality

No complaints about power quality

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Complaints about power quality or service received at the customer contact centre or to Impact Research team likely to be caused by CLASS trials

= 0

CLASS trial results overview

Kieran Bailey

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Trial overview

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CLASS Trials					
Trial/ Description	Load modelling	Peak demand reduction	Stage 1 frequency response (49.7Hz)	Stage 2 frequency response (49.8Hz)	Reactive power absorption
Objective	Establish voltage demand relationship	Demand response for peak reduction	Response to reduce demand when frequency falls		Reduce high volts on transmission network
Technique	Raise and lower tap position	Lower tap position	Switch out transformer	Lower tap position	Stagger tap position
Trial period	Across entire annual cycle	Peak demand	Any time		Low load

Load model development

Static load model found to be the most appropriate load model for CLASS

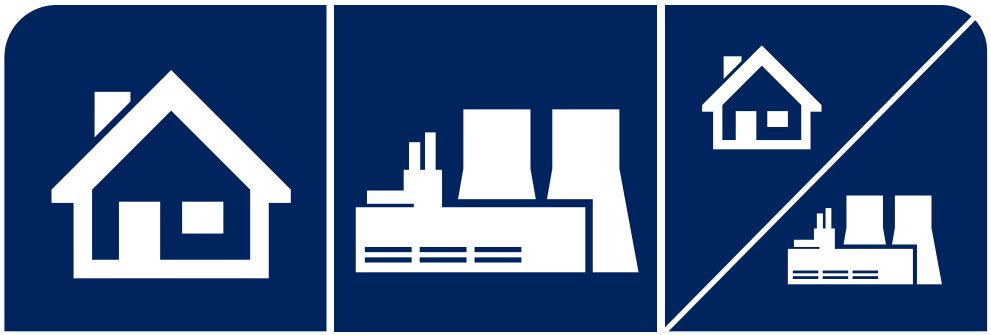
Static exponential load model is chosen for load modelling at all substations due to its simplicity and clear coherence in defining demand-voltage matrix.

The Kp and Kq represent the voltage exponents of real and reactive power for a static exponential load model

$$P = P_o\left(\frac{V}{V_o}\right)^{kp} \qquad Q = Q_o\left(\frac{V}{V_o}\right)^{kq}$$

Voltage/demand relationship

Four seasonal, average week day and weekend, voltage/demand relationship matrix for every half hour interval for 3 load types



Mainly domestic	Mainly industrial/ commercial	Mixed

Average voltage/demand relationship

Mainly domestic	Mainly industrial/ commercial	Mixed
1% change in voltage ~ 1.36% change in real power	1% change in voltage ~ 1.1% change in real power	1% change in voltage ~ 1% change in real power

Seasonal average for Romiley

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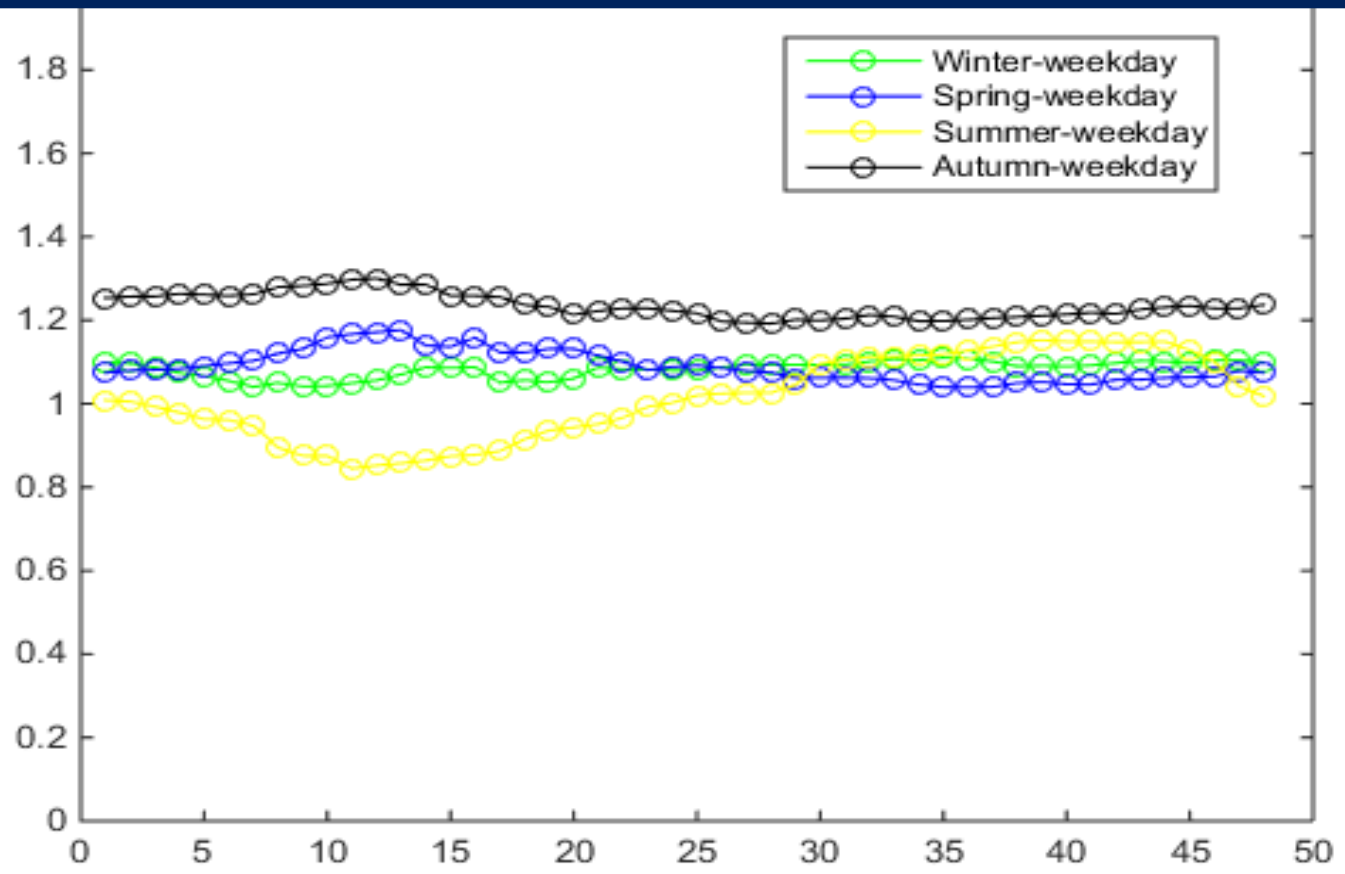
Kpv - Romiley



Average seasonal voltage/demand relationship

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Kp values	Mainly domestic			Mainly Industrial/commercial			Mixed		
	Min	Max	Av	Min	Max	Av	Min	Max	Av
Winter	1.64	1.04	1.24	1.73	0.89	1.26	1.31	0.81	1.01
Spring	1.54	1.09	1.29	1.40	0.81	1.18	1.74	0.84	1.10
Summer	1.58	1.01	1.33	1.87	0.97	1.33	1.27	0.18	0.83
Autumn	1.61	1.17	1.36	1.66	1.01	1.23	1.22	0.86	0.99

Kq values	Mainly domestic			Mainly Industrial/commercial			Mixed		
	Min	Max	Av	Min	Max	Av	Min	Max	Av
Winter	7.24	5.31	6.16	6.86	3.12	5.54	7.45	4.61	5.81
Spring	7.94	5.93	6.62	6.80	2.42	5.32	7.62	4.31	5.96
Summer	7.03	5.75	6.31	6.35	4.62	5.34	6.15	5.02	5.57
Autumn	7.30	5.53	6.27	6.69	4.15	5.65	7.33	4.13	5.90

Domestic winter weekday real power exponent

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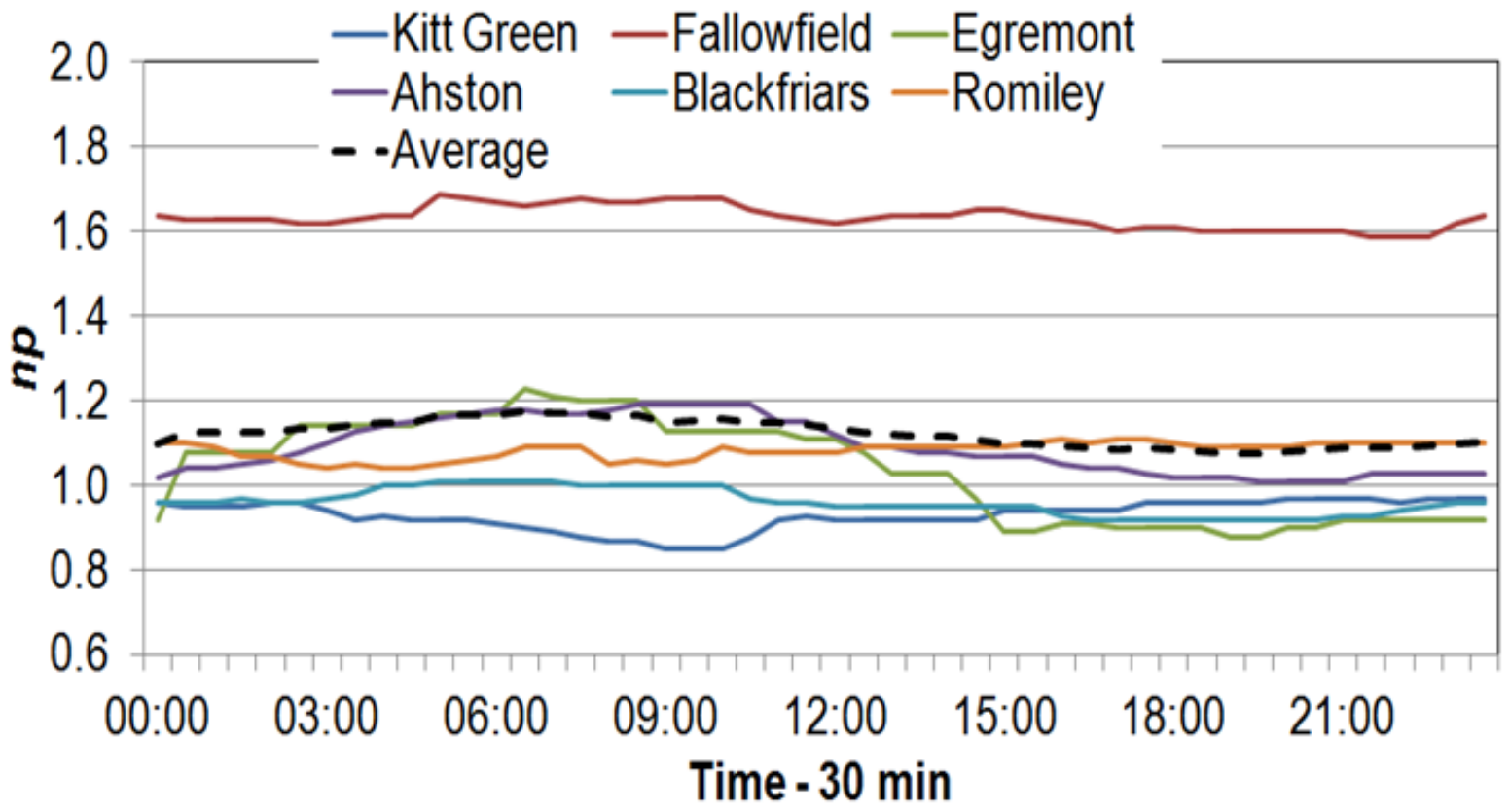
Domestic winter weekday



Demand reduction (DR)

Electricity North West		Great Britain	
			
Summer Minimum demand response = 90MW	Winter maximum demand response = 185MW	Summer Minimum demand response = 250MW	Winter maximum demand response = 1500MW

Aggregated ENW DR – winter's day

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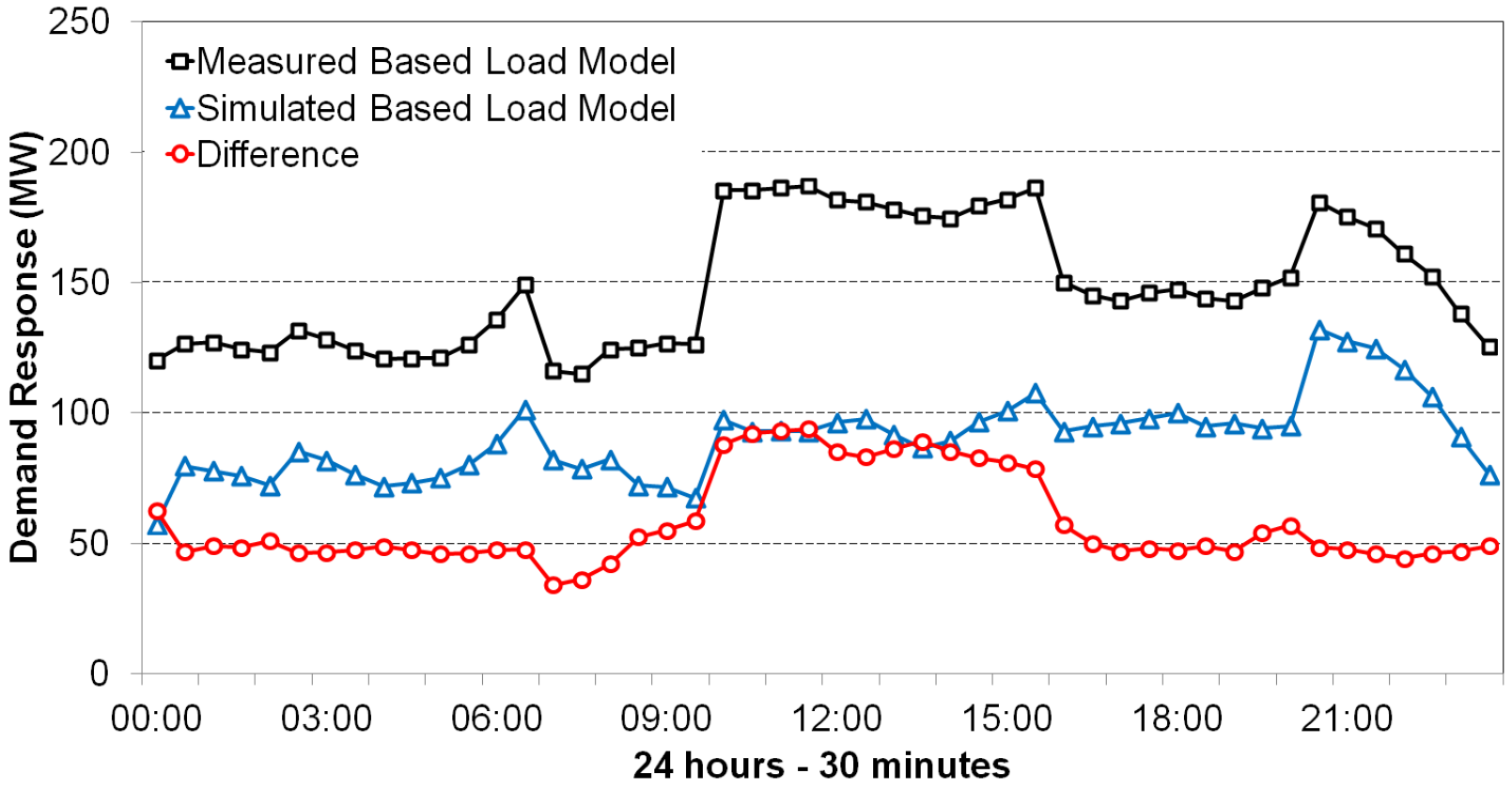
Winter's day



Aggregated DR ENW – summer's day

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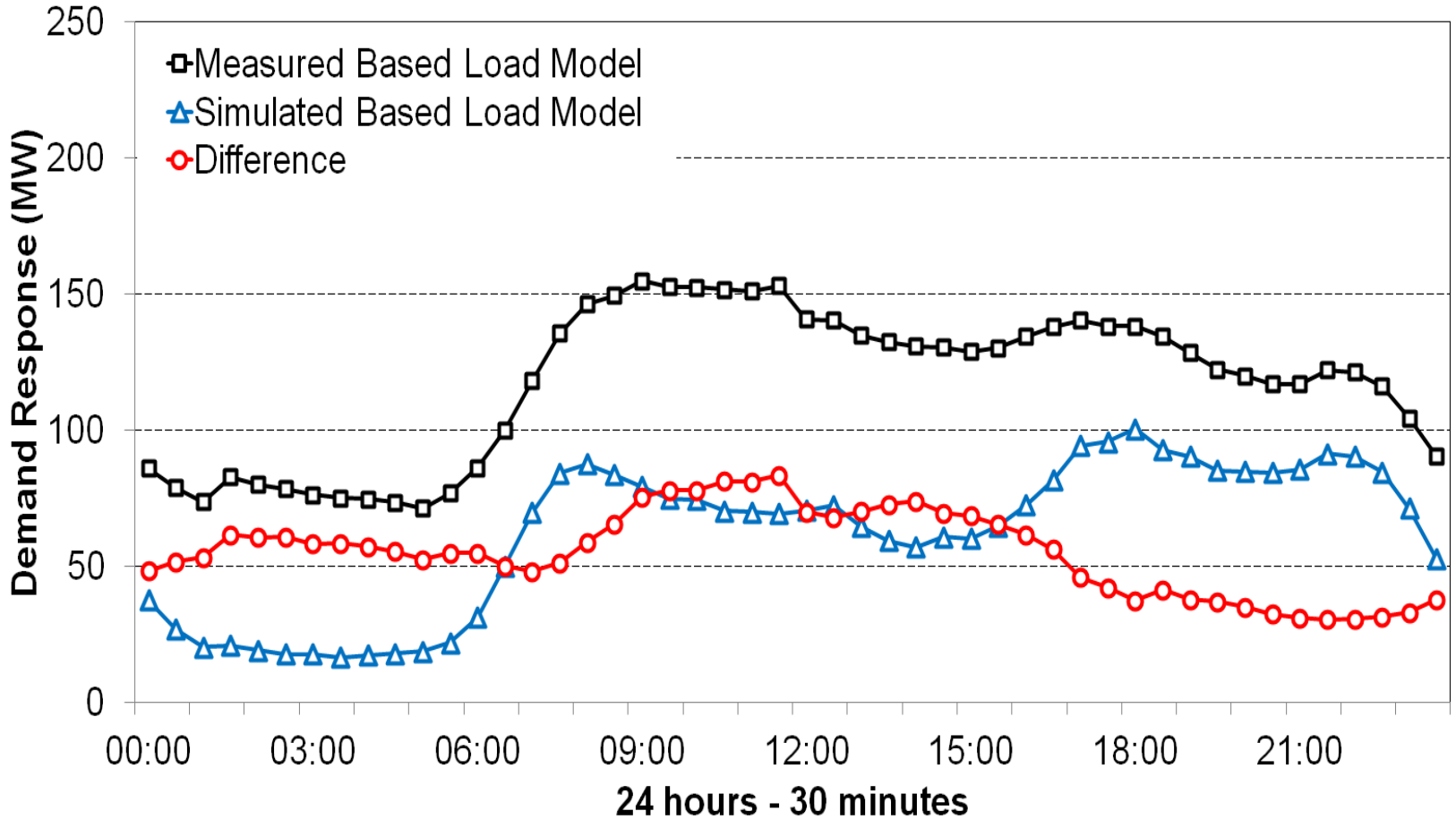
Summer's day



Demand reduction at peak demand

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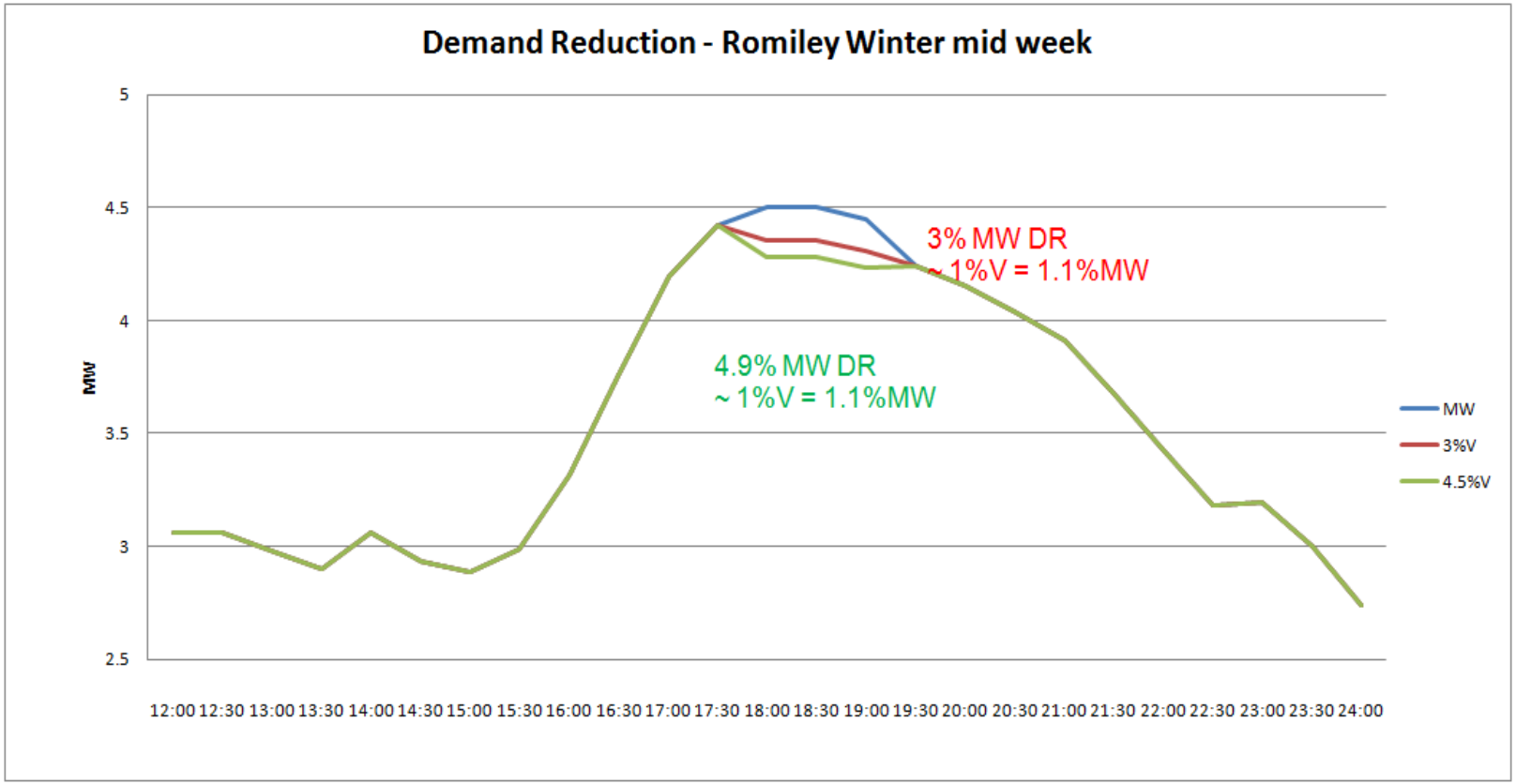
Demand reduction – Romiley winter mid-week



DR for frequency response 1st event

Primary (number)	ΔV [%]	ΔP[%]	Kp	ΔQ[%]	Kq
20:44, 17 September 2014					
Fallowfield (100114)	1.44	2.05	1.43	13.9	10.32
Baguley (100103)	1.57	2.67	1.71	12.2	8.22
22:43, Monday 15 December 2014					
Fallowfield (100114)	1	1.78	1.78	7.14	7.37
Baguley (100103)	1.7	1.9	1.12	10.6	6.53

Reactive power absorption

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Electricity North West area – 6 tap stagger

Spring	Summer	Autumn	Winter
130MVAr to 171MVAr	136 to 160MVAr	132-160MVAr	139 – 176MVAr

Asset health

Transformers and tap changers monitored during trial	Results show that the CLASS functions are in line with normal BAU operations indicating negligible loss of life

Closedown & Summary

Steve Cox

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Closedown activities

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Closedown report

Knowledge sharing event

Website

Your views?

Feedback

How would you like us to disseminate this learning?

What do you need from our final closedown event?

What do you need from our closedown report to enable you to understand and use the CLASS functions?

Would you like to see more of these type of workshops on future projects?

Summary

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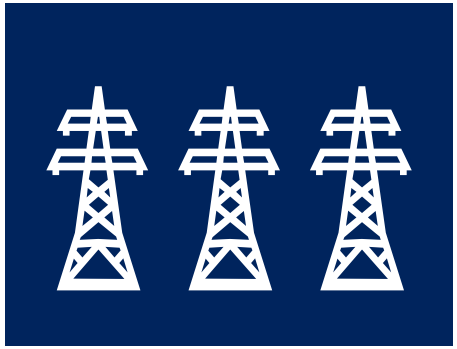
Statistical findings are that domestic customers did not notice the CLASS functions



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

CLASS has provided National Grid with the ability to use an ICCP link which provides them with a demand response during a system frequency event

CLASS has shown an approximately linear relationship between voltage and demand

QUESTIONS & ANSWERS

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Want to know more?

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