CLASS webinar

27 June 2014

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Agenda

Introduction

Voltage regulation technologies

Baseline survey report

Questions & answers

Webinar format

30 minutes presentation

10 minutes questions & answers

Submit written questions on line during the webinar

or

Press 01 on your telephone key pad
to take part in the Q&A at the end of the presentation

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Electricity North West's innovation strategy

Our smart grid development

Leading work on developing smart solutions

Deliver value from existing assets

LCN Fund
Low Carbon Networks

£30 million

Three flagship products

C2C Capacity to Customers

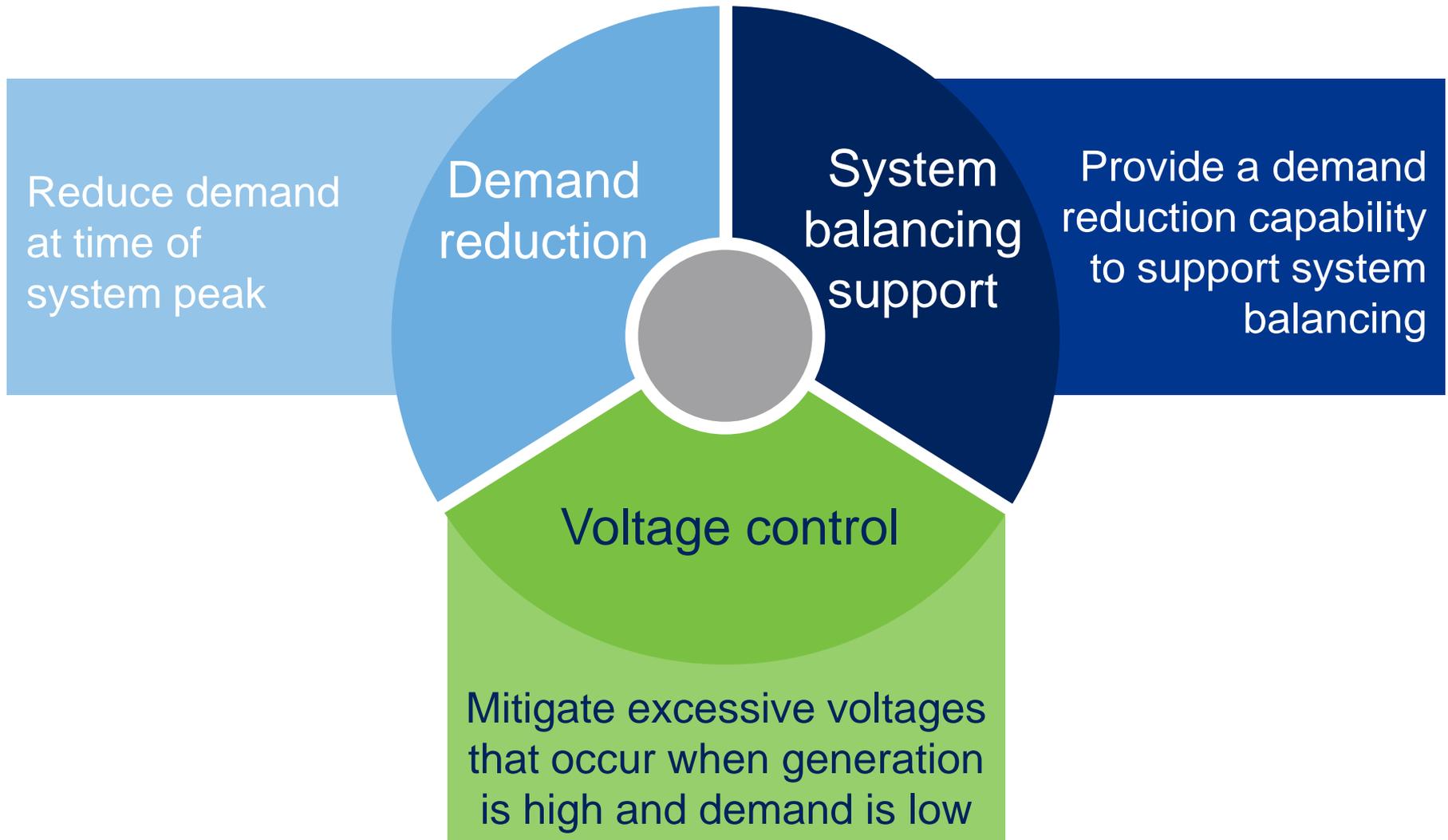**CLASS** Customer Load Active System Services

SMART STREET

"

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

…without any discernible impacts on customers

"

Elements of CLASS

Reduce demand at time of system peak

Demand reduction

System balancing support

Provide a demand reduction capability to support system balancing

Voltage control

Mitigate excessive voltages that occur when generation is high and demand is low

Key activities to date

Jan 2013

June 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 to elicit customer views

Knowledge sharing and dissemination
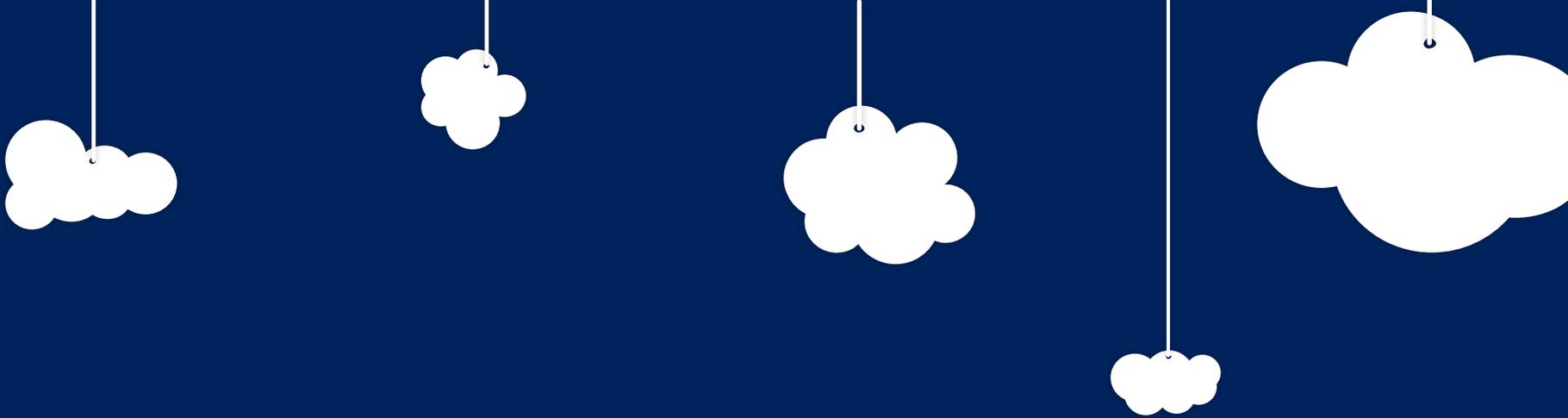
Automation technologies and substation intelligence

Dr Vincent Thornley

Siemens Smartgrid Division

Energy Automation

SIEMENS

Presentation Overview

Introduction to CLASS

- CLASS Functions and Techniques

Voltage-Demand Relationship

Tap Stagger Principle

Substation Arrangements

- Numerical AVC Relays

- Retrofit Considerations

ASC Functionality

Customer need → Detection / activation → Action → Effect

- Frequency response → Onsite frequency detection → Trip parallel transformers → Reduction of customer voltage, which reduces load
- Balancing and system security → Command from SCADA → Adjust AVC target voltage → Increase of customer voltage, which increases load
- Reactive power → Command from SCADA → Stagger taps → Absorption of VArs from EHV network

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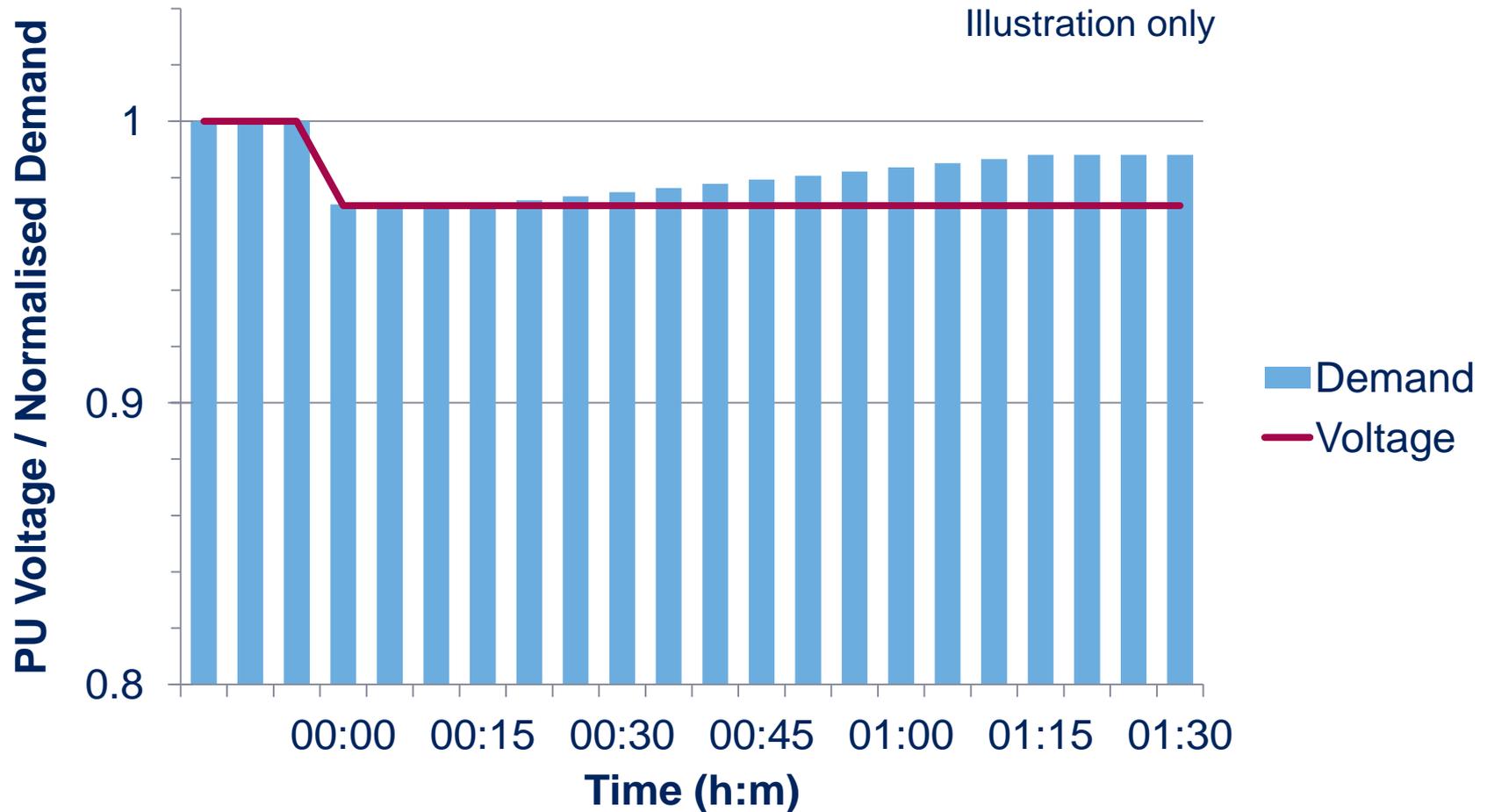# Voltage-Demand Relationship
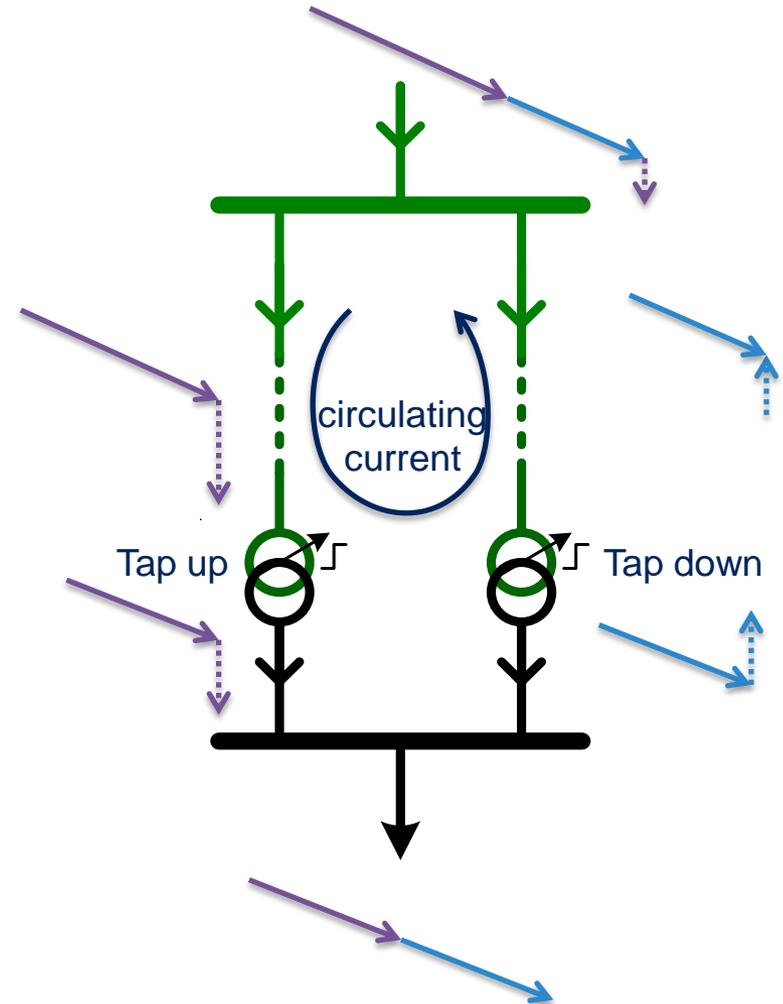## Instantaneous Relationship
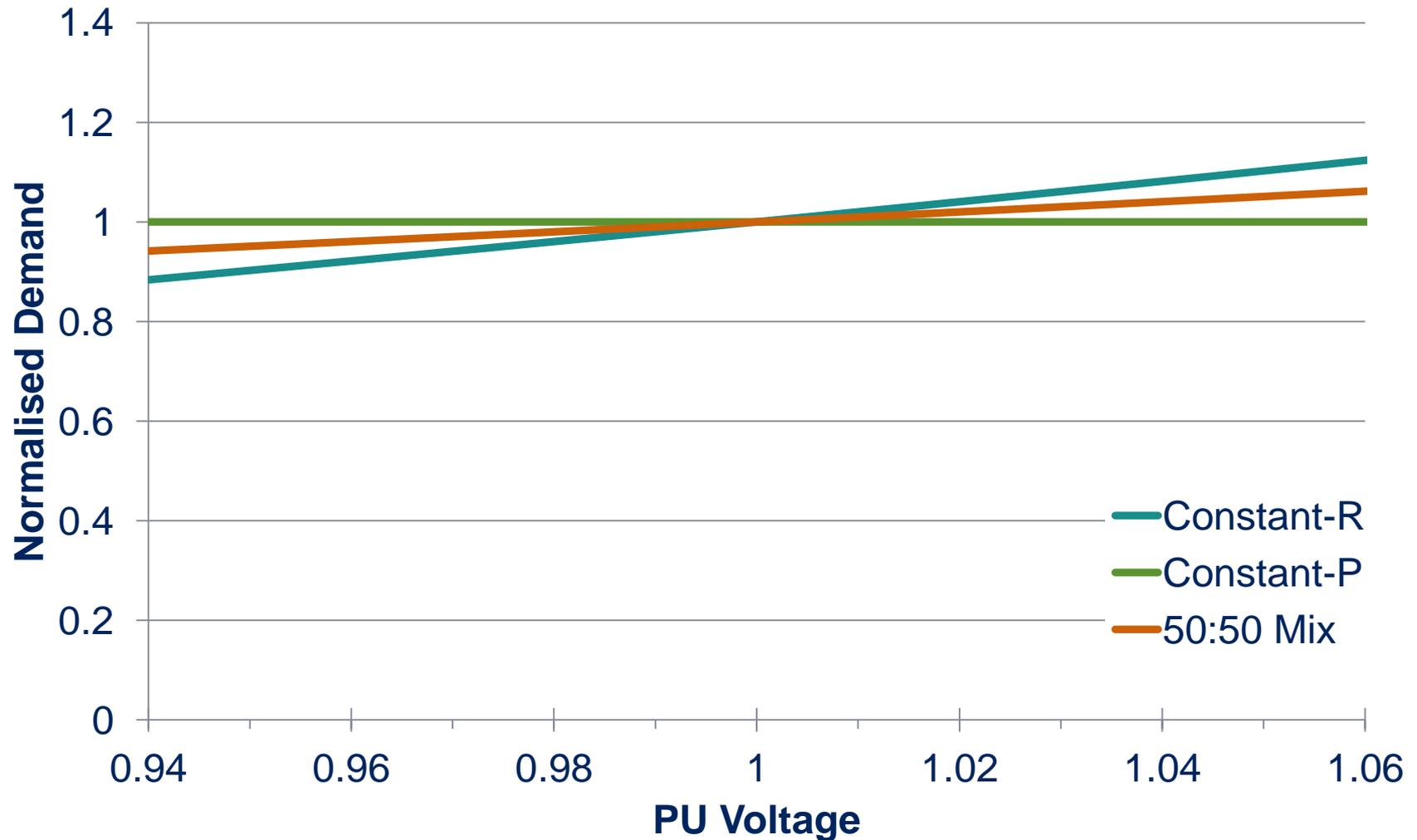
Voltage-Demand Relationship
Time Impact on Demand

- Can be used to create additional reactive load presented to transformer primary-side network

- Diagram shows vector currents at different points
  - Solid arrows represent load
  - Dashed arrows represent circulating current

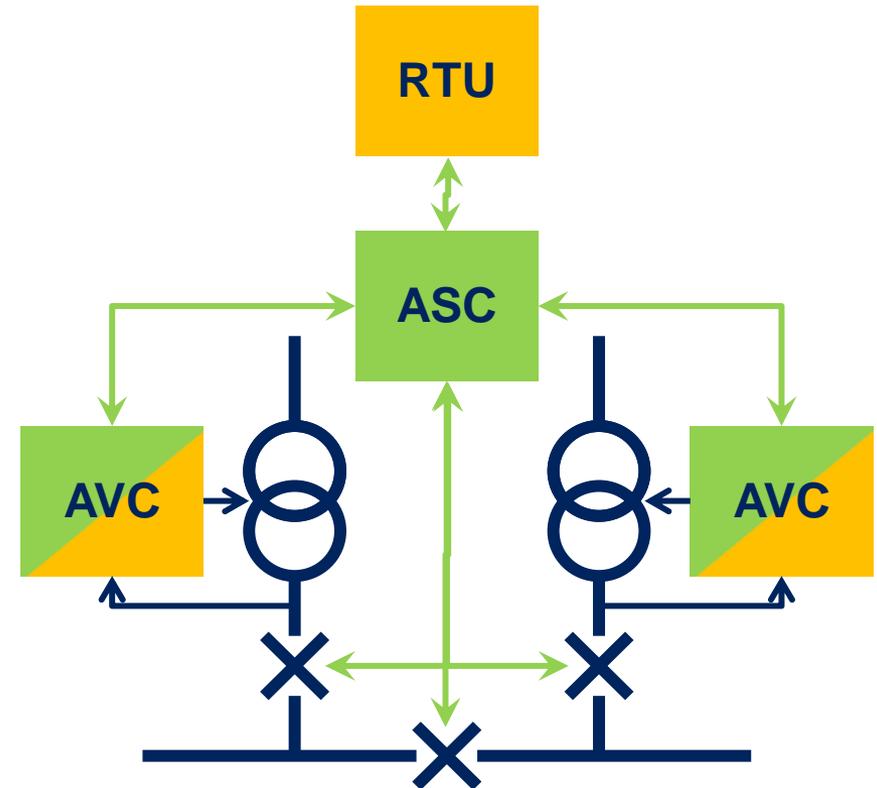- Mismatch of taps creates 'spill' of circulating current on primary side

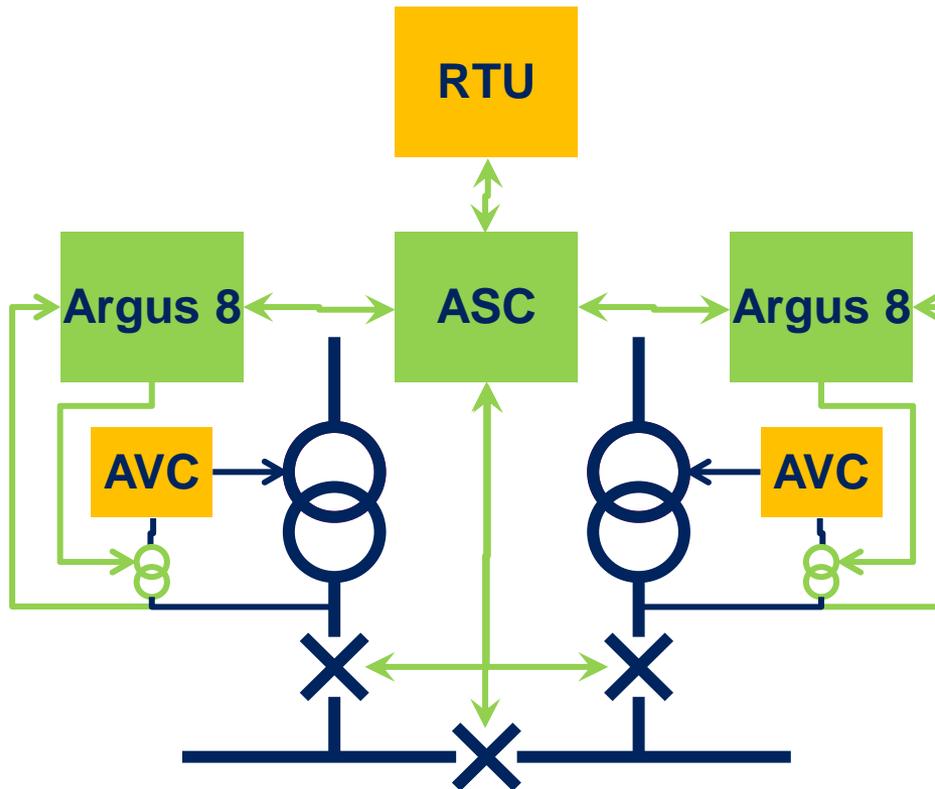circulating current

Tap up

Tap down

- **Measurements from AVC relays:**
  - V, P, Q, f

- **Instructions to AVC relays:**
  - Target voltage adjustment
  - Tap stagger adjustment

- **Circuit breaker I/O:**
  - CB status, trip, close

- **Interface with Control Desk**
  - via standard substation RTUs
  - Commands from and status to CLASS dashboard

ASC = Autonomous Substation Controller

Existing

CLASS-installed

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RTU

Argus 8 ◄──► ASC ◄──► Argus 8

AVC ──►

◄── AVC

ASC = Autonomous
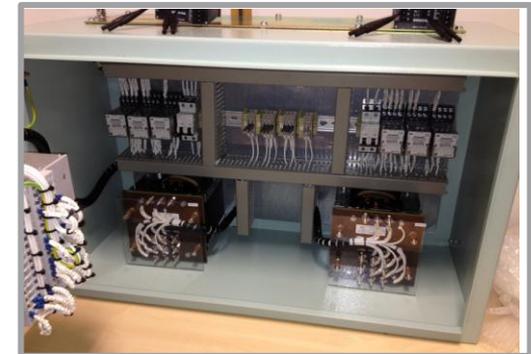Substation Controller

Existing

CLASS-
installed

- Target voltage adjustment:
  - Older relays (particularly e/m) don't have ability to adjust targets
  - Multi-tapped interposing VT allows adjustment (similar to OC6)
  - Tap selection by Argus 8 relay outputs

- Measurements:
  - Not available from AVC relay
  - Additional relay (Argus 8) measures V and f

- ## Two Responses, termed primary and secondary

- ## Secondary Response – slow
  - 'Higher' setpoint (e.g. 49.8Hz)
  - Adjustment of AVC setpoint only

- ## Primary Response – fast
  - 'Lower' setpoint (e.g. 49.7Hz)
  - Trip parallel transformer and adjustment of setpoint
  - Includes checks for bus coupler, transformer on load and firm capacity
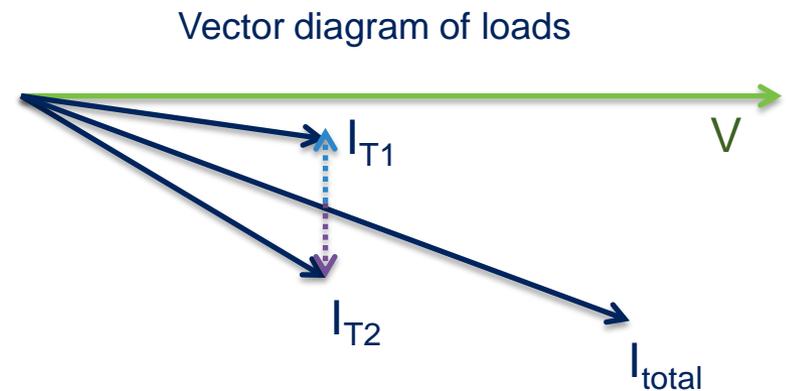
- Makes use of functionality inherent in AVC Relay
- Combined requirements
  - Maintain regulation of voltage
  - Introduce circulating current
  - Prevent tap changers from running away
- Achieved by setting different reactive power targets for each AVC relay
- Three stages of operation

Tap up

Tap down

Vector diagram of loads

I_{T1}

V

I_{T2}

I_{total}
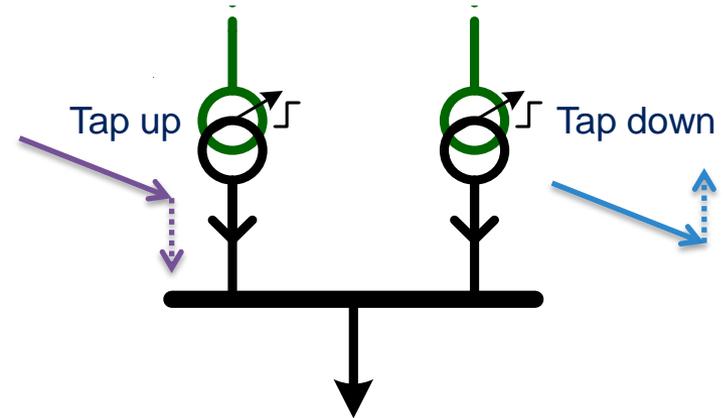
- **Manual services**
  - Demand reduction (full and half)
  - Demand boost (full and half)

- **Automatic demand reduction**
  - Single stage

Autonomous Substation Controller
SICAM ACP

RTU

CBs / Feeder panels

Battery bank / inverter

AVC relay

Capacitor bank

Premises – LV Conn Mgr

Data concentrator

Switch management

Battery capacity management

OLTC AVC management

Capacitor control

Demand management

Local coordination and prioritisation

Feeder Line modelling

Thermal modelling

Local thermal management

Frequency management

Local voltage management

Reactive power management

Component layer   Abstraction   Device management   Coordination   Network function

CLASS functionalities   Outside CLASS functionalities

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

Where are we now in the customer engagement plan?

Agree process for dealing with customer enquiries

Brief customer facing employees

First seasonal survey (summer)

Additional face to face recruitment as appropriate

WE ARE HERE: Baseline survey completed

Findings published

April 2014

May 2014

August 2014

September 2014

This presentation contains feedback from our panel of 696 CLASS participants prior to any CLASS tests

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All 696 CLASS participants live or work at properties on selected CLASS circuits.
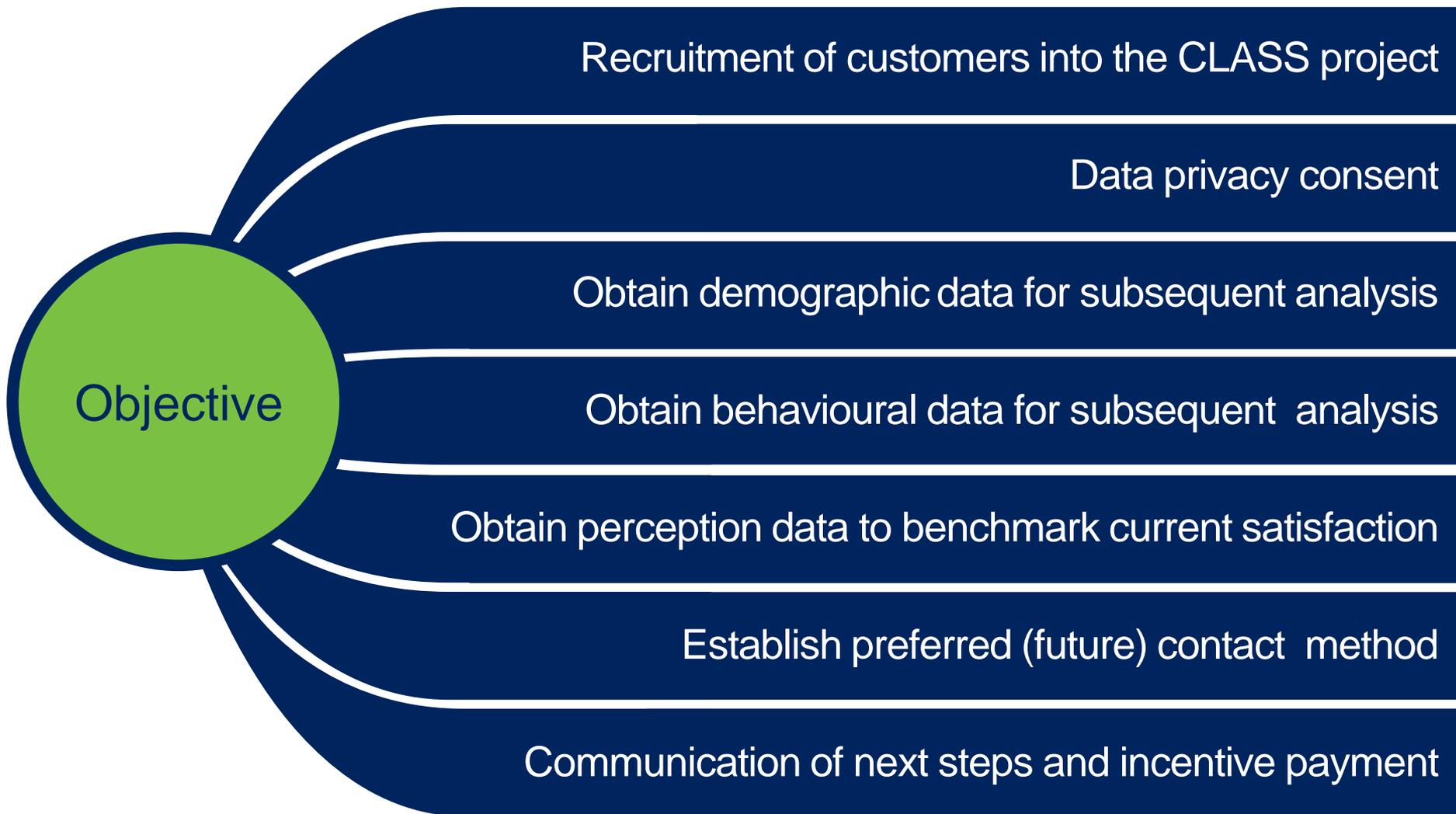
496 domestic customers

200 industrial and commercial customers

A statistically robust and representative sample

Objectives of the baseline survey

Objective

- Recruitment of customers into the CLASS project
- Data privacy consent
- Obtain demographic data for subsequent analysis
- Obtain behavioural data for subsequent analysis
- Obtain perception data to benchmark current satisfaction
- Establish preferred (future) contact method
- Communication of next steps and incentive payment
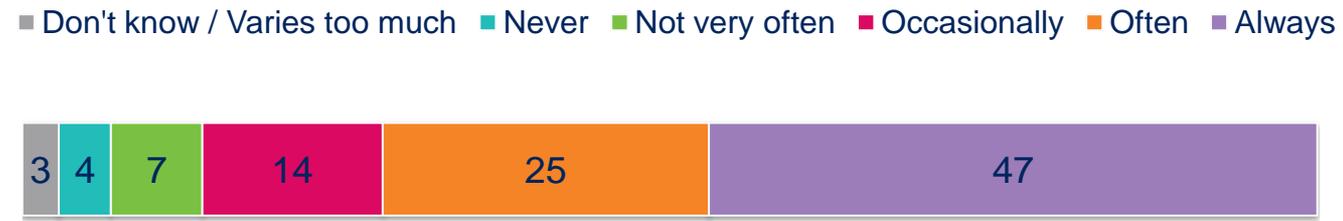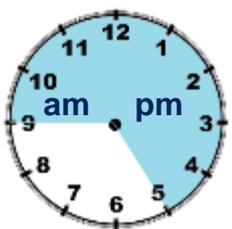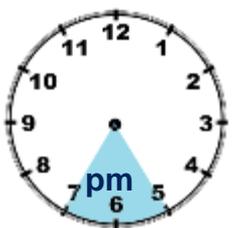
92% of households are 'often' or 'always' in during peak demand hours of 4-7pm - hence they at least have the opportunity to observe CLASS
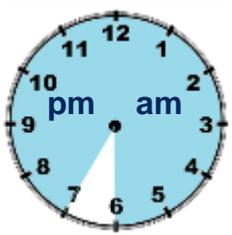
Legend: ■ Don't know / Varies too much ■ Never ■ Not very often ■ Occasionally ■ Often ■ Always

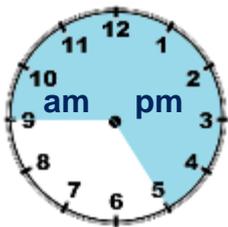| Time period	Don't know / Varies too much	Never	Not very often	Occasionally	Often	Always
Day time Monday to Friday (9am-5pm)	3	4	7	14	25	47
Tea time Monday to Friday (5pm-7pm)	3	0		4	23	69
Evening Monday to Friday (After 7pm)	2	0		2	19	77
Weekends	3	1		7	26	64

Domestic N = 496 Ask All C3 On average, when are you or other members of your household, at home during the week and weekend for extended periods of time?

28

A significant proportion of I&C participants and their colleagues are on-site during conventional working hours. Almost half are on-site after 5pm.
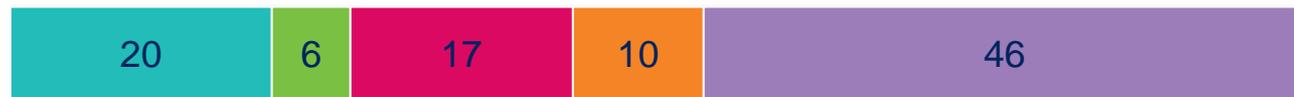
Legend: ■ Don't know / Varies too much ■ Never ■ Not very often ■ Occasionally ■ Often ■ Always

Day time Monday to Friday (9am-5pm)
| 1 | 2 | 11 | 85 |

Tea time Monday to Friday (5pm-7pm)
| 20 | 6 | 17 | 10 | 46 |

Evening Monday to Friday (After 7pm)
| 45 | 6 | 7 | 6 | 36 |

Weekends
| 14 | 11 | 11 | 13 | 51 |

Overall satisfaction with the service provided by Electricity North West is currently at a high level

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88%

Satisfied Top 3 Box

94%

This is a key measure that will be benchmarked in subsequent Trial surveys. Any significant decrease will be investigated for underlying causes – such as CLASS.

Overall Satisfaction

However, satisfaction is significantly lower amongst domestic participants who have had *reason to contact* Electricity North West about an interruption
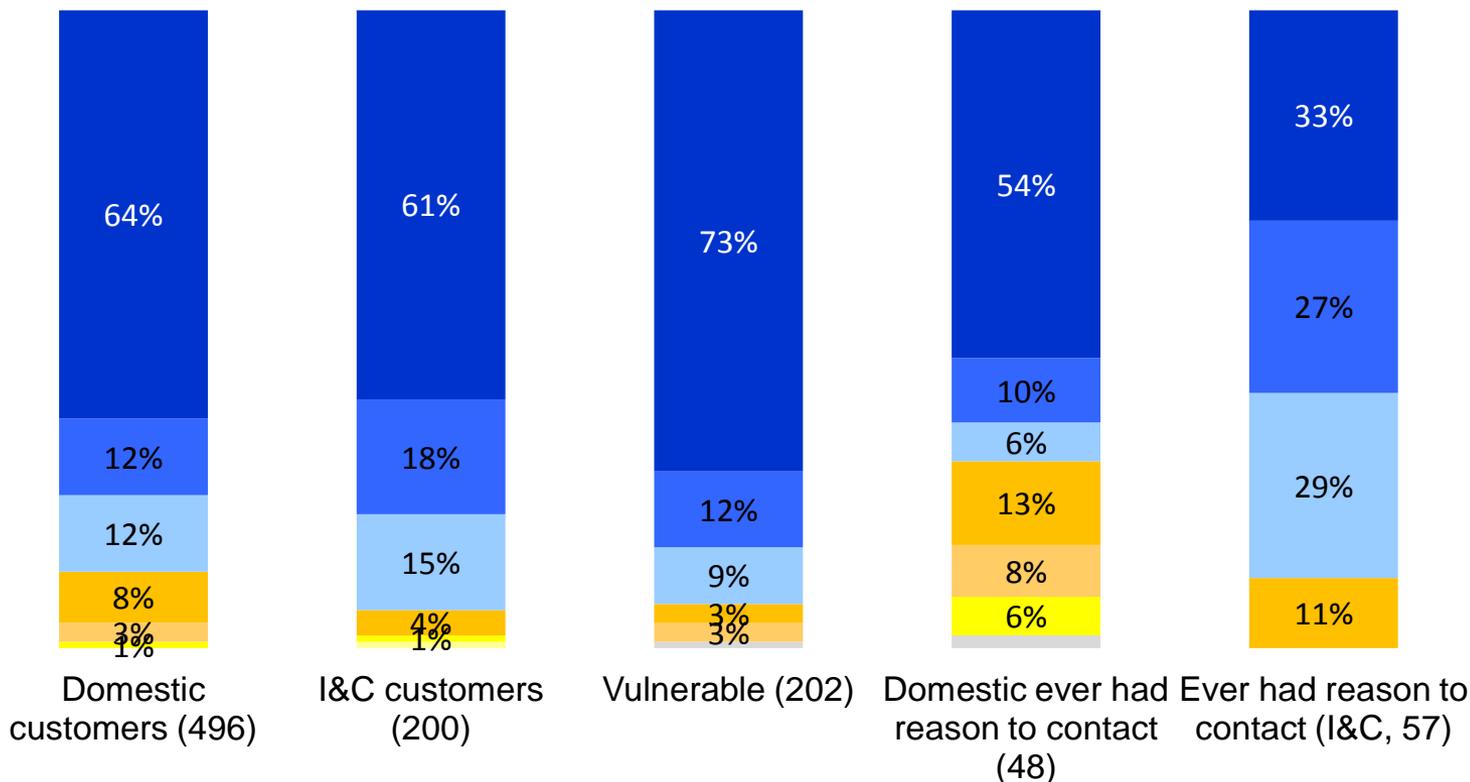
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% Satisfied Top 3 Box

	Domestic customers (496)	I&C customers (200)	Vulnerable (202)	Domestic ever had reason to contact (48)	Ever had reason to contact (I&C, 57)
Top 3 Box	**88%**	**94%**	**95%**	**71%**	**89%**

Legend:
- Satisfied - 10
- 9
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- Dissatisfied - 1

Domestic customers (496): 64%, 12%, 12%, 8%, 3%, 1%

I&C customers (200): 61%, 18%, 15%, 4%, 1%

Vulnerable (202): 73%, 12%, 9%, 3%, 3%

Domestic ever had reason to contact (48): 54%, 10%, 6%, 13%, 8%, 6%

Ever had reason to contact (I&C, 57): 33%, 27%, 29%, 11%

Overall satisfaction with call handling and fault management is out of the scope of this study, however, if it is influencing perception of power quality, this will be observed and differentiated from any potential CLASS effect

Overall Satisfaction

Domestic N = 496 Ask All E1 On a scale of 1-10 where 1 is completely dissatisfied and 10 is equal to completely satisfied, how satisfied are you with the service provided by Electricity North West?
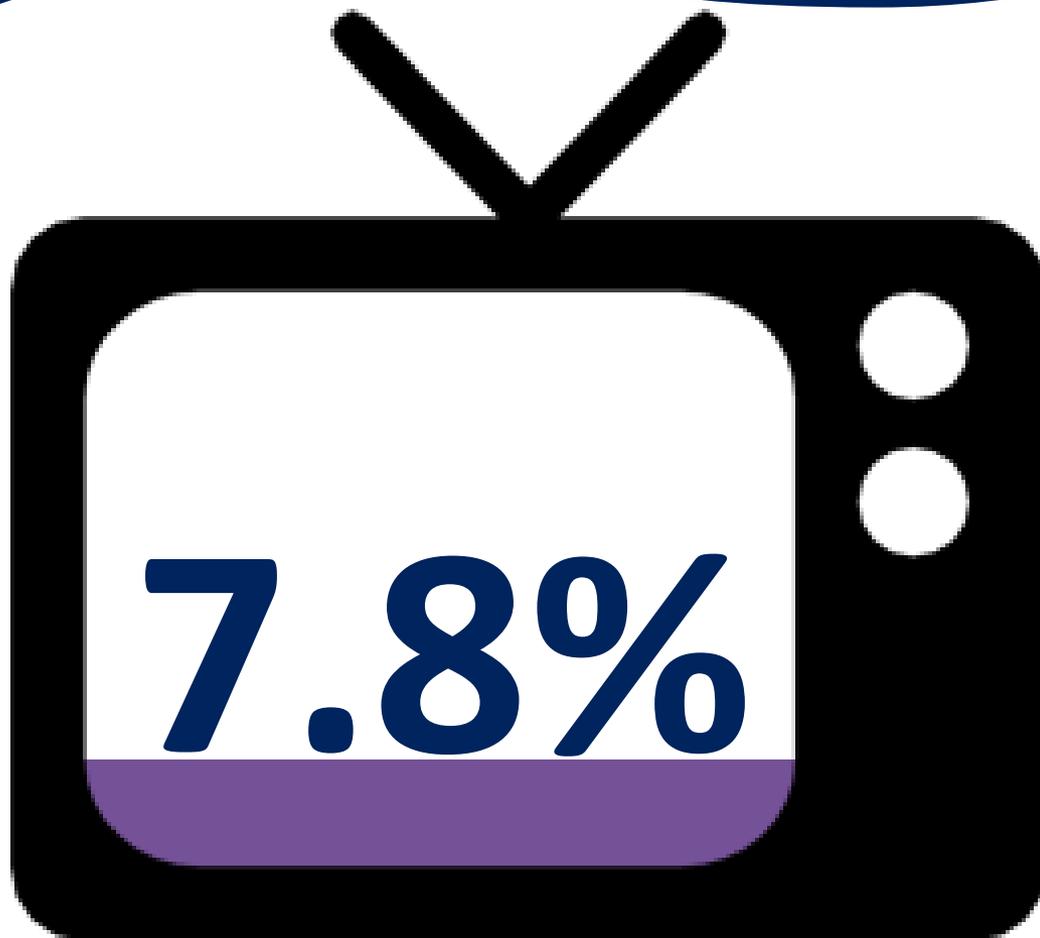
31

There are…

41,794

…appliances amongst the total sample

The proportion of customers noticing a difference in *any* of their appliances in the last 7 days is a key measure and will be monitored in subsequent surveys

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7.8%

of customers said 1 or more of their appliances were working slower / less effectively in the last 7 days.

Power quality experience

The proportion of customers noticing a difference in *any* of their appliances in the last 7 days is a key measure and will be monitored in subsequent surveys

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2.2%

of customers said 1 or more of their appliances were working quicker/more effectively than usual over the last 7 days.

Power quality experience

Domestic N = 496 Ask All E5 Did you observe any of your appliances/electrical items working quicker or more effectively than usual at certain times of the day over the last 7 days?

Households are significantly more likely to have observed a change in their lighting over the course of the last 7 days - particularly flickering

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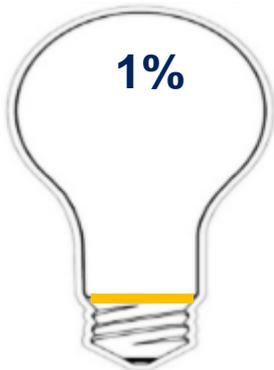
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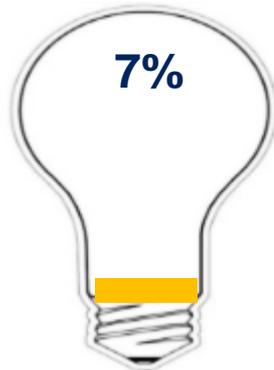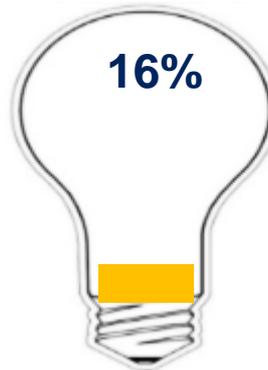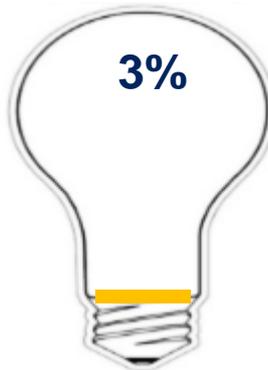
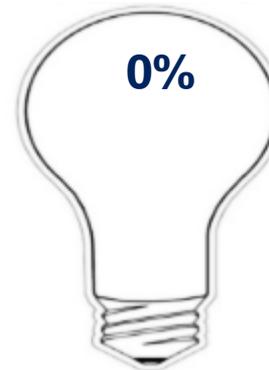|	Dimming of lights	Flickering of lights	Brightening of lights	None of these
Household	7%	16%	2%	80%
I&C	1%	3%	0%	95%

Power quality experience

Domestic N = 496 I&C N=200 Ask All E7 Thinking specifically about the lighting in your home/on your site have you observed any of the following over the last 7 days?

35

Executive summary 1

Do CLASS participants have the opportunity to observe CLASS tests?

92% of households are often in at times of peak demand 4-7pm

1/2 of I&C organisations are on-site after 5pm.

Are specific groups of customers more sensitive to CLASS?

?

1/5 of households have a medical related dependency on electricity and 2/5 are eligible for the PSR register, which may heighten their sensitivity.

The type of electrical appliances customers own/use may also mean they are more susceptible to noticing CLASS.

Executive summary 2

What are customers currently observing?

1/5 households **notice dimming or flickering or brightening of their lights,** mostly between 4pm-7pm, for a few seconds**.**

Only **5%** of I&C customers observed these effects.

7.8% observed one of their appliances working **slower/less effectively:**

- Electric showers between 7am-9am *(household)*
- Lighting between 4pm-7pm *(household)* and between 11am-1pm and 4pm-7pm *(I&C)*
- CRT televisions between 4pm-7pm *(household)*

2.2% observed any one of their appliances working **faster/more effectively:**

- Tungsten light bulbs after 7pm *(household)*

Executive summary 3

Can we measure impact on customer satisfaction?

Yes – but significant difference between satisfaction levels of households who have experienced an **interruption to their supply** and those who have not.

How will we differentiate between the two?

We will compare 'control' and '**test**' groups of customers, both of whom will have similar exposure to interruptions, but only one of which will be affected by CLASS.
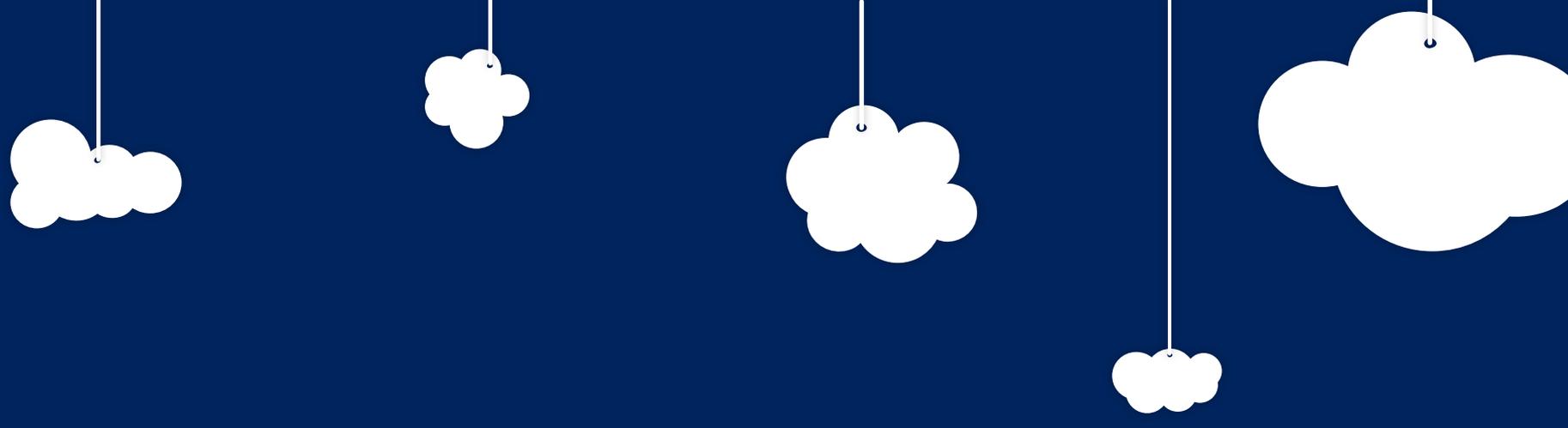
QUESTIONS

&

ANSWERS

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