Customer-Led Network Revolution

Switch on to the Customer-Led Network Revolution

Customer Trials Knowledge Sharing Event
October 1st 2013

Customer-Led Network Revolution

Phil Jones, Northern Powergrid

Why CLNR matters

What the project means for Northern Powergrid and GB consumers

Why CLNR matters

Phil Jones, Chief Executive

CLNR Customer trials knowledge sharing event

1st October 2013

NORTHERN POWERGRID

Significant changes

CREATION OF A SMARTER POWERGRID

- Integration of ‘smart solutions’ into business as usual engineering operations
- Engagement of customer groups into industrial-scale demand-side response
- Bring to an end the passive network control paradigm

THE INTRODUCTION OF SMART METERS

- Complete overhaul of our settlement systems
- The end of the era in which we have to wait for a customer to tell us that the lights are out
- Putting half-hourly system utilisation data to work to create tangible benefits

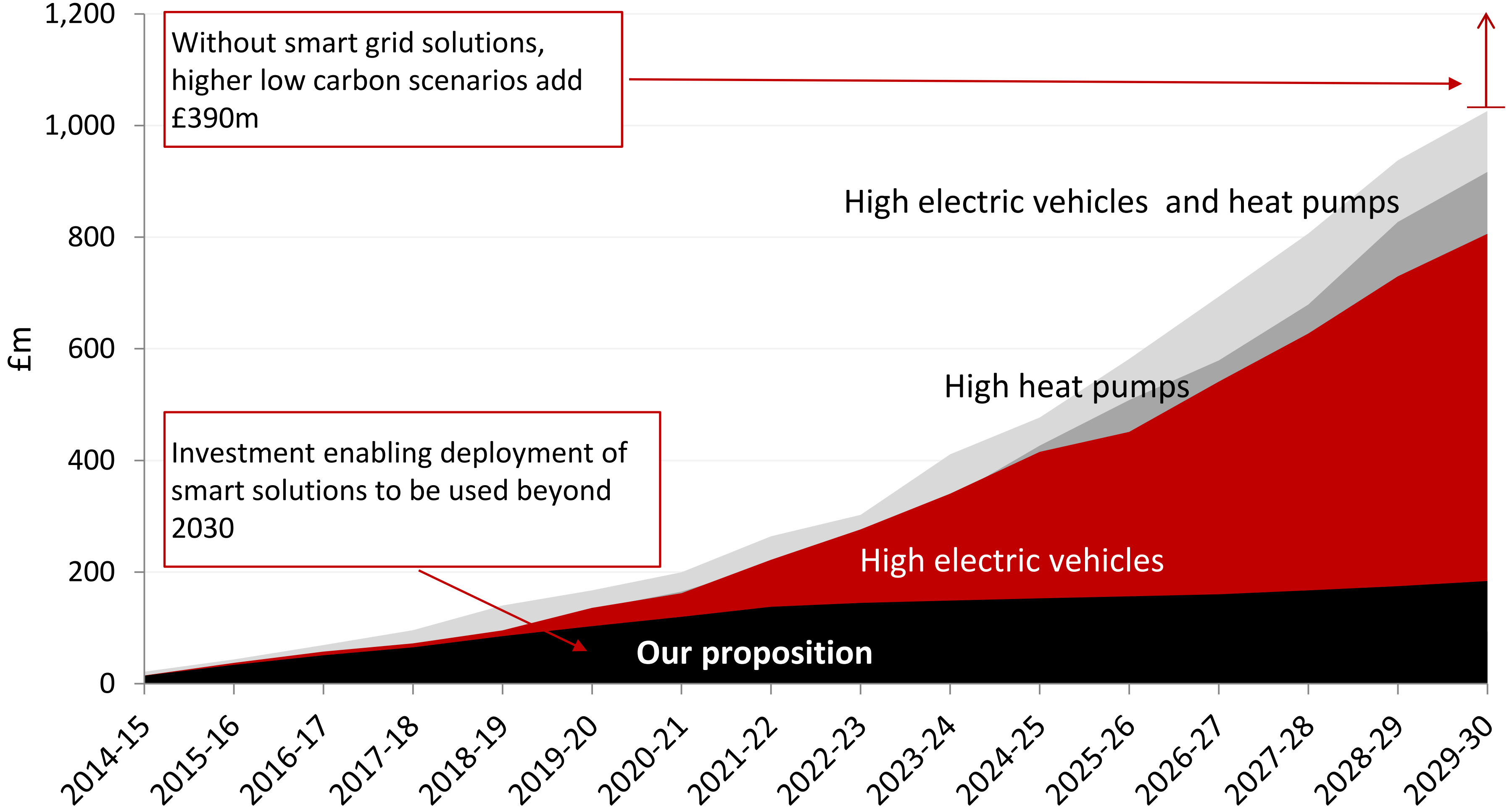
CONTINUED GROWTH IN WEB-BASED AND DIGITAL SERVICES

- Self-service business models become part of the mainstream offering
- Outbound communication becomes the dominant mode of operation
- The potential for an explosion of spin-off services at the confluence of smart meters and smart grids

DEEPER ENGAGEMENT IN ISSUES OF AFFORDABILITY

- Maintain downward pressure on costs
- A change of corporate personality in relation to the ‘social contract’ that we operate
- Tailored response to power cuts – driven by deeper insights and higher-resolution local knowledge
- The potential to create and deliver a range of smartgrid-enabled vulnerable customer services

Significant benefits



Smart grid solutions costs based on scenario modeling

NORTHERN POWERGRID

Significant results

£8bn
savings on bills

75%
success rate in I&C DSR

10%
peak reduction

43.5Mt
CO_2 abatements

2.85 MVA
electrical storage

9,000
smart meters

12,000
customers

£32m
savings on reinforcement

460
PV users

450
Heat pumps

630
Time of use tariffs trials

Customer-Led Network Revolution

Jim Cardwell, Northern Powergrid

How CLNR is delivering

Project overview, progress and outlook




How CLNR is delivering

CLNR Customer trials knowledge sharing event

Jim Cardwell

1 October 2013

NORTHERN POWERGRID

Delivering a smart grid toolkit

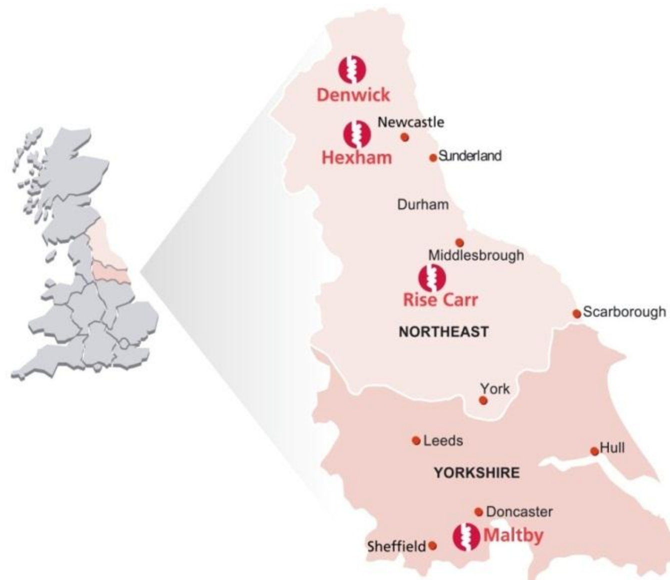
CUSTOMER SOLUTIONS

National smart meter data

Active customer participation

2

TRIAL AREAS



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CUSTOMER TECHNOLOGY

Heat pumps

Photovoltaic panels

Electric vehicles

1

INTEGRATED NETWORK TECHNOLOGY

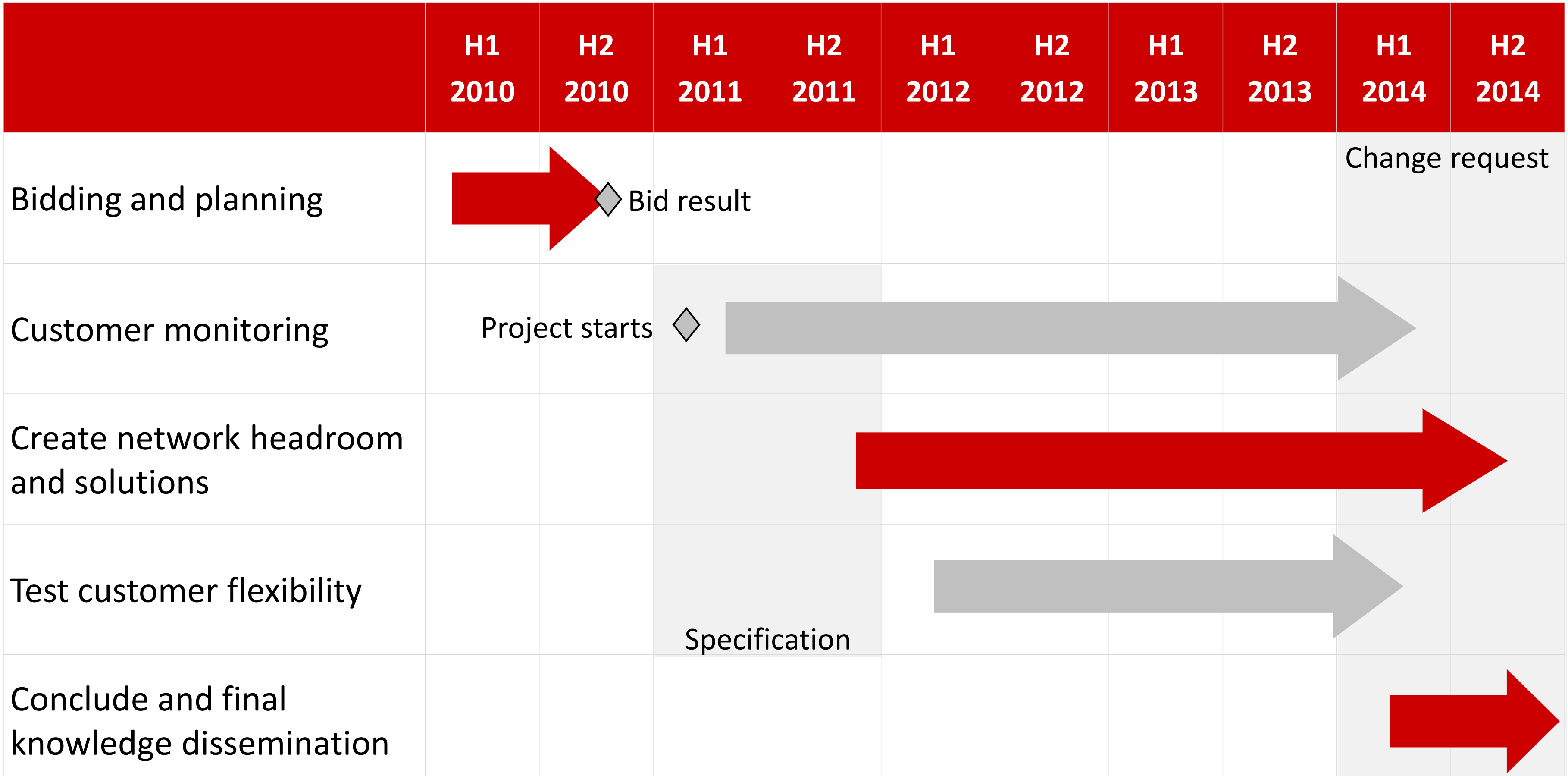
Electrical energy storage

Enhanced automatic voltage control

Real-time thermal rating

3

Progress and outlook



An industry-wide collaboration and strong consortium

Northern Powergrid	British Gas	Durham University	Newcastle University	EA Technology
• The distribution network operator for Yorkshire and Northeast, with 3.9 million domestic and business customers	• UK's largest energy supplier and leader in smart meter deployment	• Internationally recognised academic institutions		• Engineering consultancy with extensive experience of the electricity industry, including smart grids
• Operates the electricity network on which trials are taking place	• Leads on the customer-facing activities	• Researches customers' attitudes and energy-related behaviour	• Delivers end-to-end monitoring and analysis	• Creates practical outputs to implement new solutions

Sharing the knowledge gained from our customer trials

MORNING	Trials experience	Stavros Sachinis, British Gas Chris Thompson, Northern Powergrid
	Consumer behaviour - qualitative learning	Prof. Harriet Bulkeley, Durham University
AFTERNOON	Trials analysis - quantitative learning	Prof. Phil Taylor, Newcastle University
	Outputs	Mark Drye, Northern Powergrid
	Expert panel – Q&A	

Customer-Led Network Revolution

Stavros Sachinis, British Gas

Why 12,000 customers joined the revolution

Customer-Led Network Revolution

Planning for Britain's Energy Future

Why 12,000 customers joined the revolution

Stavros Sachinis

1st October 2013

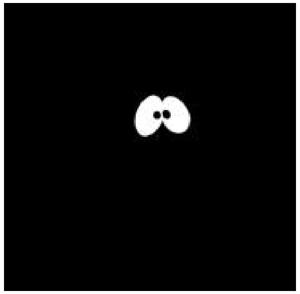
British Gas

Looking after your world

As a smarter grid evolves, Suppliers' role is to deliver maximum value for our customers

Allow customers to easily install renewable and low carbon technologies

Keep the risk of supply interruption low, in the most cost-effective way possible



Ensure flexibility services help to keep the costs of reinforcement low and customers are rewarded for any DSM action

British Gas
Looking after your world

It is important we do all we can to keep our customers’ bills down...

...but a large proportion of the bill is outside our control

With more volatile and inflexible generation and changing demand patterns, transmission and distribution requirements for balancing will rise, putting more pressure on customer bills.

*Based on actual 2011 results, is an average of all payment types/tariffs/regions and is based on consumption levels of 443 therms for gas and 3,805 kWh for electricity

British Gas
Looking after your world

Smart Grids could allow us to give our customers control over more of these costs

Saving
Shifting
On-demand
Home Automation
Intelligent Controls
Smart Appliances
Load Balancing
Microgeneration

- ✓ Reduced transmission and distribution costs
- ✓ Avoid unnecessary network reinforcement costs
- ✓ Access to cheaper wholesale prices
- ✓ Uptake of renewable and low carbon technologies
- ✓ Security of Supply

British Gas
Looking after your world

British Gas is already starting to join the dots for our customers...

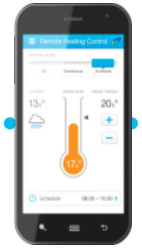
Smart		Connected Home energy / heating services			Digitalisation
Smart meter	Smart tariffs	Smart Energy Report	Remote Heating Control	Connected Boiler	**Online Account Management**

Personalised data to enable tailored advice and offerings

A bill based on accurate and up-to-date usage...

... that I understand and on a tariff that suits my needs...

...supported by real under-standing about what affects my energy usage



...with the ability to control key appliances and make choices around comfort, convenience, cost and the environment

...secure in the knowledge that my heating is working reliably and efficiently...

...and I am able to interact with British Gas how and when I want to

British Gas
Looking after your world

Smart Meters and In Home Displays are the first customer entry point to deliver Smart Grids

Real time information on energy consumption

Opportunity for meaningful engagement

Time of use Tariffs can be used to encourage customers to shift consumption and save money

Home appliances/services can be used by customers to improve the energy management of their homes

British Gas is looking to bring these benefits to our customers as early as we can

British Gas
Looking after your world

Over 1 Million Smart Meters installed through our Go-Early roll-out programme

The UK government has mandated smart meter supply to all domestic and SME customers. All retailers need to begin roll-out 2015, but British Gas has decided to start bringing benefits to customers now. To date we have installed over 1 million smart meters with in-home displays and early insight is positive.

48% of customers say they engage with their smart energy monitor on a daily basis

51% of customers still use the smart energy monitor after 6 months

71% found the traffic light system the single most helpful

94% of customers have no concerns about data collection (with reassurance)

73% of customer said that smart meters have made them think about ways they can reduce usage and save money

50% of customers say smart makes them feel more positive about BG

British Gas
Looking after your world

Go-Early roll-out points to a positive customer response to Smart Meters

Smart meter customer inbound contact NPS is significantly higher than our other contact centres.

Customers with smart meters make significantly less complaints than customers with legacy meters.

Business as Usual	Customers with Smart Meters
38	49

CLNR builds on our Smart Metering Programme to innovate in Smart Grid

22 Customer-Led trials

Customer-Led Network Revolution

Over 12,000 customers

Historic data for over 11,000 Smart Meter customers

Essential data and insight for 2/5 key Learning Outcomes:

- LO1: Understanding of current, emerging and possible future customer (load and generation) characteristics
- LO2: To what extent are customers flexible in their load and generation, and what is the cost of this flexibility?

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Looking after your world

...and a lot has been achieved so far

Over 12,000 residential and SME customers recruited

Equipment installed in almost 1,500 homes and business We

Over 600 customers live on our Off-Peak Saver 3-Rate Time of Use Tariff

Secured £2.8 million R&D grant and installed almost 450 new heat pumps

Less than 3% customer drop out rate

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We've worked with a number of partners and suppliers along the way...

INDESIT

solar&wind applications

passivSYSTEMS

coolpower

G4S

UKFM GROUP RENEWABLE TECHNOLOGIES LTD

CAPITA

INNASOL Innovative Alternative Energy Solutions

NEURA smart energy systems

pepper

OPTIMISA research inspired intelligence

GREENCOM NETWORKS

Dodd Group

JML

blahdblah we communicate

BAXI

PTS Plumbing Trade Supplies

DAIKIN

Bringing ideas to life = Charterhouse

gentoo It's how you live

MITSUBISHI ELECTRIC AIR CONDITIONING SYSTEMS

NORTHERN POWERGRID

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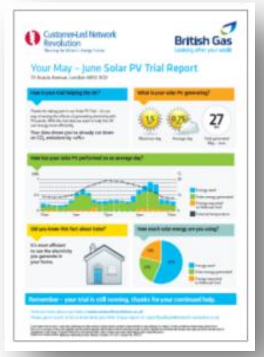
Durham University

ea technology

To recruit 12,000 customers, a complex but flexible Customer Journey was needed



50,000+ Engaged

Recruitment Campaign → Phone/ f2f Recruitment → Welcome Pack → Smart meter/ DPI → Monitoring/ Intervention Equipment → Start of Trial Vouchers → In-Life Trial Comms

Tariff Switch

Low Carbon Technology → Broadband/ GSM

12,000+ Monitored

British Gas
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We had great response from customers on our Smart Meter and microgeneration trials

Lower than expected Opt-Outs

<1% on our Control Trial

Direct Marketing Success

8% Time of Use

11% Solar PV

Time of Use Trial Oversubscribed

600+ still remaining

Smart Meters an incentive for customers

Smart eligible recruitment rates **11%** higher than existing

Saving Money through behaviour change

Overwhelming reason for sign up

British Gas
Looking after your world

We've had to Change and Adapt our Trials to Reflect what we've Learnt about our Customers

300+ rent-a-roof customers removed

Backfilled through a successful community based recruitment scheme

Abandoned electric Hot Water DSR

<1% heated water during peak hours

1/3+ customers on E7 are on gas

Limited knowledge around electric hot water usage in the UK

Re-designed trials to understand usage of electric heating

British Gas
Looking after your world

Delay to RHI meant that Social housing became a critical recruitment channel for Heat Pumps

16 Social Landlords, 3,000 properties, 950 surveys, **450** new installs

Most projects replacing storage heaters

Price conscious, technically astute market

100 tenant refusals

"Happy with existing system"

"Unsure about new technology"

"Installation upheaval"

Only 8 sales in 'able to buy' market

85 site surveys for 8 sales

Community engagement essential to successful installations

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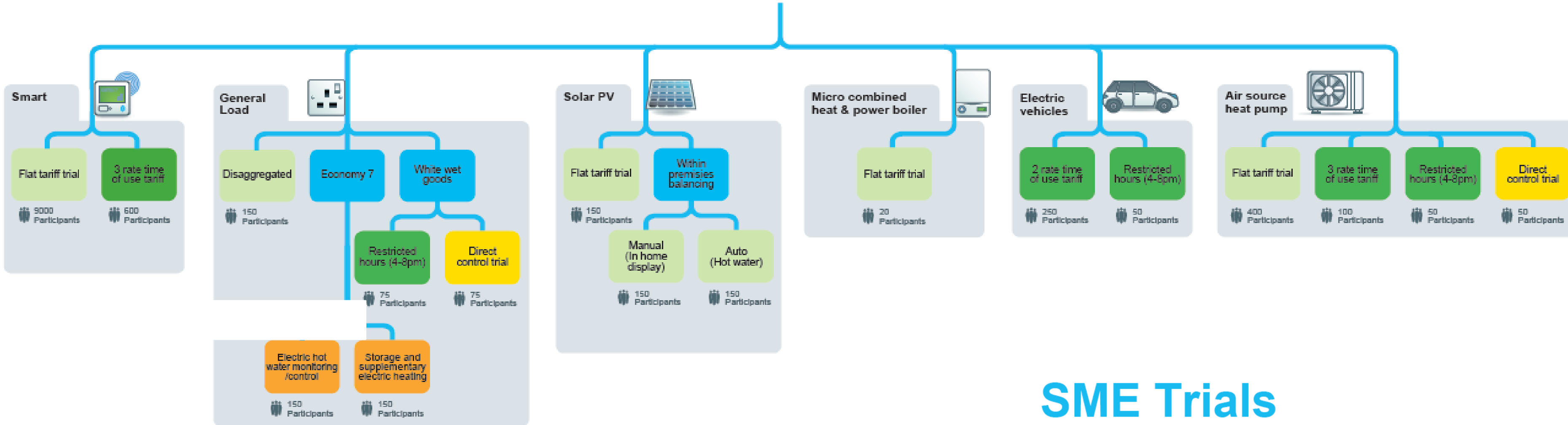
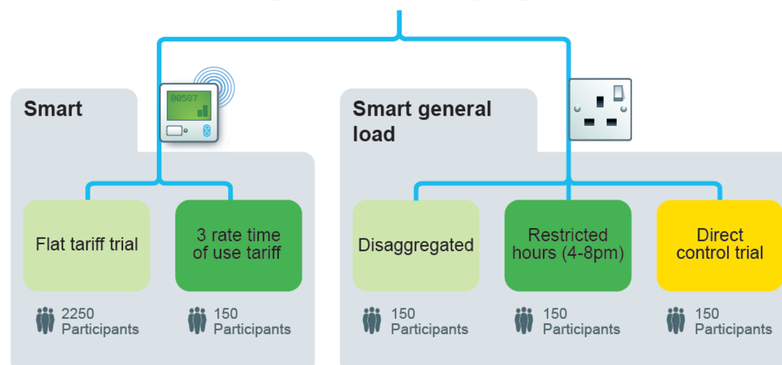
Our 22 Customer Trials Involve a range of Low Carbon Tech and Demand Side Response

Residential Trials



SME Trials



Trial type

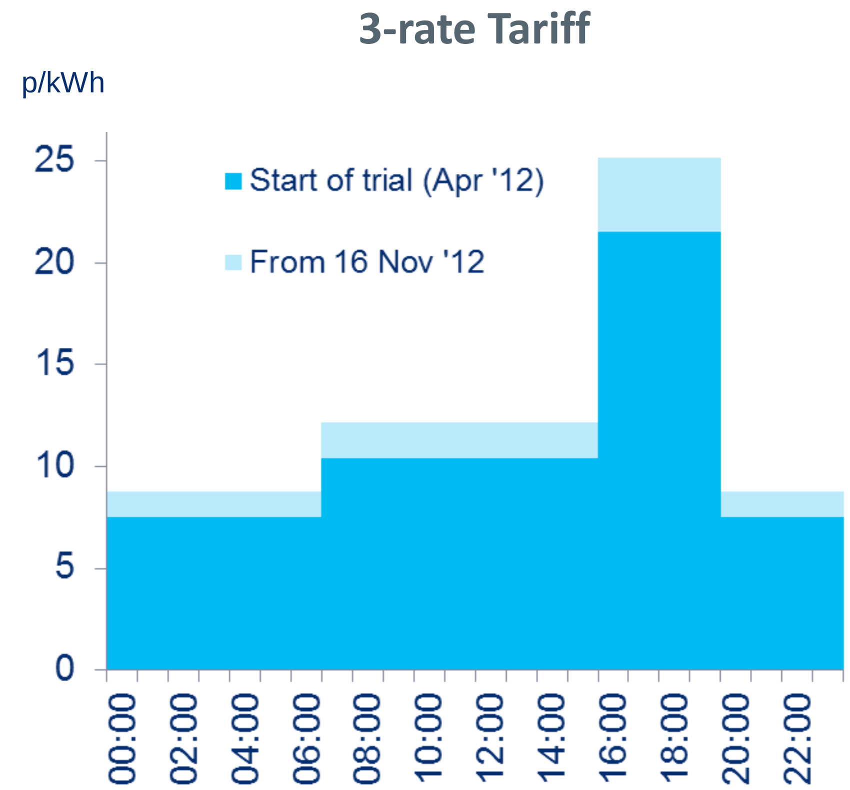
- F Flat tariff trial
- S Smart time of use tariff trial
- D Direct control trial
- E Economy 7 / 10 trial
- T Trial technology

Off-Peak Saver 3 Rate Tariff (Smart Time of Use)

Designed to reflect future prices and encourage load shift away from Peak

Rate	Time period	Per kWh adjustment
"Day"	0700 – 1600, M-F	- 4%
"Peak"	1600 – 2000, M-F	+ 99%
"Night"	2000 – 0700, M-F	- 31%
"Weekend"	Sat & Sun	- 31%
Standing charge	Daily	16p

20 hours of reduced rate electricity



The November price rise increased the peak/off-peak differential

NB: Participants are still being settled against average profile

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Peak Electricity Saver (Restricted Hours)

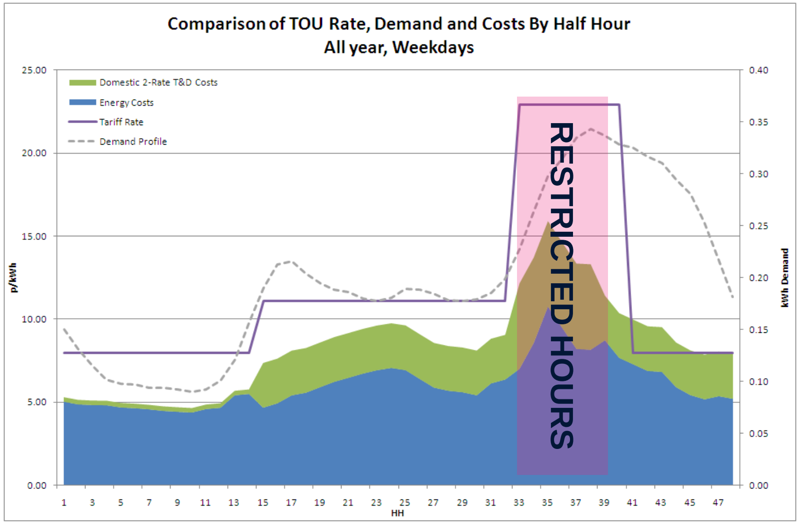
Time of Use Tariff with appliance automation to help avoid peak

Indesit Smart Washing Machine

Automated scheduling

Neura Smart Heat Pump

Automated 'turn down' for periods of up to half an hour during peak



Customers always in control - Override without penalty

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Looking after your world

Peak Energy Supply Manager (Direct Control)

Remote appliance automation to avoid peak usage at times of network constraint

- Max 15 interruptions per year
- 1 interruption per day
- Up to 10 consecutive days
- Up to 4 hours each interruption
- Peak periods only
- Customer override without penalty

Similar implementation to Restricted Hours on Smart Washing Machines and Smart Heat Pumps

British Gas
Looking after your world

New ways of working have been developed with industry to deliver a functional DSR solution

Network Operator	• Specifies Requirements • Sets demand	Northern Powergrid
DSR Operator	• Calls Response from Supplier • Assesses Response Provided	Northern Powergrid, British Gas
DSR Supplier	• Calls Response from Customer • Rewards Customer for Response	British Gas
Comms Provider	• Communicates Demand to Appliance • Communicates response to Supplier	Greencom Networks
Appliance Manufacturer	• Provides DSR Capability • Provides Communication Capability	Indesit, Neura smart energy systems

British Gas
Looking after your world

Two types of Within Premises Balancing for Solar PV customers

Automatic Balancing

Use of surplus solar PV generation to heat hot water electrically

Manual Balancing

Can real-time information encourage customers to maximize in-home use of on site generation via an IHD?

British Gas
Looking after your world

Early Results show a positive response to Time of Use, Reducing peak and overall Demand

Customers reduced peak consumption and reduced their demand overall

Behaviour is consistent over 6 months

Reduced consumption at weekends despite no price incentive

94% of customers found it possible to shift their energy usage

93% of customers were interested in staying on the tariff

95% of trial participants would choose a multi rate tariff over a standard tariff if it were available post-trial

83% expressed an interest in the idea of a smart appliance that would schedule their operation according to their tariff

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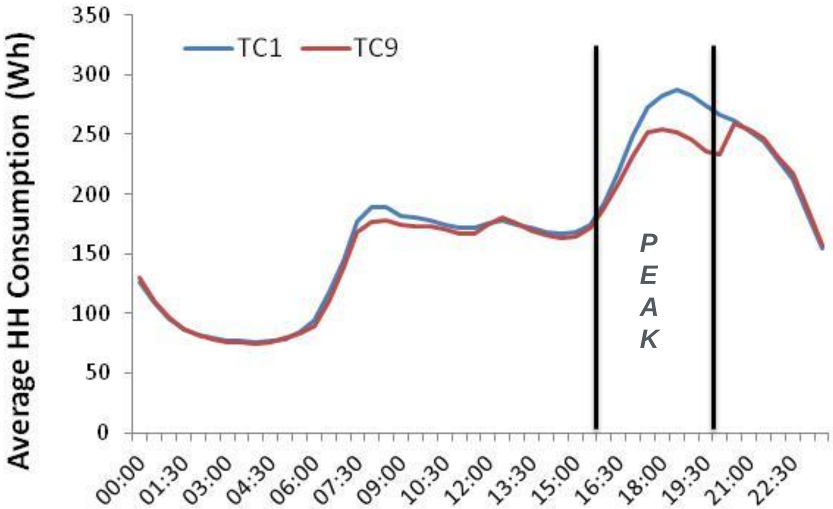
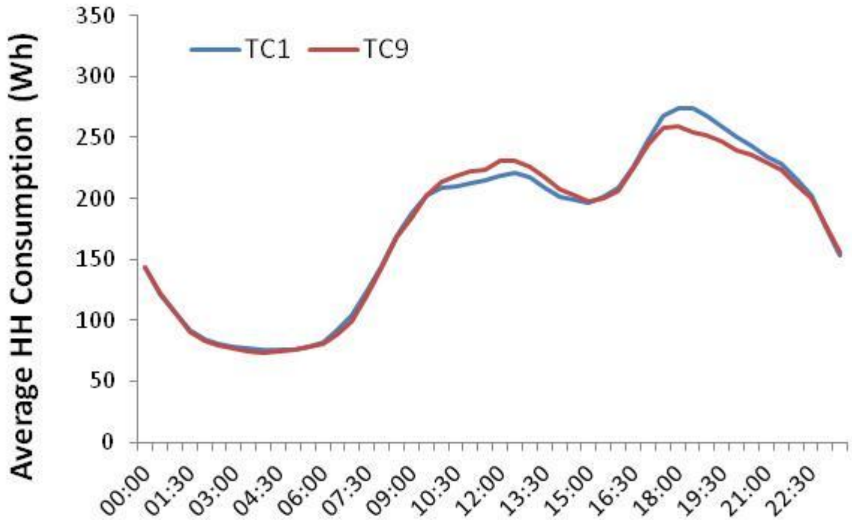
Looking after your world

During the trial, there was a noticeable change in consumption as customers avoided the peak period

WEEKDAYS



WEEKENDS



On average the ToU customers consumed 3% less than the control group and their peak consumption was 10% lower.

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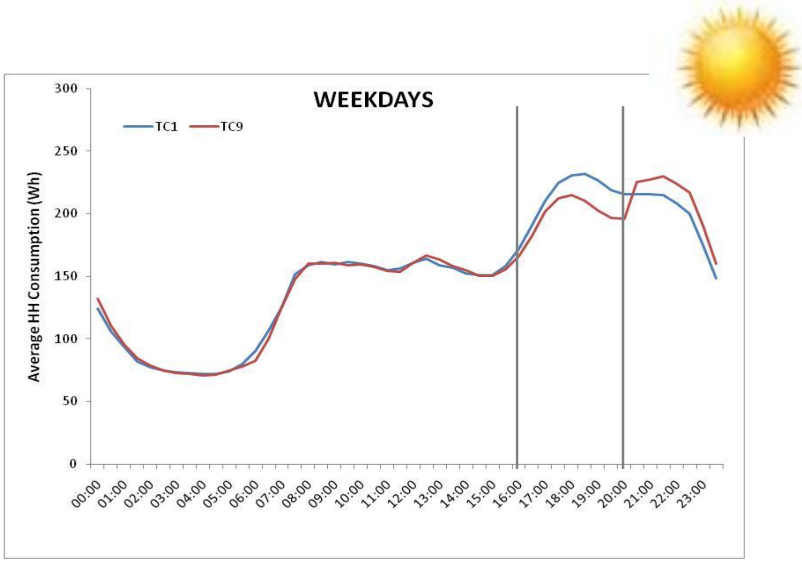
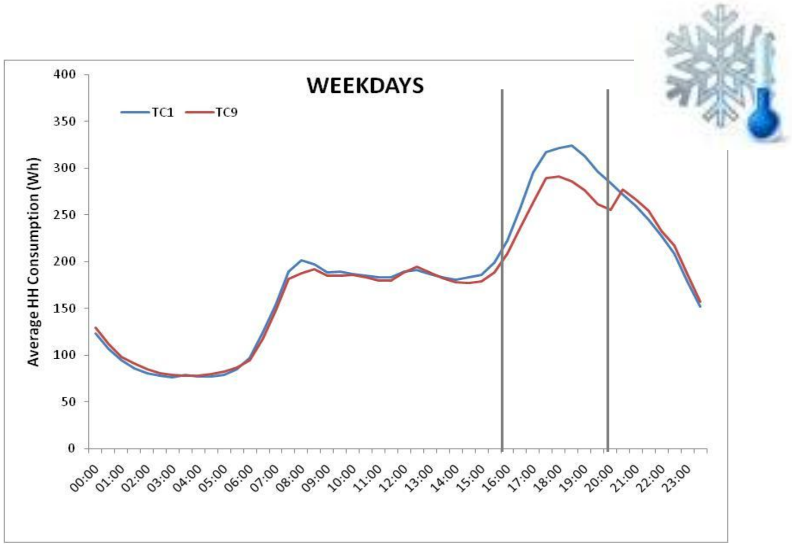
Looking after your world

Behaviour persists over time, with greater load shifting and savings in winter months





- ToU customers reduced their peak consumption by 4.5% vs. 4% increase in the control group
- Overall, both groups increased their consumption by 1% in the summer months

- ToU customers reduced overall consumption by 15% vs. 14% in the control group
- ToU customers considerably reduced their peak consumption by 23% vs. 12% in the control group

British Gas
Looking after your world

Now, we're integrating trial findings into everyday business innovation

Free Saturdays

New smart meter customers are being offered a Free Saturdays tariff, the first commercial Smart ToU tariff trial

Business Energy Insight

New analytics capacity is being rolled out to allow customers to access their own consumption data online and benchmark it against similar sector averages

Industry advocacy

We are working with partners and gathering evidence to highlight and help remove regulatory and policy barriers to wider use of DSM

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Looking after your world

CLNR has allowed us to explore potential energy services through innovative Customer Trials

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Time of Use Tariffs

Tariff/Tech Energy Reports

Appliance Automation

In-Home Balancing

Storage & Demand Side Response

British Gas
Looking after your world

What needs to happen for customers to start benefiting from Smart Grid

Successful Smart Metering Programme

Cost-reflective price signals

incentivised innovation open to all

Emergence of new competitive market models

More choice in how customers control energy

Better customer experience – Reduced bills

Clear Customer Communication

What's next from British Gas on CLNR…

Produce analysis and insight from the trial data, working with Durham University

Test Direct Control and Restricted Hours on smart heat pumps and washing machines

Test innovative communications with customers

Disseminate results and insight across our business and industry

Talk to our customers about their experience

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Customer-Led Network Revolution

Chris Thompson, Northern Powergrid

Demand side response trials with industrial and commercial customers




Demand Side Response

CLNR Customer trials knowledge sharing event

Chris Thompson

1 October 2013

NORTHERN POWERGRID

Demand side response (DSR)

What is Demand side response?

- Any program which encourages shift in demand for energy by end customers
- Participation is a response to factors such as incentive pricing, new tariffs, greater awareness or increased sense of responsibility
- End consumers agree to be involved, but their actual participation might be active behavioural changes or passive through automated responses

What DSR is the CLNR project trialling?

- Industrial and Commercial customers (I&C)
  - Generation
  - Load
- Domestic Customers (direct control test cells)
  - ‘Smart’ washing machines
  - Heat-pumps with thermal store

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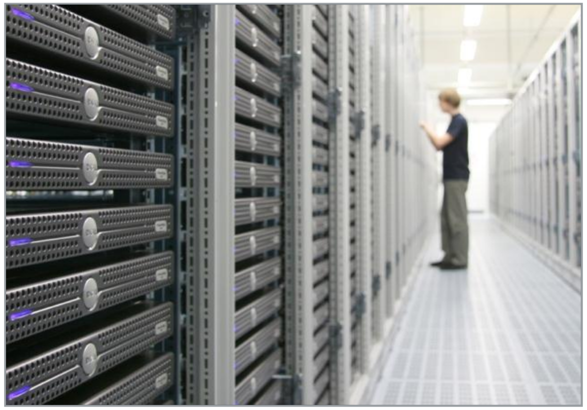
DSR trials Winter 2011-12: I&C customers



Customer 1: Mining

- Contracted DR: 2 MWh
- DR Type: CHP Generation
- Availability: 3pm - 6pm, weekdays
- Response Time: 15 minutes
- Season: Jan. – Feb. 2012

Customer 2: Refrigeration

- Contracted DR: 0.75 MWh
- DR Type: Load Reduction
- Availability: 3pm -7pm, weekdays
- Response Time: 20 minutes
- Season: Jan. – Feb. 2012

Customer 3: Web-Hosting

- Contracted DR: 0.8 MWh
- DR Type: Diesel Generation
- Availability: 3pm - 7pm, weekdays
- Response Time: 20 minutes
- Season: Feb. 2012

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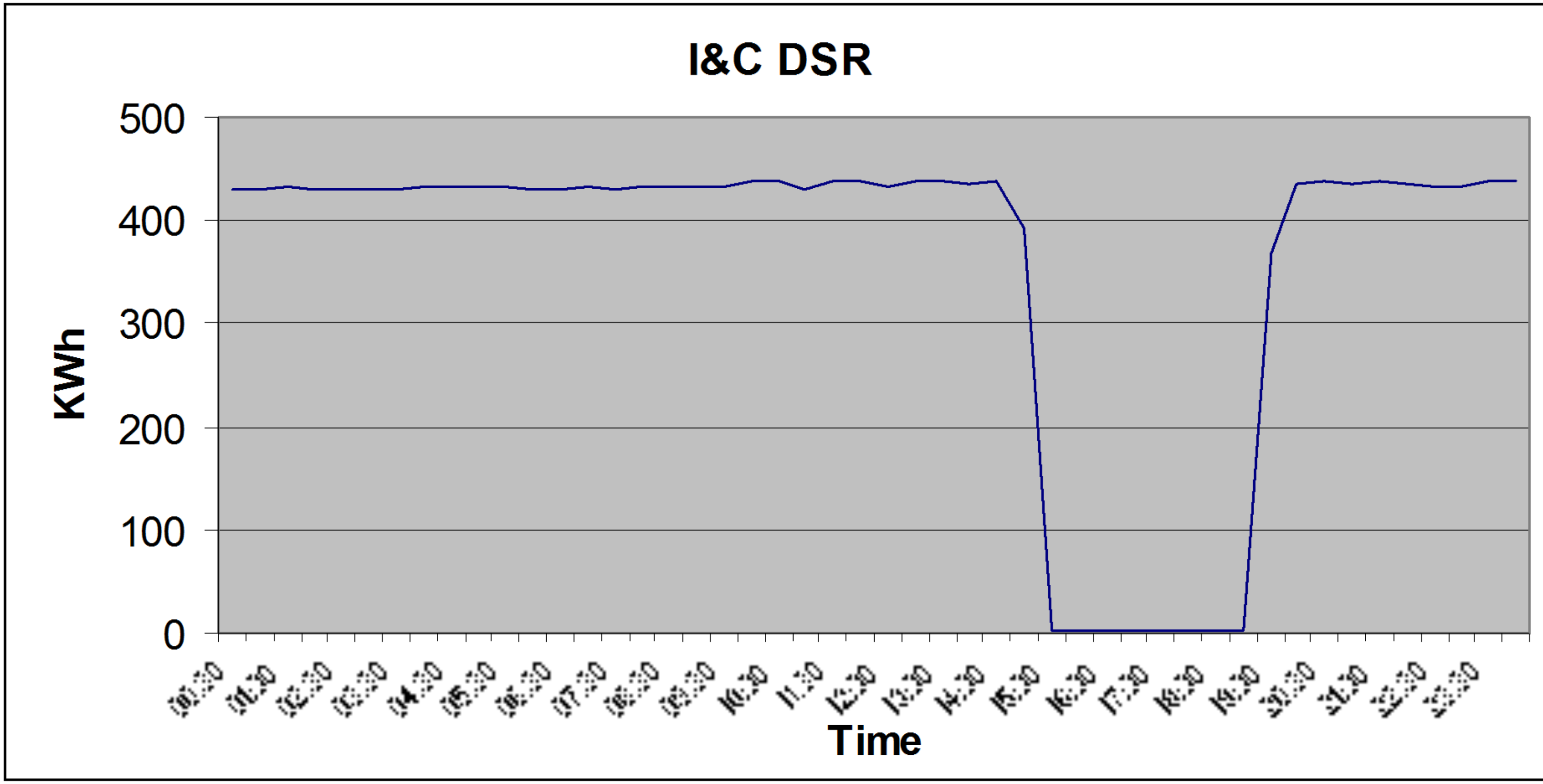
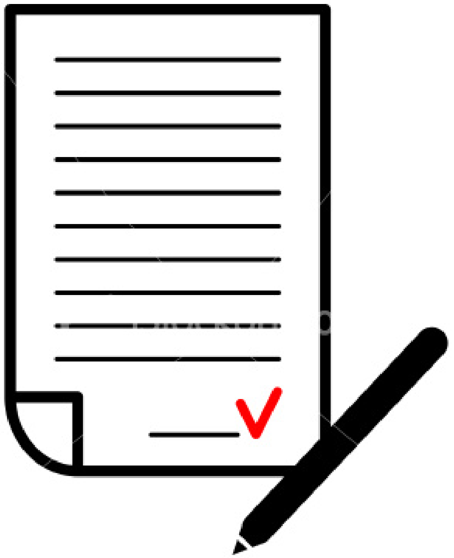
DSR trials Winter 2011-12: I&C customers

Pre/ Post Event Metering



DSR trials Winter 2011-12: I&C contract performance



Instruction log

- 4 – 1-day events called across 3 sites
- 1 – 4-day event called across 2 sites

Successful events

- 9 successful DSR events from 13 instructions

Failure events

- Fire on site which removed one site for the winter 2011/12 trial period
- Generator failure on 1 day, site resumed full availability following day
- Event failure vs. contractual parameters – DSR already provided for Triad (although load reduction was achieved from a DNO perspective)
- Demand reduction delivered but not at the contractual level

DSR trials Winter 2011-12: I&C lessons learned

- DNOs can strike deals with aggregators to deliver ancillary services that benefit distribution networks' customers
- There are synergies between ancillary services for distribution and transmission
- Limiting factors include cost, disruption, contract lead times and committing to repeat interruptions
- The DSR contracts delivered a 77% success rate when participants were instructed to deliver DSR. The 2013-14 trials will test this further
- Knowledge transfer from the project to operational teams will involve a significant resource commitment

DSR Research: Flexitricity & ESP

- Sought targets based on a sample of primary substation locations
- Low level of awareness of DSR from business decision makers
- Once DSR is explained decision makers want to know more
- Even if customers show a positive interest in DSR, there may be no scope to provide it, e.g. insufficient load or uncorrelated peak usage
- When targeting a tight geographic area the initial customer drop-out rates are high
- The implementation of DSR from generation substitution is the most successful entry point for new I&C customers
- The lead times from making initial contact with a customer to finalising a DSR contract can range from 12 to 24 months

DSR trials Winter 2013-14: Learning objectives

We aim to test and analyse:

- Customer appetite for actively playing a role in DSR
- Equipment procured for the trials
- System and communications reliability (including GUS interface)
- Customer behaviour
- Consecutive weekday interruptions

Following analysis will:

- Complete the learning capture
- Document DSR trials and disseminate

DSR trials Winter 2013-14: Domestic customers

Smart Washing Machines

- 90 customers in Northern Powergrid's region
- DSR type: Direct Control
- Availability: 4pm-8pm, Weekdays
- Contracted DSR: 15 events maximum, 4 hours each interruption
- Messaging: In-home display or WWG display
- Incentives: Wet-white goods (WWG), £50 at end of trial

Heat Pumps with Thermal Store

- 17 customers nationally
- DSR type: Direct Control
- Availability: 4pm-8pm, Weekdays
- Contracted DSR: 15 events maximum, 1 hour each interruption
- Messaging: Telephone call
- Incentives: DECC subsidy (average £3,500) £50 at start and end of trial, free broadband during trial

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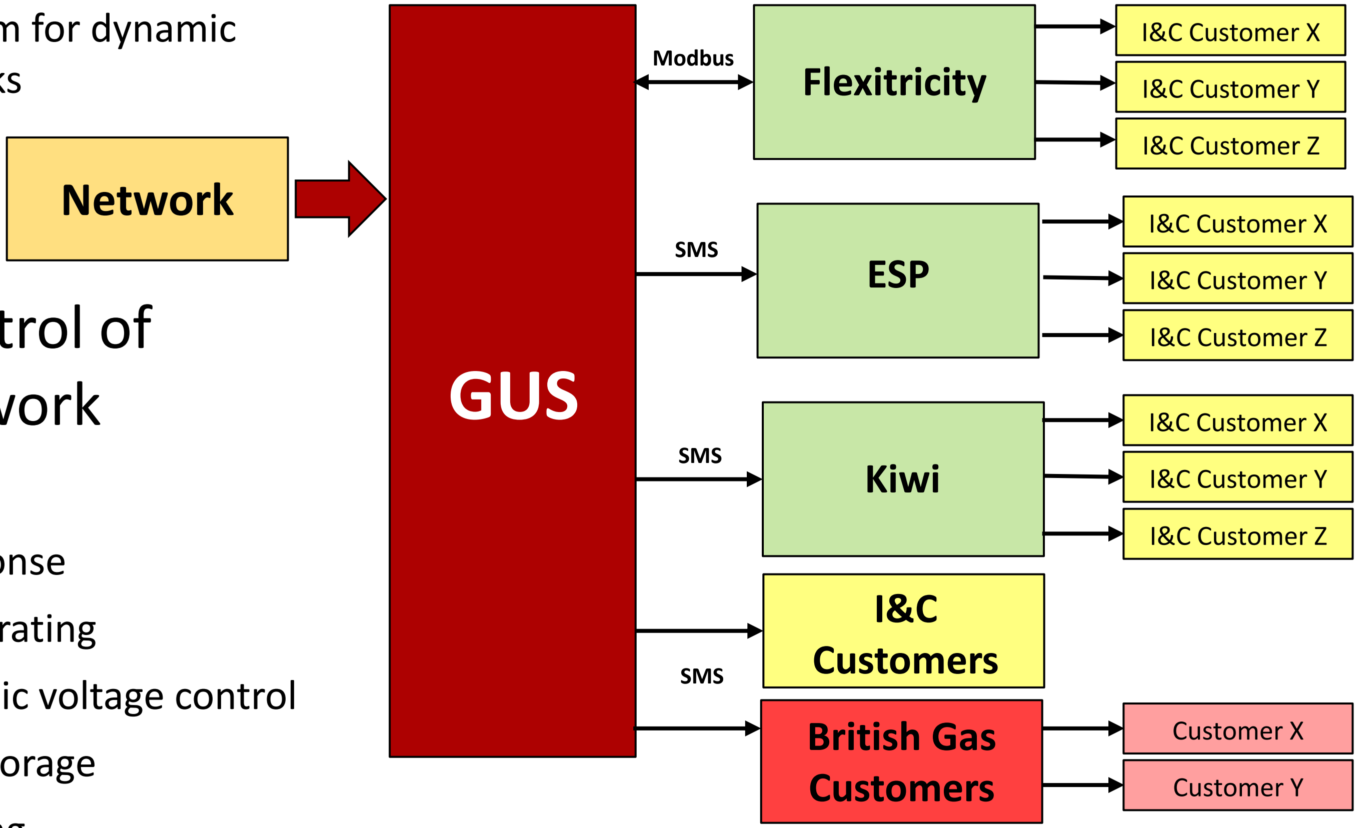
DSR trials: Grand unified scheme (GUS) interface

What is GUS?

- Active control system for dynamic distribution networks



Integrated control of enhanced network devices

- Demand side response
- Real-time thermal rating
- Enhanced automatic voltage control
- Electrical energy storage
- Network monitoring

DSR trials: Next steps & outputs

Next steps

- Plan and execute domestic DSR trials – starting November 2013
- Plan and execute I&C DSR trials – starting November 2013
- Engage direct with I&C customers for DSR - by March 2014
- Test the end-to-end GUS interface to DSR customer interface – by March 2014
- Capture trial results – May 2014
- Produce trial learning outputs – July 2014
- Disseminate – August to December 2014

Outputs

- The interim DSR Report on I&C customers can be found in the project library at: www.network revolution.co.uk

NORTHERN POWERGRID

Customer-Led Network Revolution

Professor Harriet Bulkeley, Durham University

Engaging consumers in the smart grid

Engaging Consumers with Smart Grids

Initial Findings from the Customer-Led Network Revolution project

Harriet Bulkeley and Gareth Powells
Durham University

Durham University
Durham Energy Institute

Customer-Led Network Revolution

Connected Smart Infrastructure

A New Social Science Of Energy

Understanding energy use

- As easy as ABC?
  - "For the most part, social change is thought to depend upon values and attitudes (the A), which are believed to drive the kinds of behaviour (the B) that individuals choose (the C) to adopt"

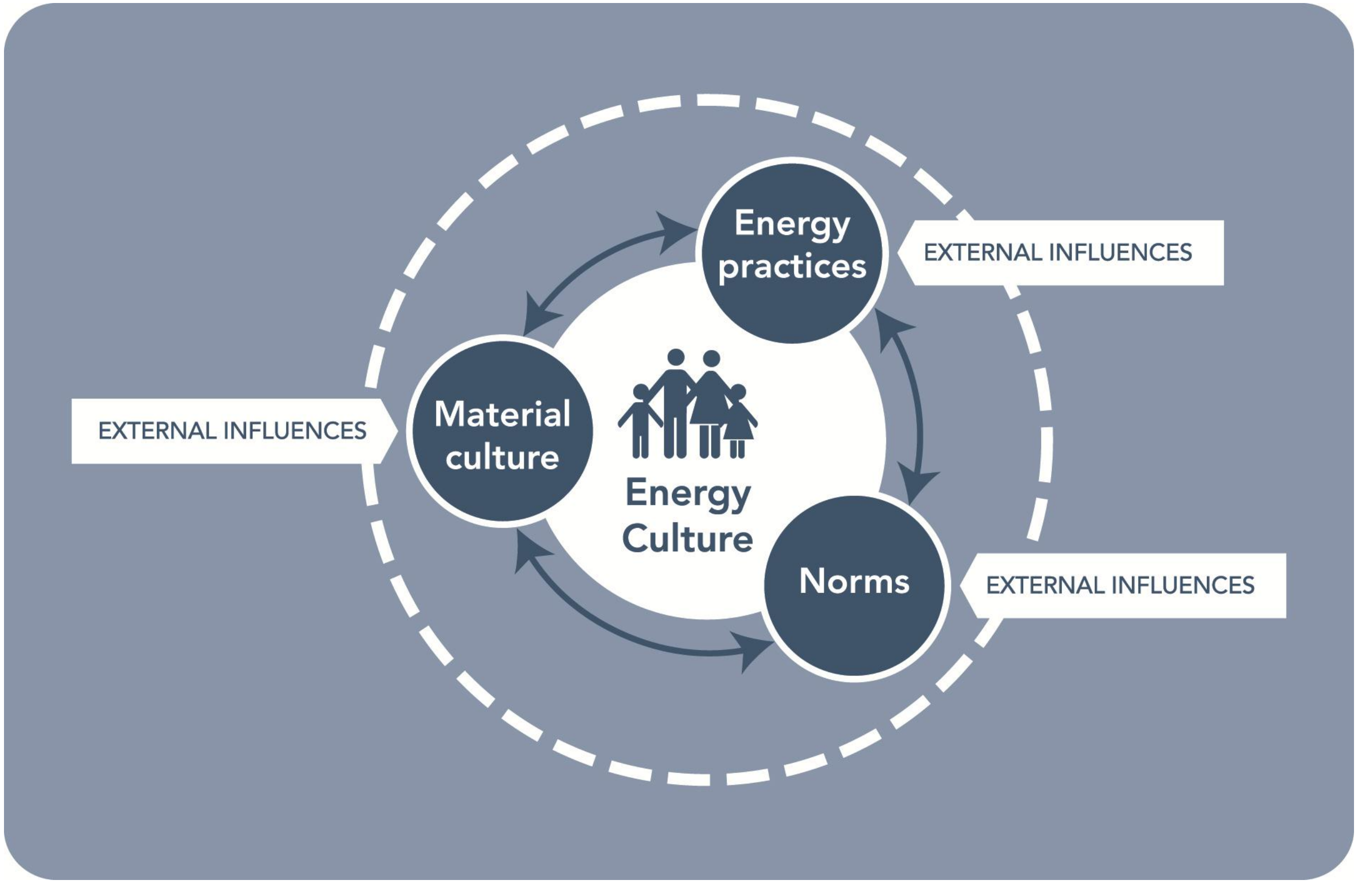
- But does this model stand up to reality?
  - Do those with similar attitudes consume energy in the same way? Are socio-demographic variables good indicators of energy use? How far do people see energy use as a matter of 'choice' or of necessity? To what extent are actions that use energy 'behaviours' or are they more like routines, habits? Is energy what people want, or is it the service it provides?

Understanding energy use

Consumers are not making market choices about their energy consumption – not the same as choosing a supplier

Instead they undertake a range of practices that use energy in different ways - why/how might these practices change?

Towards a socio-technical approach: 1



Home energy cultures

See: http://www.csafe.org.nz/energy_cultures_1

Towards a socio-technical approach: 2

Social practices

- How and why we use energy has little to do with our ***attitudes*** and is not a matter of ***rational choice*** because …
  - Technologies, artefacts and material conditions shape both what we do and how/why we choose to do it
  - Agency – the ability to act – is not held by individuals, but socially and materially structured (e.g. school runs, working days, reheating food)

The Customer Led Network Revolution Project

Approach and Findings

Social Science Methodology

- Survey of participants in the CLNR Trial
  - Approximately 700 domestic customers
  - Approximately 150 SME customers

- In-depth interviews and site visits
  - Approximately 160 domestic interviews (including some follow-ups as trial progresses)
  - Approximately 50 SME interviews

What shapes energy use?

- **Rhythms and routines**: energy load curve is driven by habitual routines and daily rhythms
- **Home economies**: active energy management in many households, often based on 'know how' rather than formal knowledge and use of multiple resources (sun, radiators, electricity, gas)
- **Shadows of technologies past**: people use new technologies with a memory of their old systems and how their families used energy in the past
- **Domestic transitions**: household change, compaction and multiple living arrangements

Illustrating the home energy economy

Cooking

“I might do my frozen veg for 4 or 5 mins (in the micro) but that’s me lot really. I think I use more gas than electric really, because when I do my cooking and froze it I'll heat it up on the hob. I take it out in the morning, leave it out to thaw, then heat it up in the hob. Very, very rarely use the microwave. It’s using electricity, it’s cheaper to leave it out on the kitchen top. I mean I do use it of I've forgotten to leave it out."

Chores

"Well, I usually wait until its quite a bit then I'll wash, There's a lot of things that can be dried in the drier but not everything like jeans and some t-shirts with pictures on, I don’t want to spoil'em. I dry my towels in there because when you hang them out they go rock hard but that’s something that does take a lot I think, the drier.”

“"With this good weather I've had everything washed, jackets and trousers. These last few days it’s been washing mad, so suddenly the good weather has made me use the washer - but not the drier."

What do people say, what do they do?

- For many, often appears that there is a ‘gap’ between what people say they want in terms of saving energy/money, and what they actually do
- This gap appears because we assume that what we think/say (attitudes) shapes our behaviour
- Instead see that how people use energy is structured by socio-technical conditions, then:
  - Such a gap should not come as a surprise
  - Closing the gap is not an individuals responsibility (they should do what they say they want to do)
  - We can recognise a desire that is not being met, and where the market/state can step in to help
  - We found a ‘stuck middle’ – especially in SMEs – wanting help and support (practical, hands on) to change

How do people use energy at home?

- Energy is used to provide comfort, services (clean clothes, cooked food), entertainment, identity.
- Energy is not used *irrationally*- it is just that the ‘***rationales***’ for using it are not purely financial
- People run an ‘economy’ – balancing spend (‘my only luxury’) with thrift, the use of multiple resources (hanging the clothes out), and what they want to achieve.
- **Control** of energy is important – people use timers and programmers, but also thermostats as switches for heat

Flexibility

What does flexibility mean?

- Demand side management/response as a means of tapping into the 'flexibility' of energy use

1. **Time Flexibility**
2. **Location flexibility**
3. **Process flexibility**
4. **Practice abstention or curtailment**

What shapes flexibility?

- **Relationships beyond the home** (e.g. commuting, school runs, caring for relatives, home-working)
- **Rhythms and Routines** of everyday life (e.g. children's tea time, watching the soaps, shower before work, cup of tea with telly)
- **Socio-technical capacity** of different energy practices (e.g. different cooking appliances, timers on dishwashers, outside drying space, damp homes)
- The **design** of interventions and forms of customer **engagement** (e.g. TOU tariffs, IHD, sense of collective response to energy challenge, distrust of motivations of energy companies)

Examining (in)flexibility

- Flexibility is not a property of *individuals* but of *practices*
  - Flexibility in some customer groups is shaped by the coincidence of social structures, routines, capacities and engagement – these groups don't map neatly to demographics
  - Even where flexibility is evident this is not the same across all forms of energy use – some practices are more or less flexible than others

Examining (in)flexibility

Cooking – less flexible

“We're quite traditional, lunch is at 12, tea is 5. … Its based around work. There will be times when you get in late but its not that often”

"It has learnt 'us a lesson in one respect in that I used to just fill the kettle up and plonk it on. Now when I see that little thing go orange I just think no … I just put enough in for a cup. Because you can be very neglectful with things you know."

Chores – more flexible

“Now that we got that (tariff) my wife’s been putting a wash in after 8 o clock at night, and before she goes to work she’ll hang it out.”

“Things like laundry, putting the dishwasher on. We used [to] put it on after tea, now it’ll get left ‘til the next morning, or after 8.”

Which interventions are most successful in producing more flexibility?

IHD:

- ***Home Economy:*** *"We've had it (IHD) just over a month about 6 weeks … since the husband left. It's brilliant. I do check it on a daily basis. Yesterday cost 54p, and 1.11 (Gas), last 7 days 5.84."* (DL07)
- ***Family Management:*** *"My husband keeps going "Get it off! Get the kettle off!"* (GP028)
- ***Optimisation Games:*** *"I think we try to use less because they're showing you how much you're using."* (DL402)

Which interventions are most successful in producing more flexibility?

Tariff:

- ***Laundry:*** *We're doing it after 8 o'clock on a night and over t'weekend. Washing, most of t'laundry gets done on a weekend unless we have something that actually crops up. (DL0602)*
- ***Family Management:*** *You'll have to change. I told you, you're going to have to adapt. (DL12)*
- ***Fixed Cooking:*** *"I probably cook my tea at about 5 o'clock, I know it's probably the wrong time, but I mean, what time are you supposed to have your tea?!"*

Where could we find flexibility?

- **Dual fuel households** have more Load Flexibility due to their ability to fuel switch away from electricity when required.
- Where there are **households for whom 9-5 working is not the norm**, there is the possibility of greater Practice Flexibility
- Active use of **timers on white goods** enables Practice Flexibility where households are aware of this functionality.
- **Engagement with the IHD** appears to encourage and provide affirmative feedback on TOU related flexibility.

Fostering engagement: what works?

- **Clear feedback** - various means
- **No direct evidence** from CLNR on the effects of **comparison/ gaming** etc. – not part of this project, and literature on this is currently sparse though there are a number of project underway
- **Experience of the 'workings' of the grid** whether through previous interruptions / strikes or through proximity to visible infrastructure
- **Effective communication** with a trusted individual

Summary

1. We need a new vocabulary – the language of 'consumers' may mean we are not looking in the right places for solutions
2. We find that there is significant variation between different practices in terms of drivers and the factors that shape the extent to which they are (in)flexible
3. Our research suggests that many households have a great deal of practical 'know how' about their energy use – this could be a resource for smart grid development
4. Engaging households with smart grids will require a different set of relationships between the providers and users of energy – the kWh retailer /consumer relationship may not be adequate for this task

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http://www.networkrevolution.co.uk

Durham University
Durham Energy Institute

Customer-Led Network Revolution

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Professor Phil Taylor, Newcastle University

Emerging conclusions from the quantitative data

Customer-Led Network Revolution

Newcastle Institute for Research on Sustainability

Newcastle University

Customer-Led Network Revolution Quantitative Data Analysis

Phil Taylor

Overview

- Residential Customer Consumption Data
- Solar PV
- Heat Pumps
- Electric Vehicles

- **How can insights from the data be used to plan distribution networks and integrate control systems?**

Socio-Technical approach to Smart Grids

Network and Customer Aspects

- Real Time Thermal Ratings
- Energy Storage Systems
- Enhanced Voltage Control
- Demand Side Response

What is the optimum mix of solutions to ensure electrical networks can enable the low carbon transition?

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Learning Outcomes

- **Learning Outcome 1**
  - *Current, emerging and future customer characteristics*
- **Learning Outcome 2**
  - *Customer flexibility cost and value*
- **Learning Outcome 3**
  - Network flexibility cost and value
- **Learning Outcome 4**
  - Optimum solutions – socio, techno, economic
- **Learning Outcome 5**
  - Embedding learning into BAU

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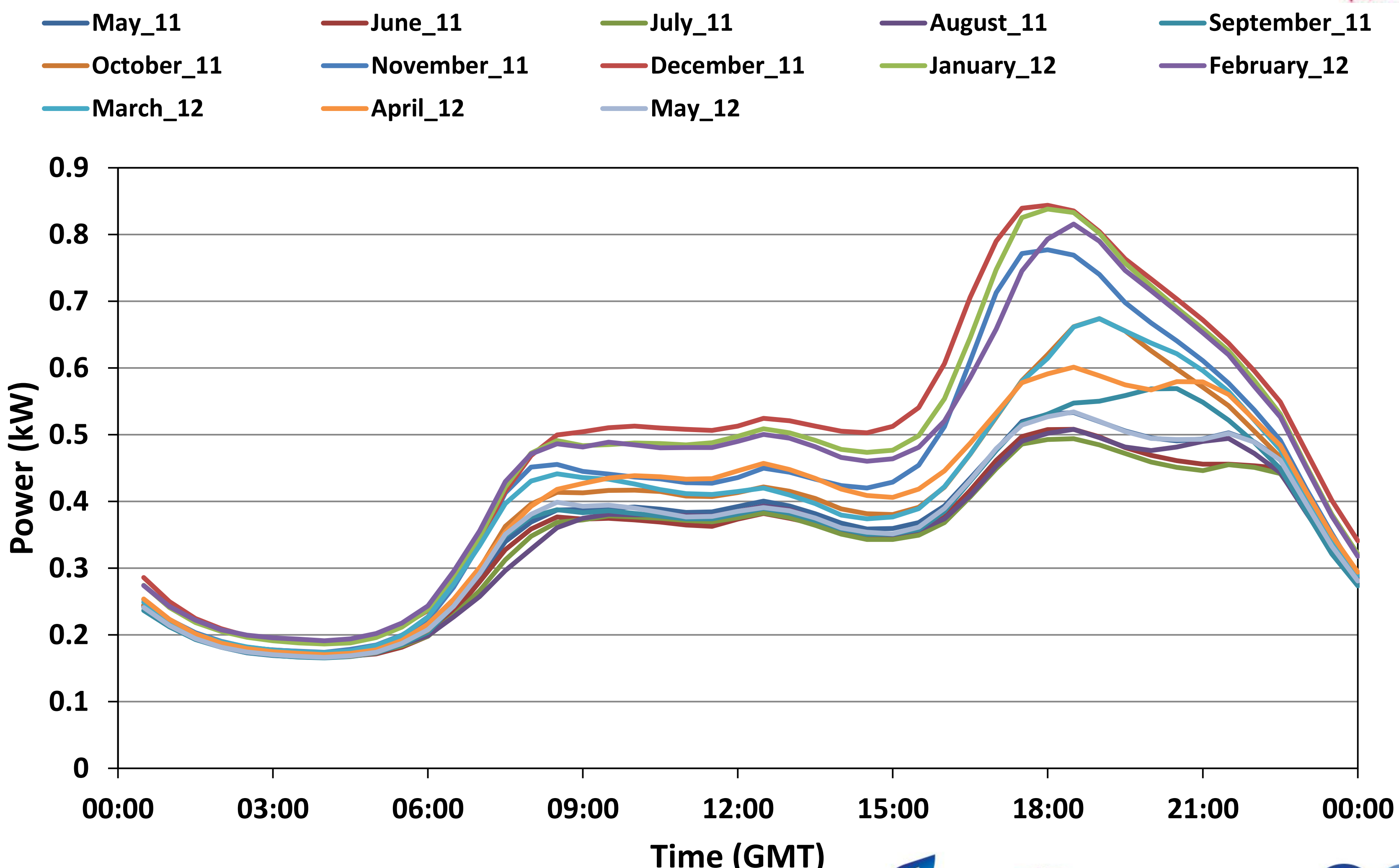
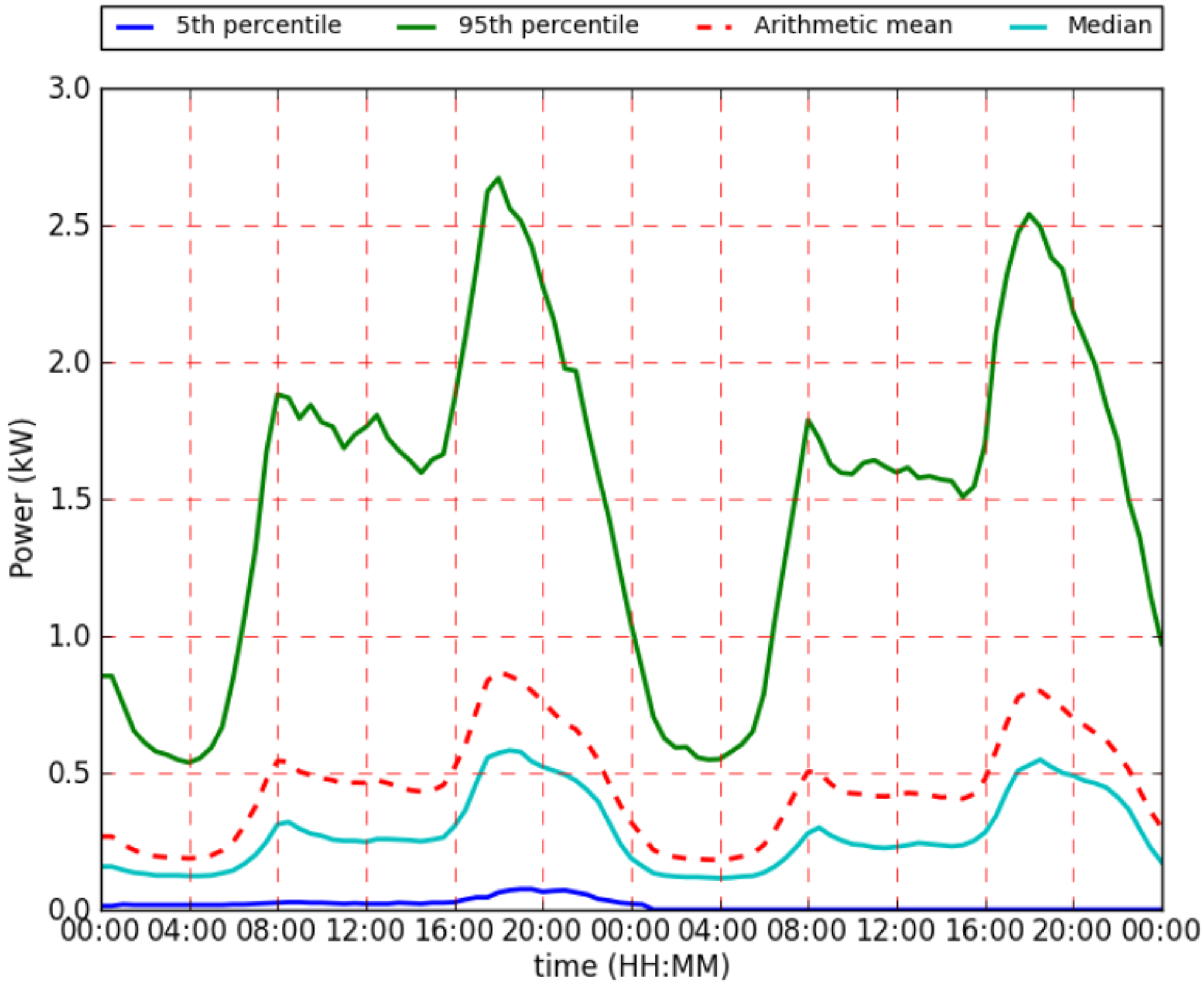
Data Analysis

- 14,000 I&C customers, ½ hourly 2 years
- 8,000 residential customers, ½ hourly 1 year
- 1,700 SME, ½ hourly 1 year
  - 2,250 target
- Plus network monitoring HV, LV, RTTR …

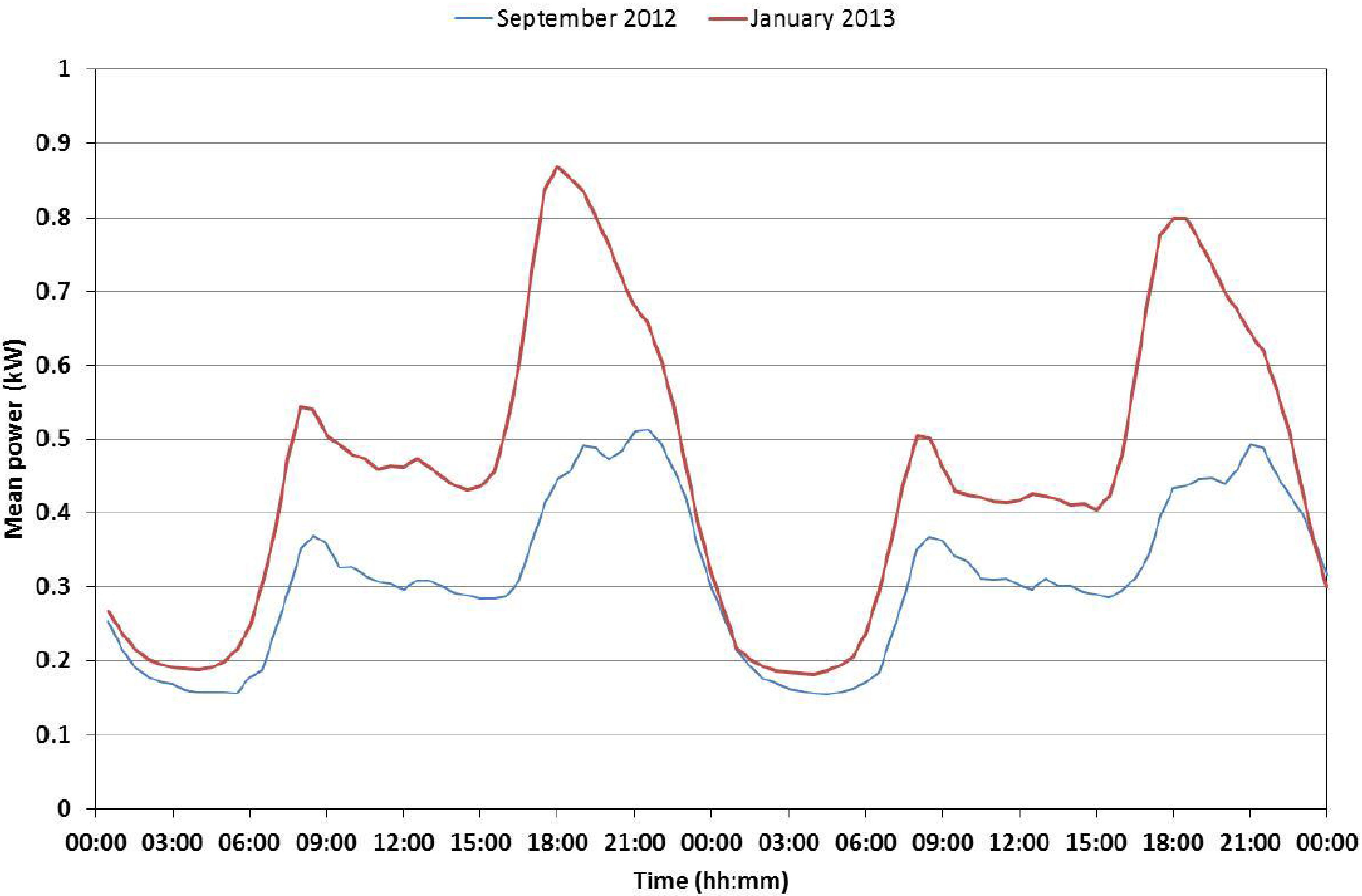
Smart Meter Data (8,000 customers) (Test Cell 1)



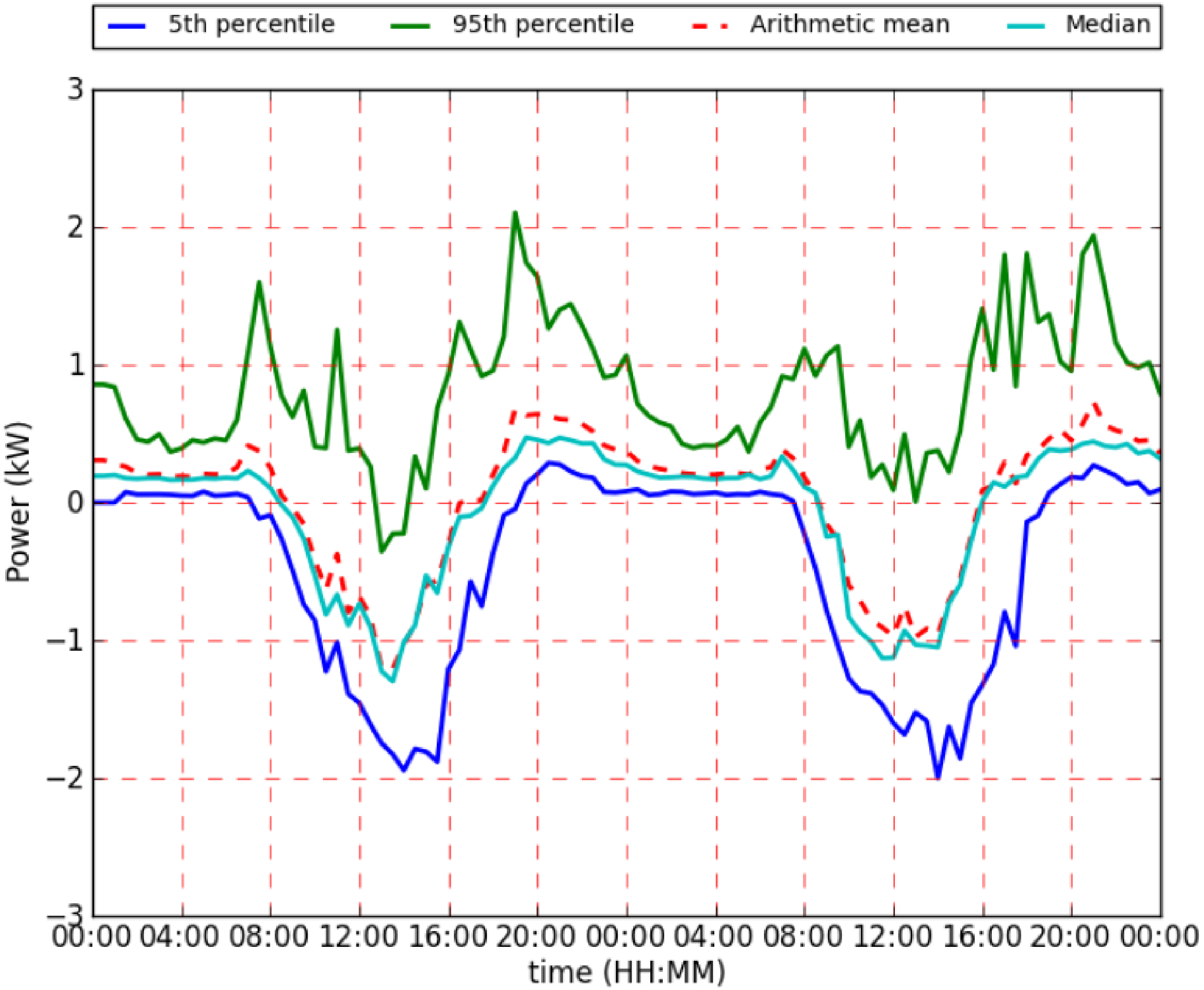
Half Hourly Consumption 16/17th Jan 2012 (TC1a)



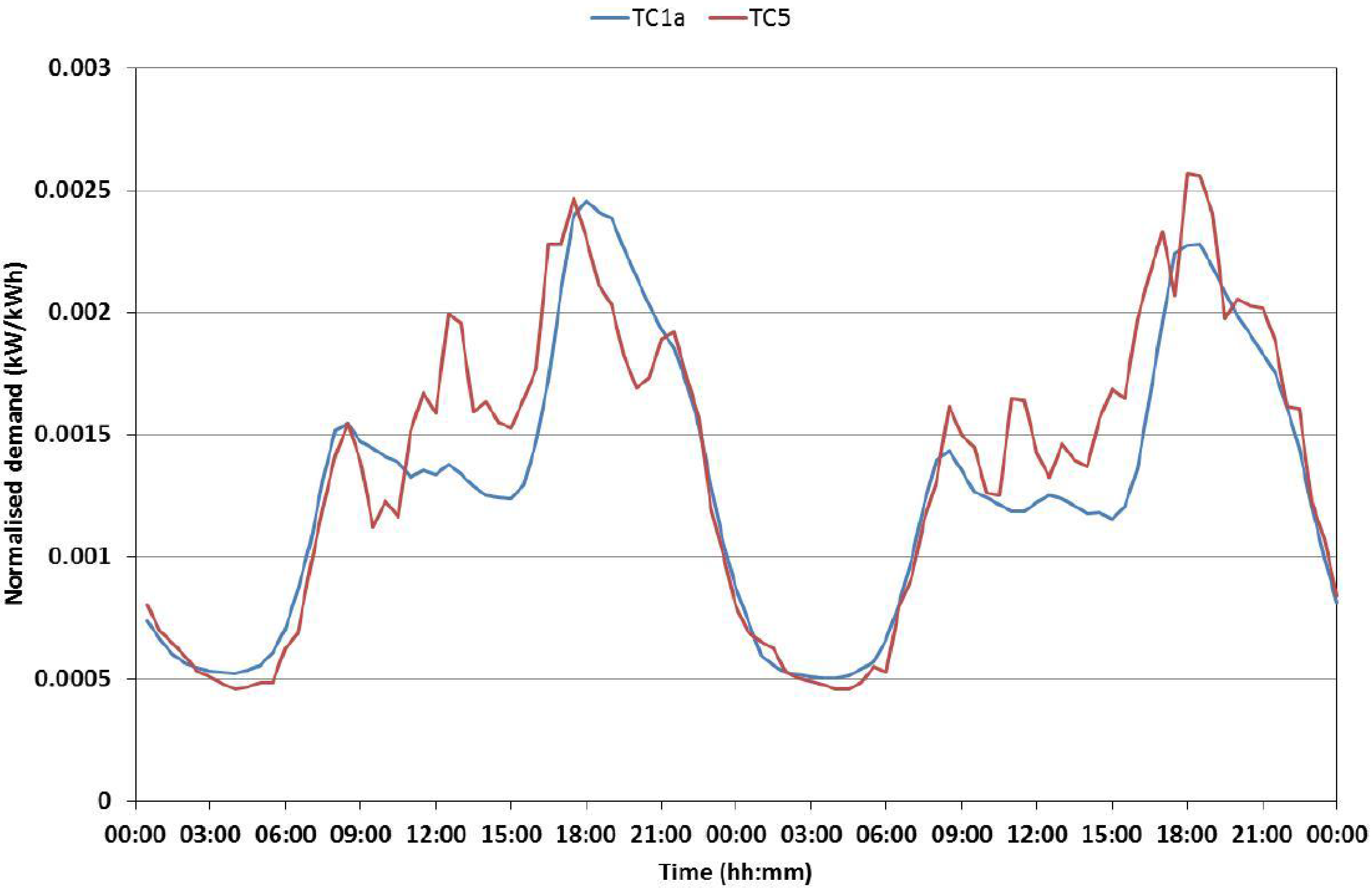
Mean half hourly demand: 2 days Winter, Summer



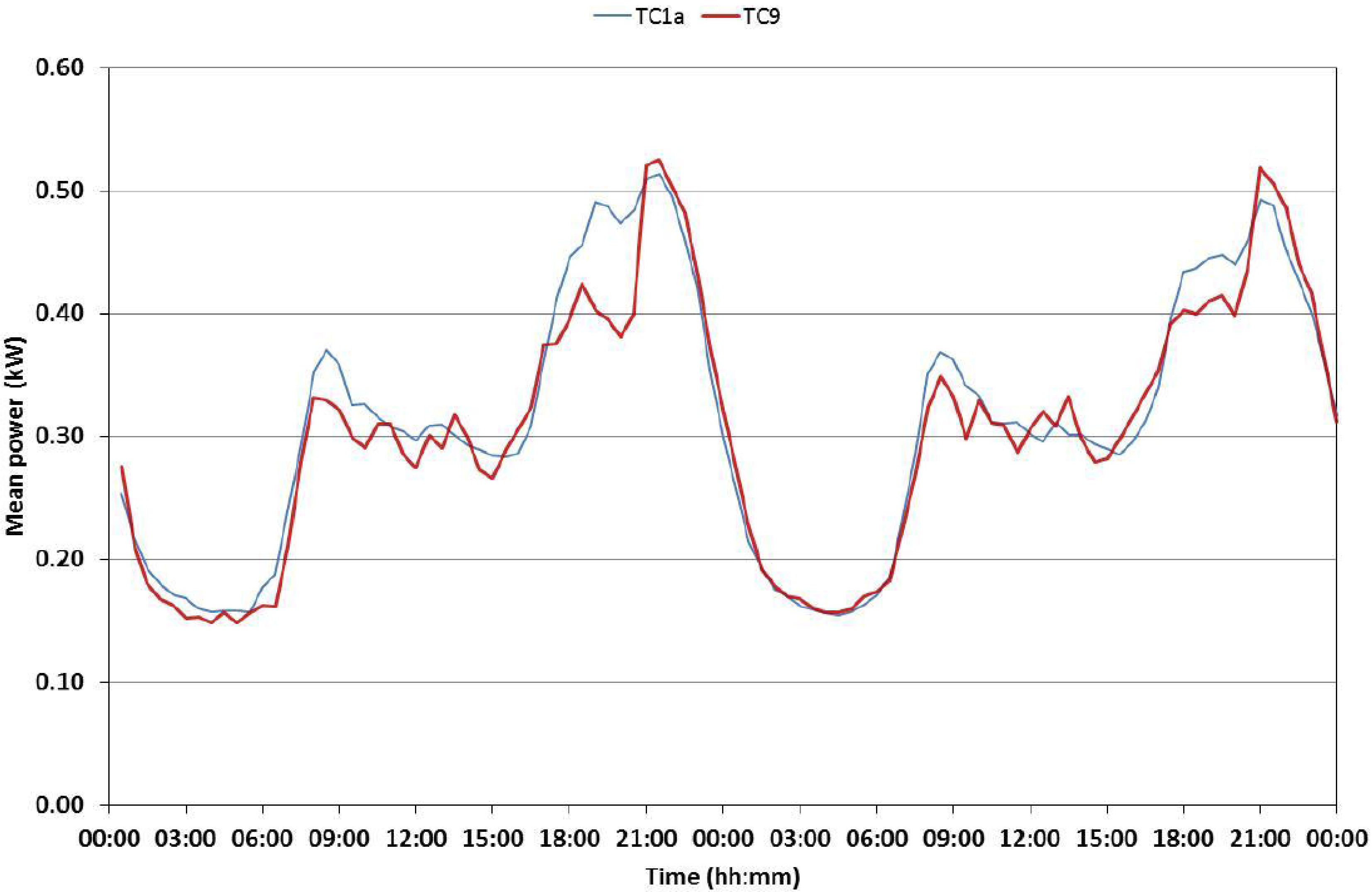
Domestic Solar PV – TC 5 6/7th Sept 2012



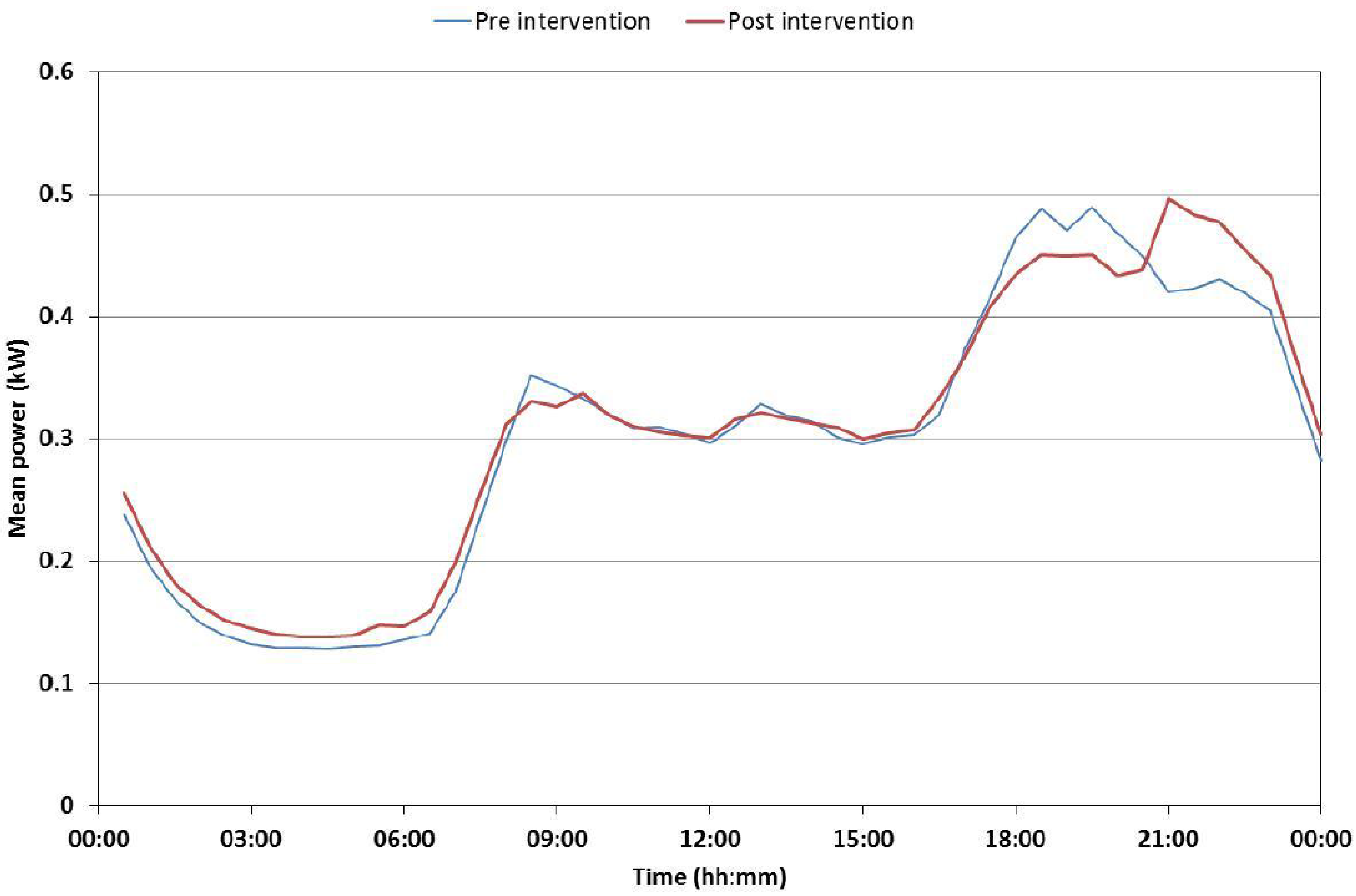
Solar PV - higher consumption during day



Time of Use Tariffs – TC1 - TC9



Time of use Tariffs pre – post intervention



Solar PV Manual in premises balancing

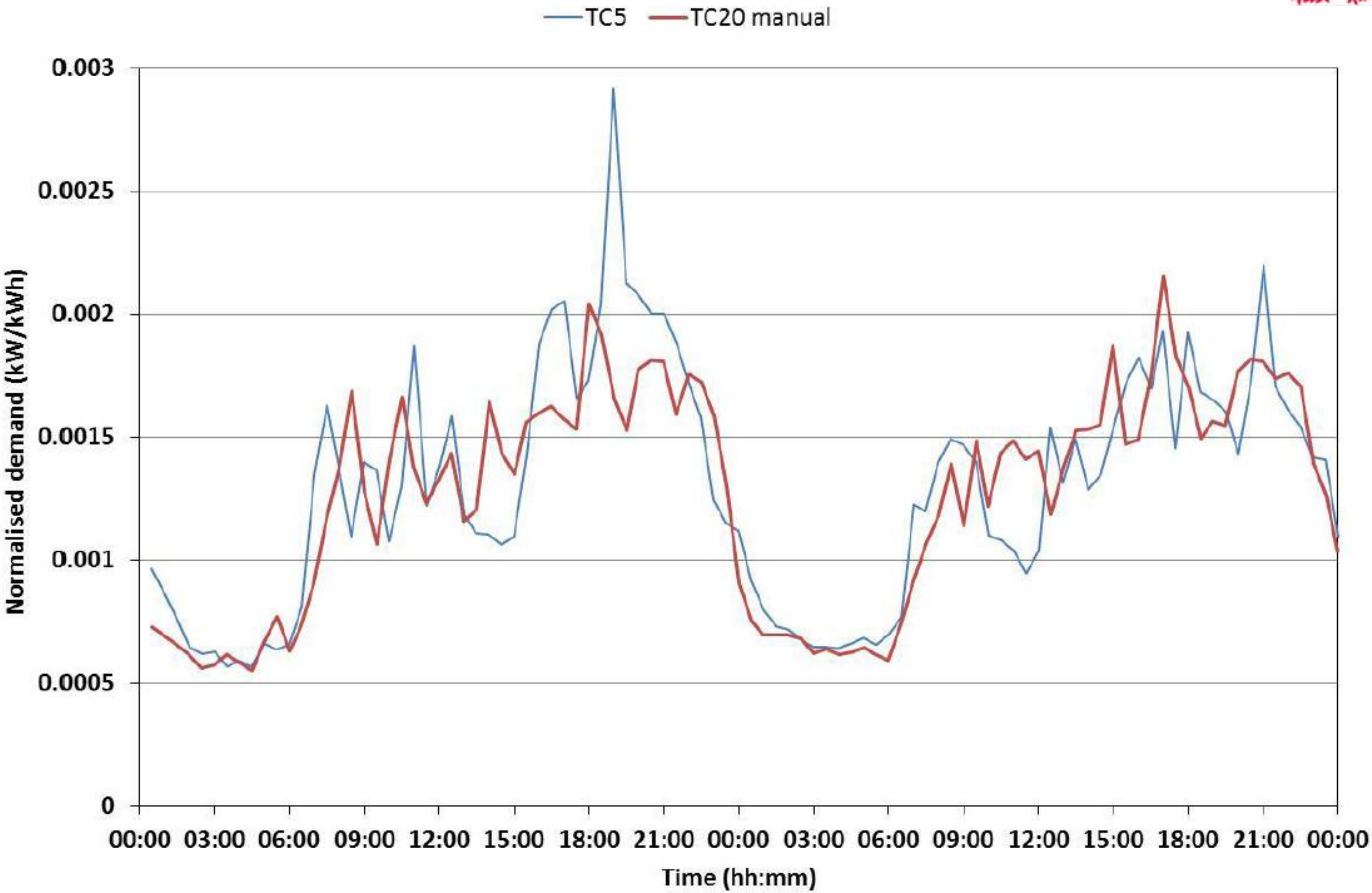
Display when net exporting

Display when net importing

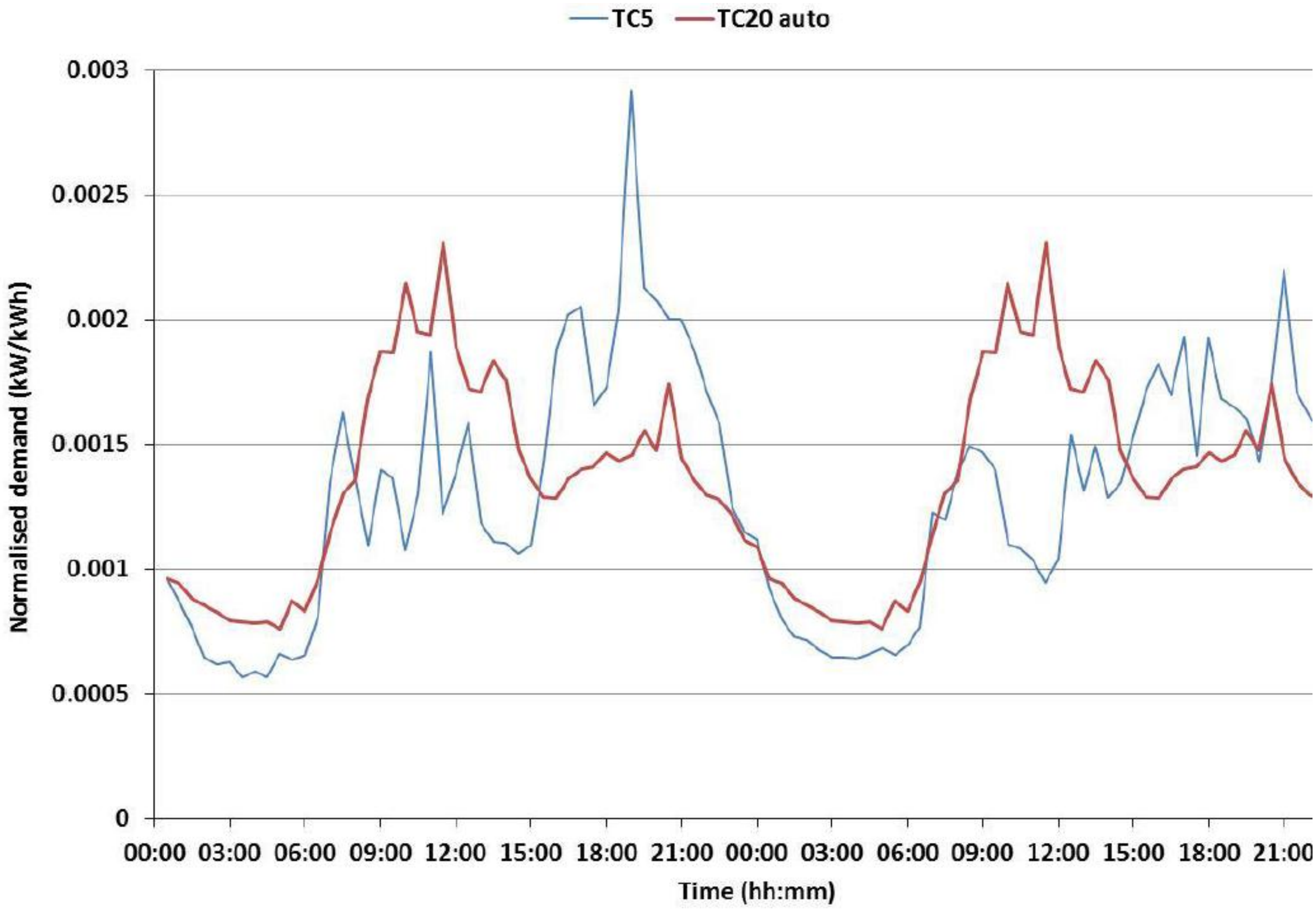
Display when in balance

Display when configured for generation only

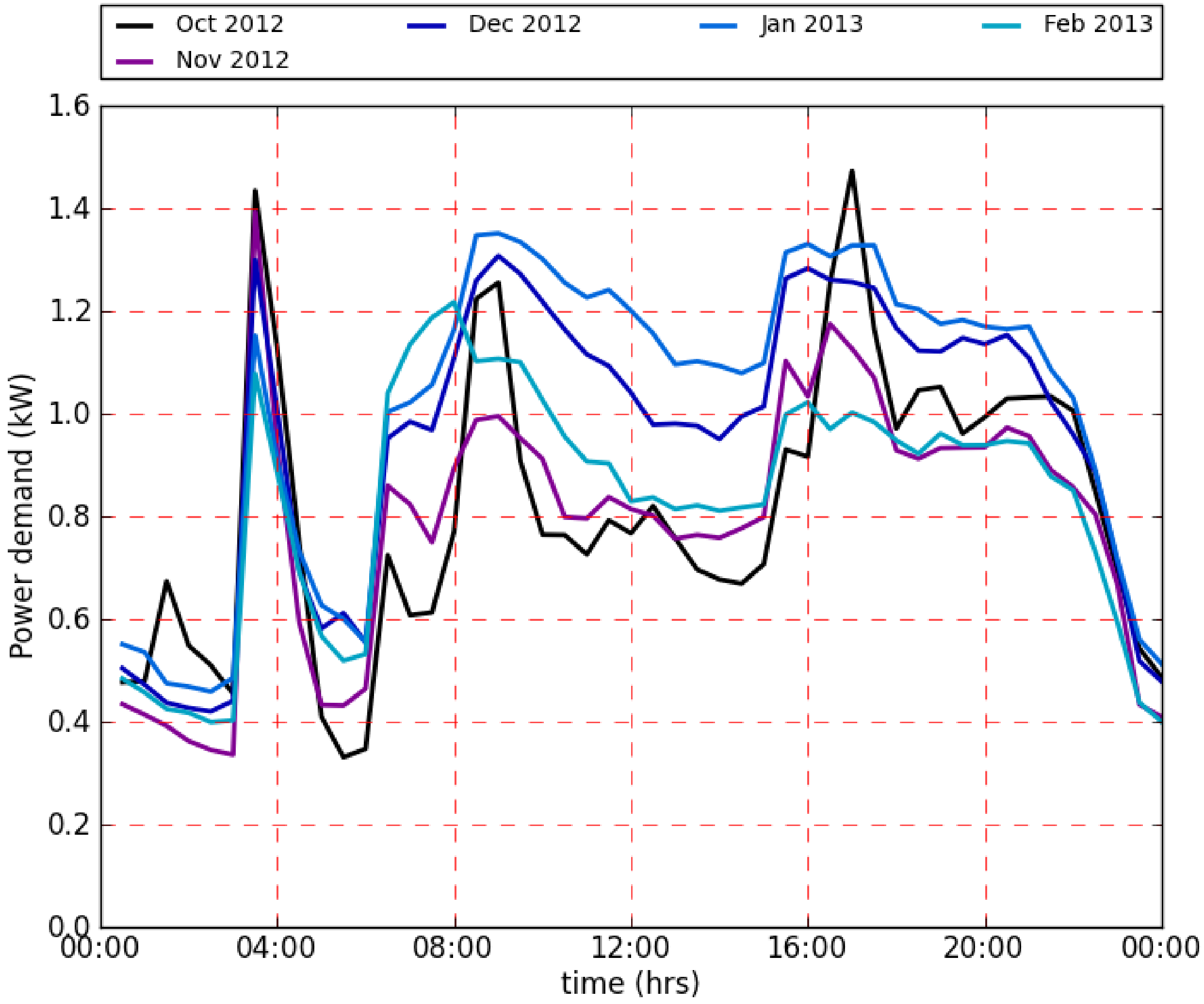
Solar PV Manual in premises balancing



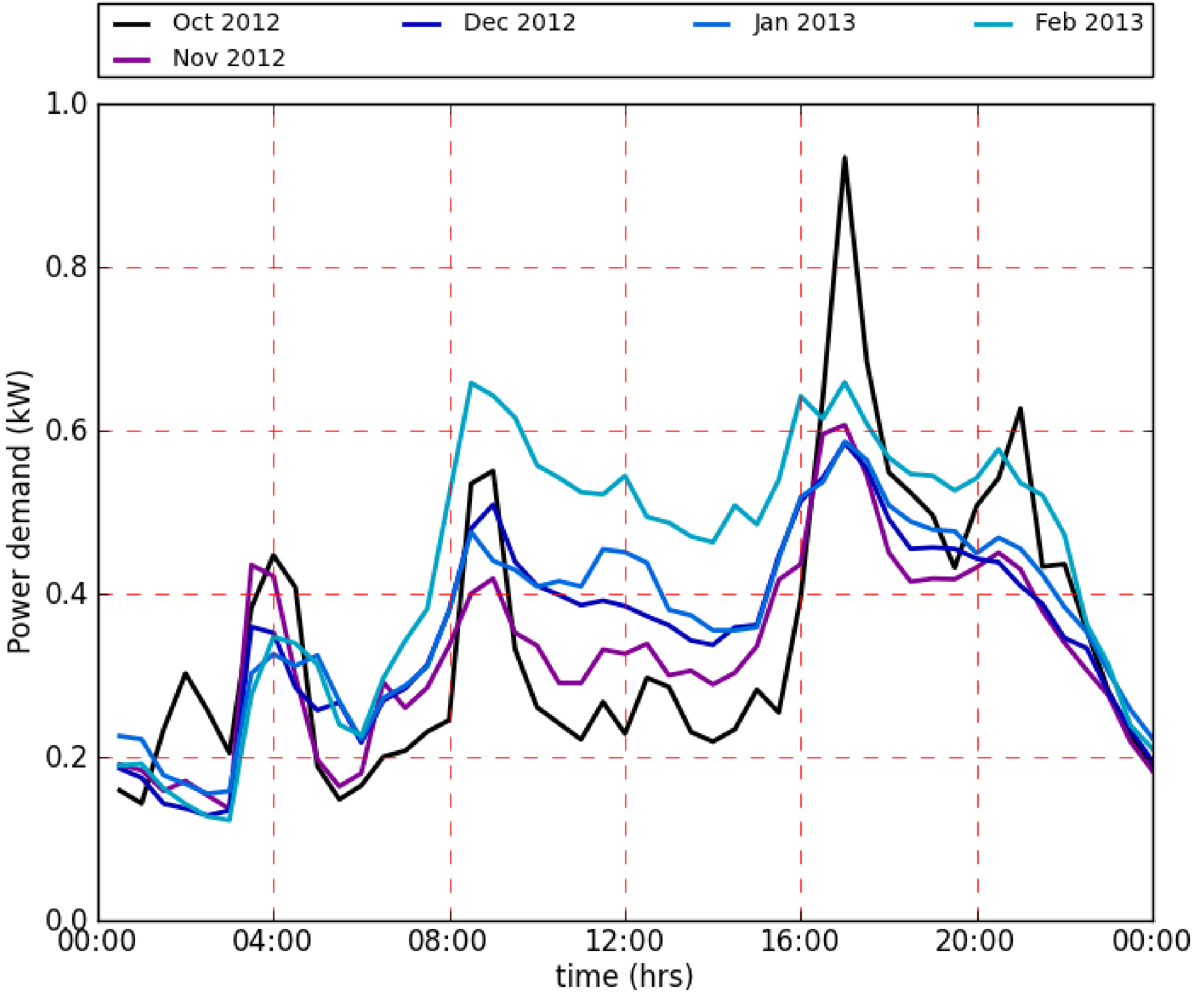
Solar PV – Automatic in premises balancing



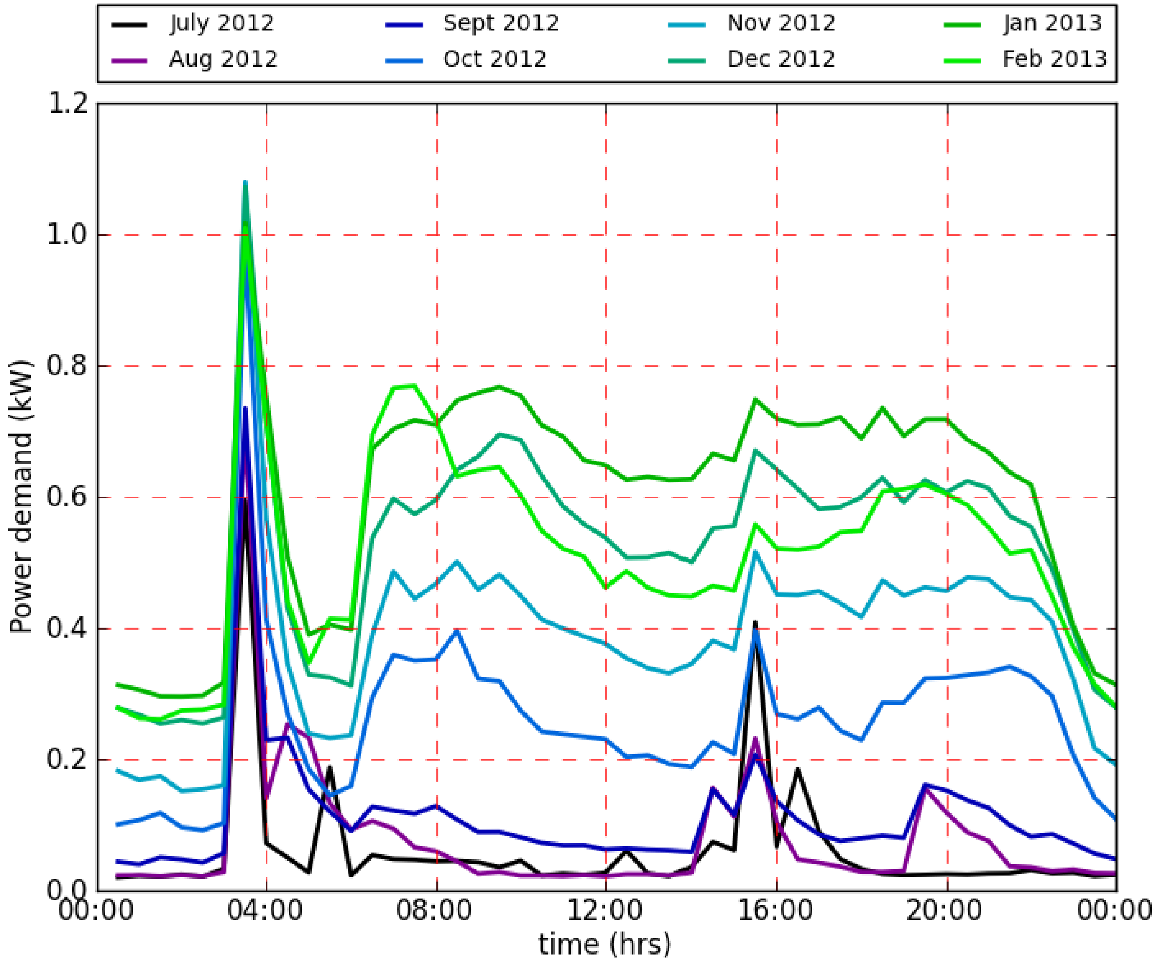
Heat Pumps - Monthly mean half hour whole home power consumption



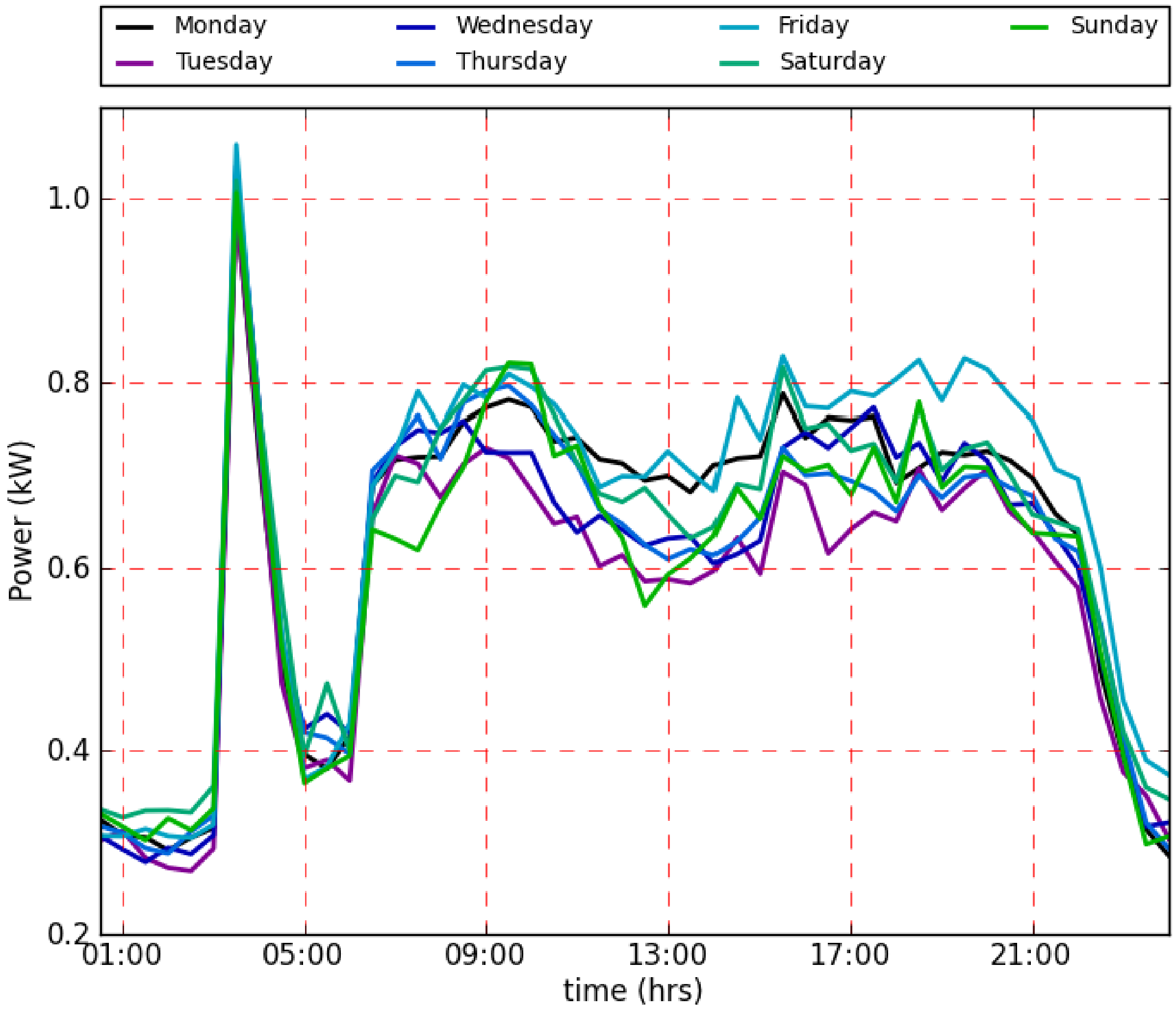
Heat Pumps - Monthly mean half hour electricity consumption excluding heat pump power



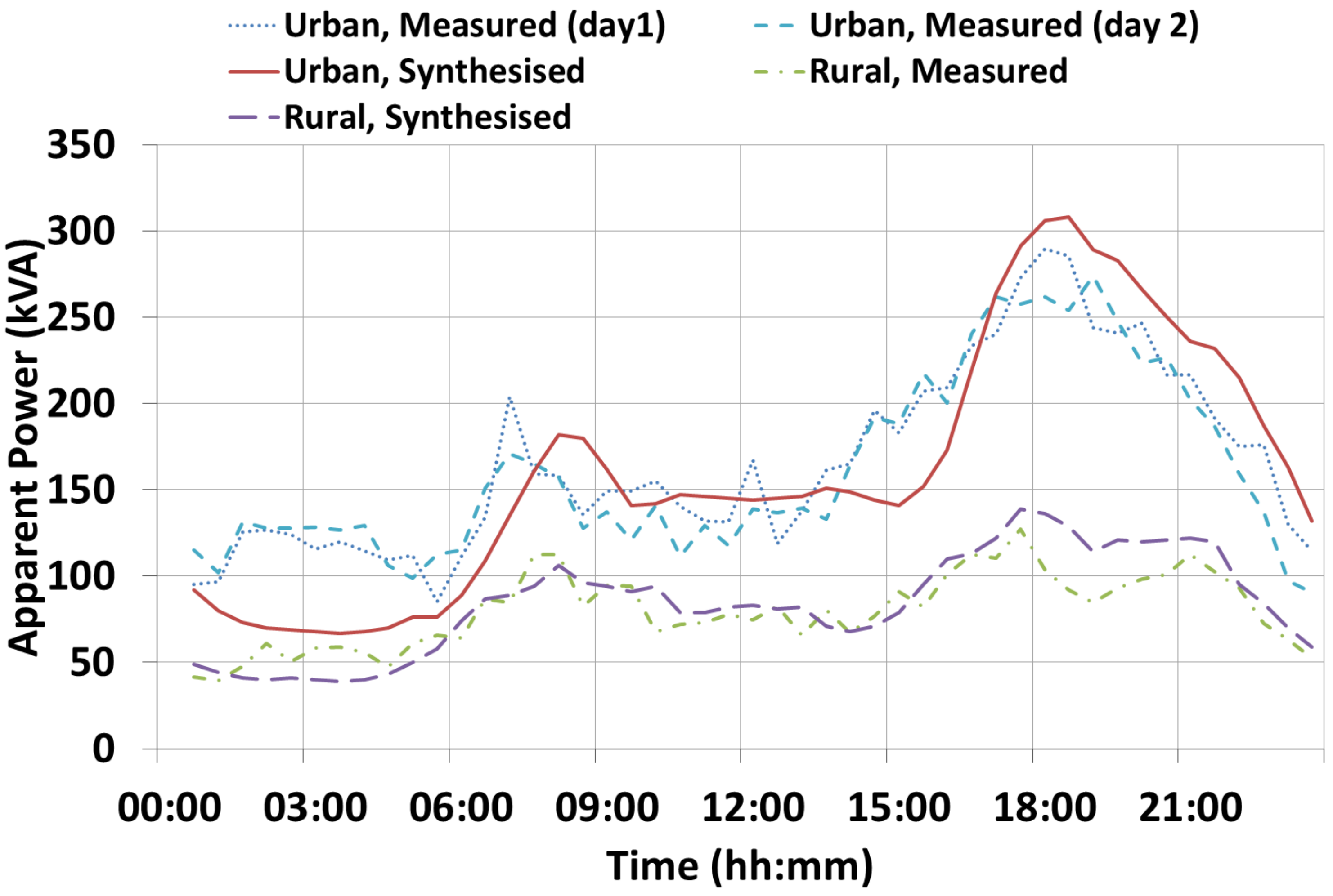
Heat Pumps – Monthly mean July to Feb



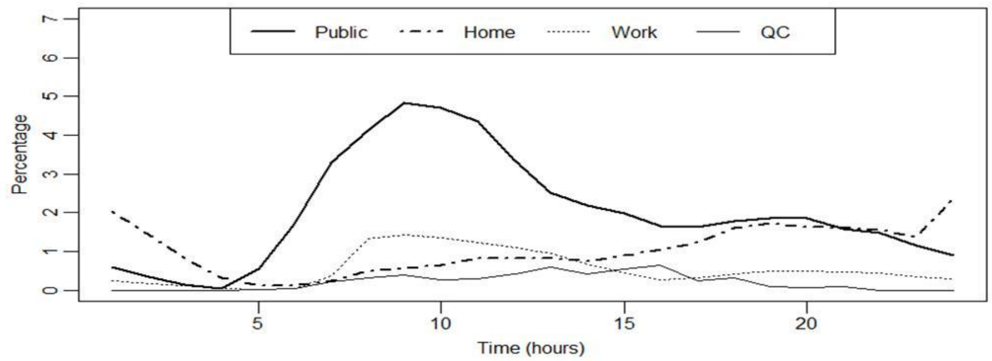
Heat Pumps - January

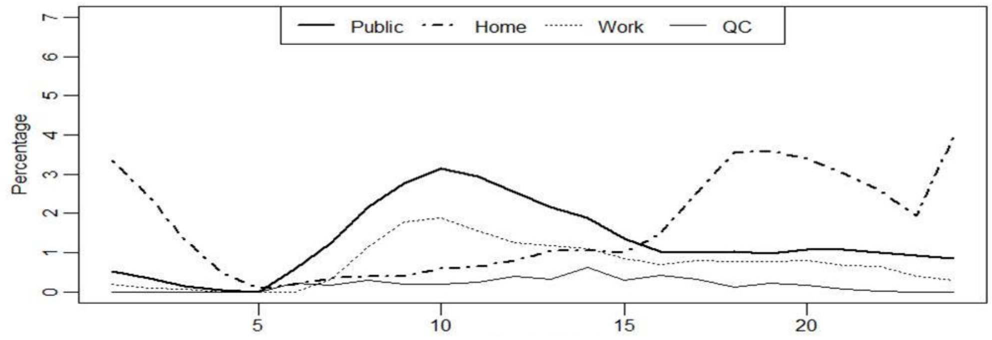


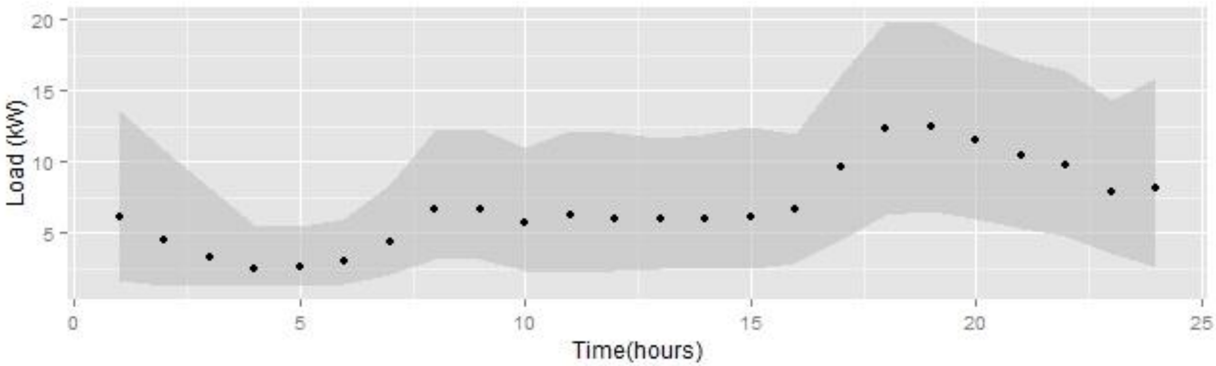
Electric Vehicles
Urban and Rural Domestic Load Synthesis



Electric Vehicles,
Urban and Rural EV Charging







Fusion of Smart Meter Data and Switch EV Data

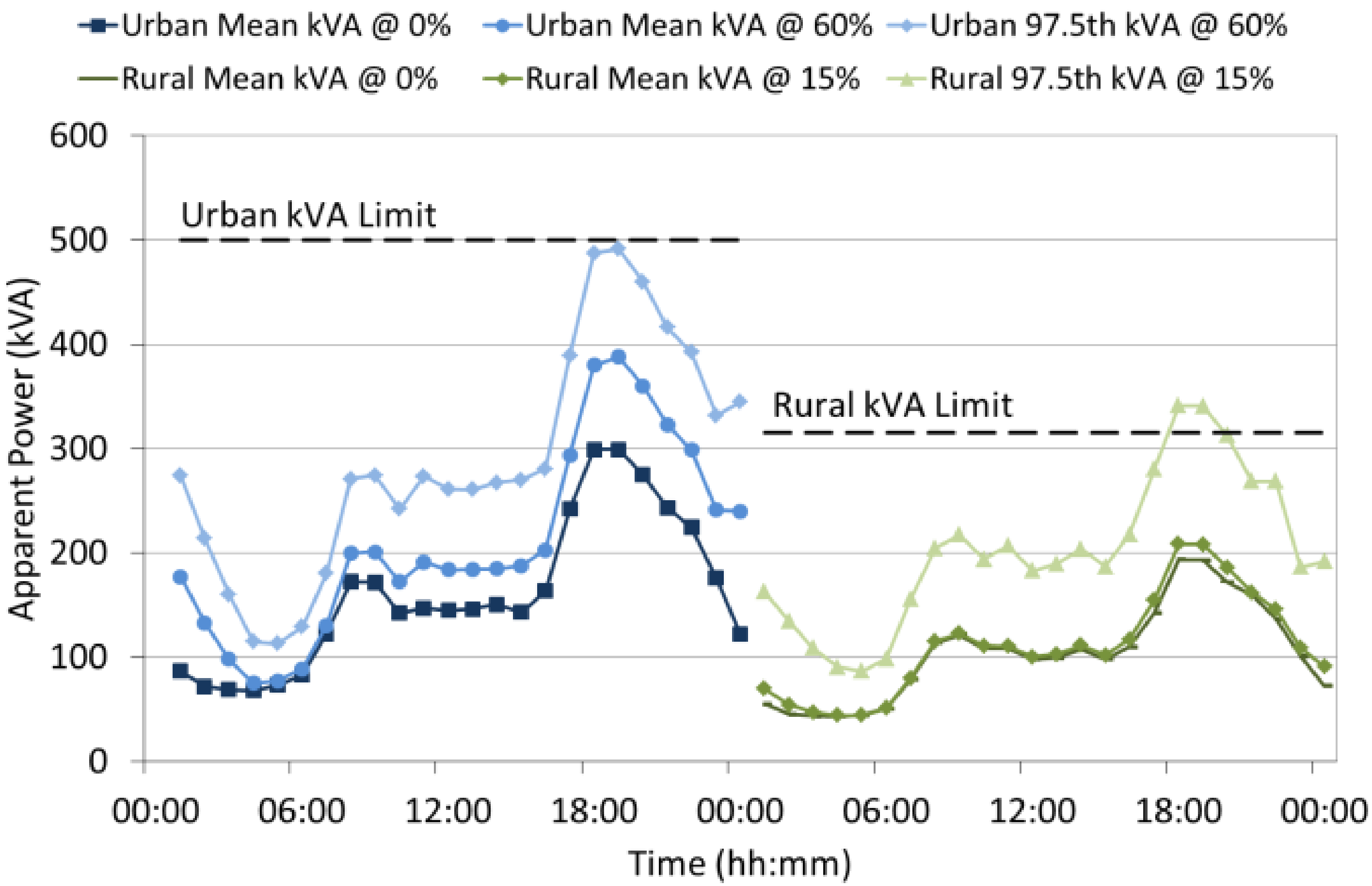
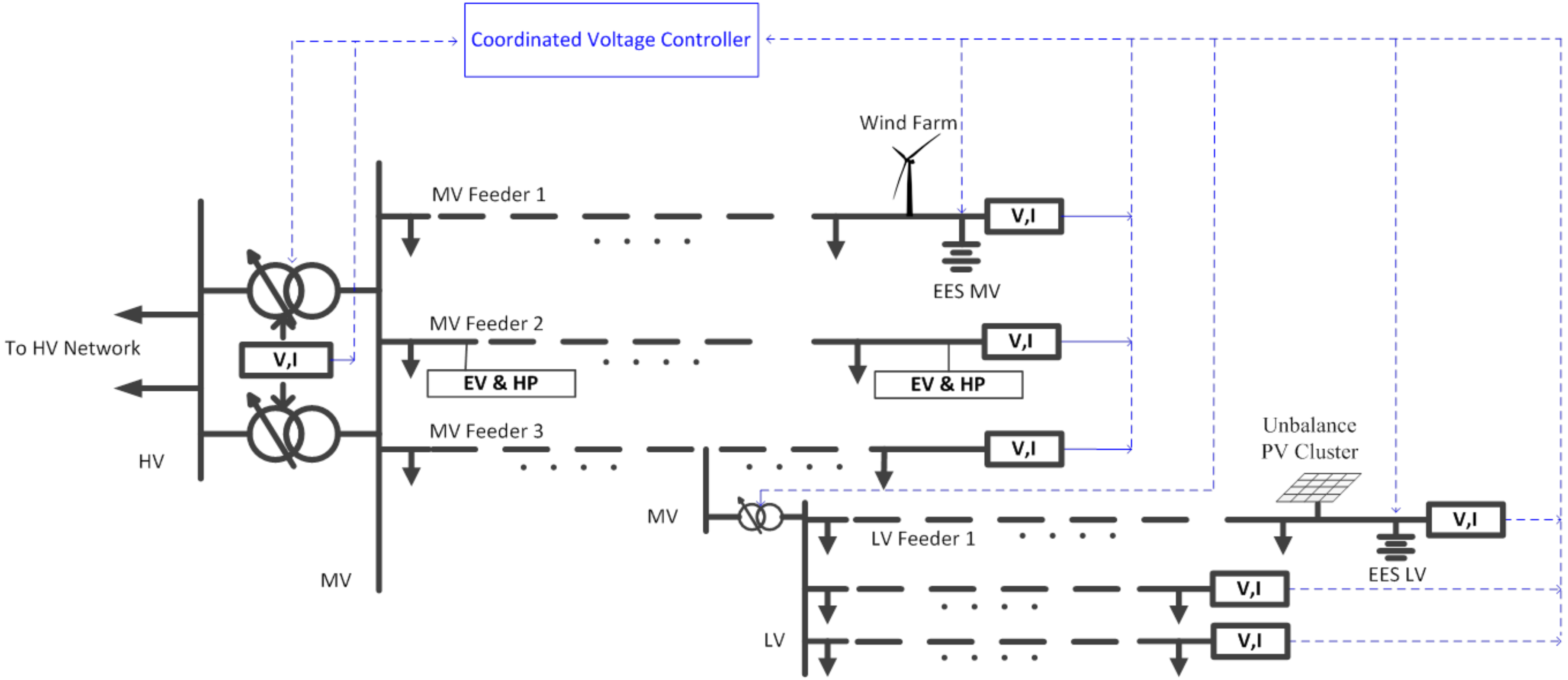


Table 2. Maximum voltage drops on the test networks.

	Mean Load 0% EVs	Mean Load 15% EVs Rural 60% EVs Urban	97.5% Load 15% EVs Rural 60% EVs Urban
ΔV - Rural	-2.33%	-2.52%	-5.39%
ΔV - Urban	-1.40%	-1.72%	-2.90%

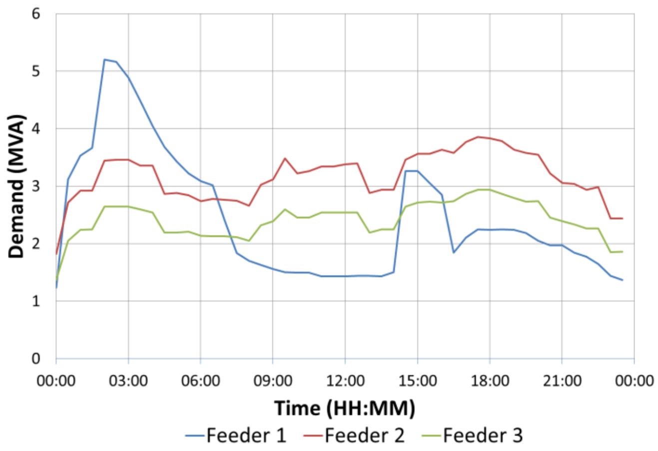
Case Study:
An example of how we use the data?

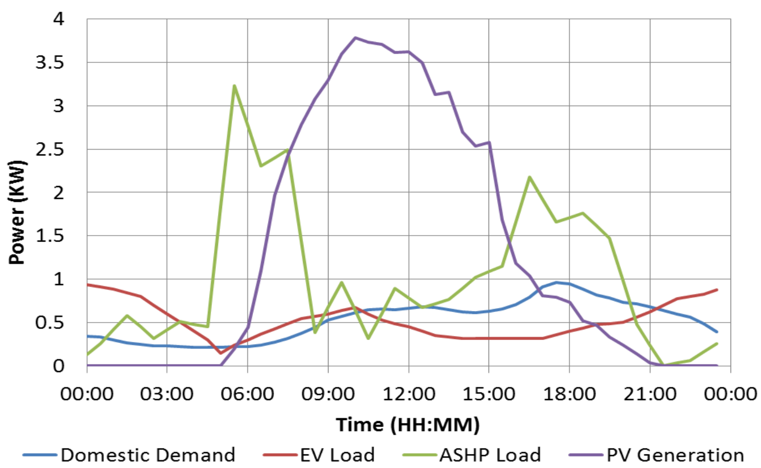
A real, smart grid enabled distribution network is adopted as the case study network, to investigate the voltage problems and to evaluate the proposed coordinated voltage control scheme. This network, operated by Northern Powergrid, is a rural network located in the Northeast of England.

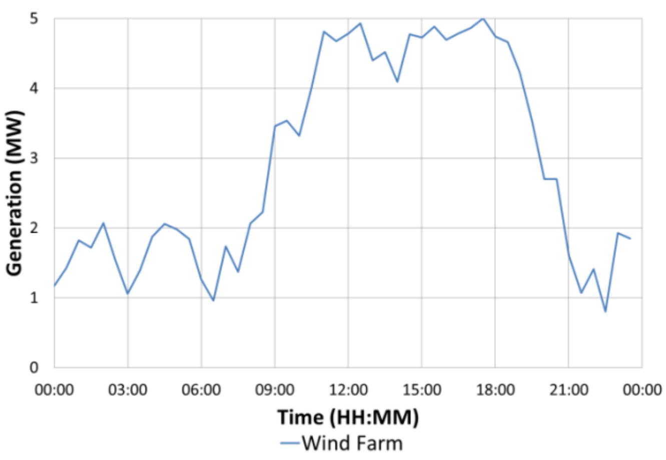


Data from the CLNR project are used to create the future scenario:

- Typical daily demand profiles from case study network SCADA data for MV feeders;
- Typical wind farm generation profile derived from 30 wind farm sites owned by Northern Powergrid;
- Domestic customer demand profile and power profiles of multiple LCTs derived from historical data from over 5000 domestic customers covering the period May 2011 to May 2012

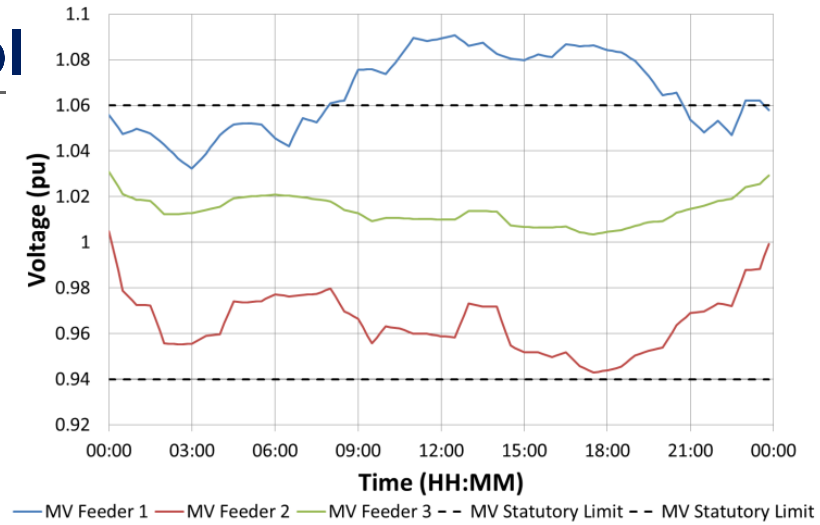


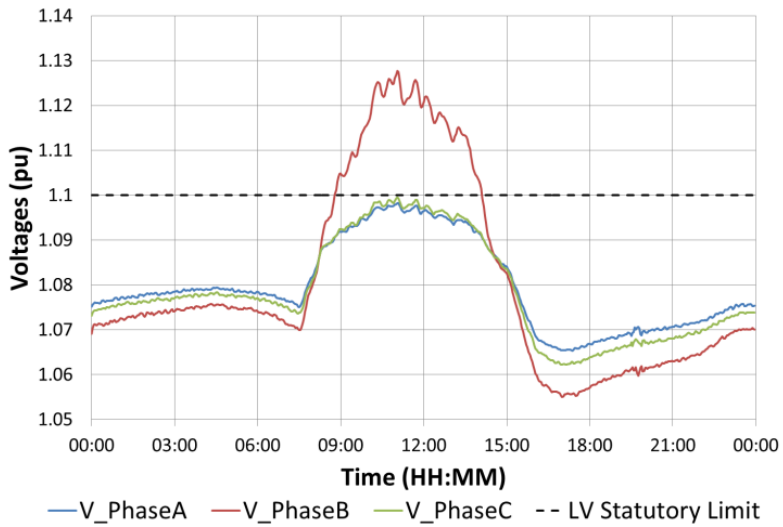


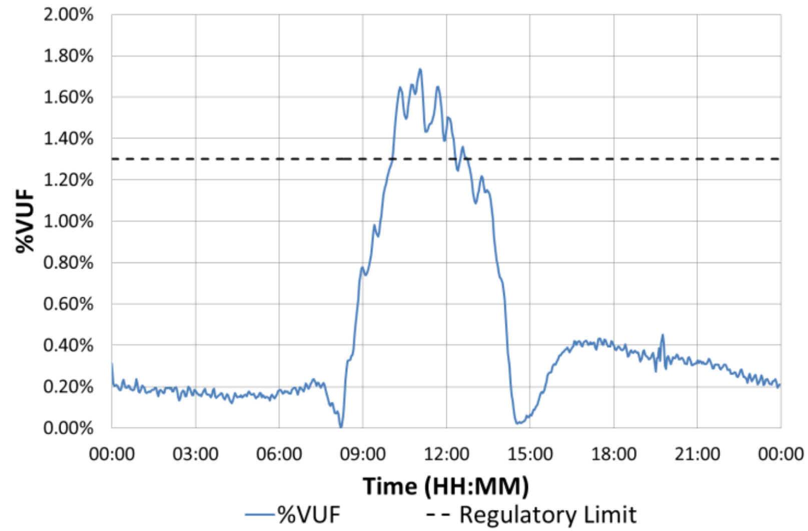


Voltage problems in the case study network without control

- Voltage profiles at MV feeder ends;
- Voltage profiles at LV Feeder 1 end;
- %VUF at LV Feeder 1 end.







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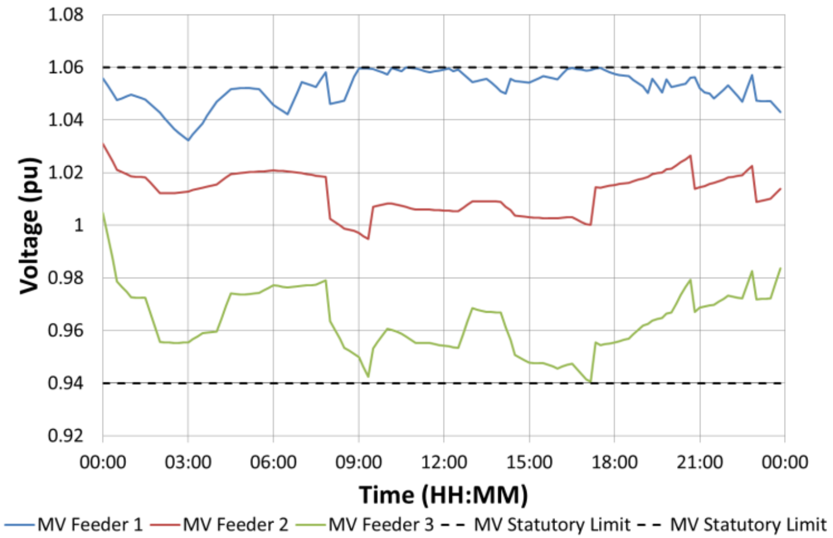
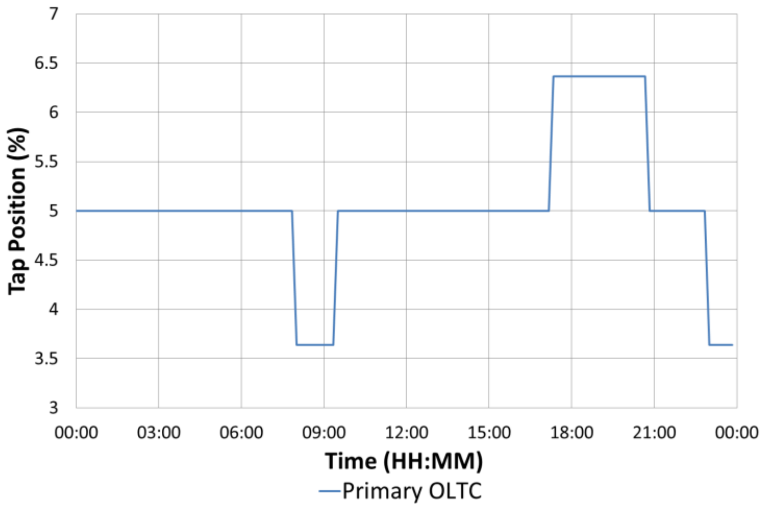
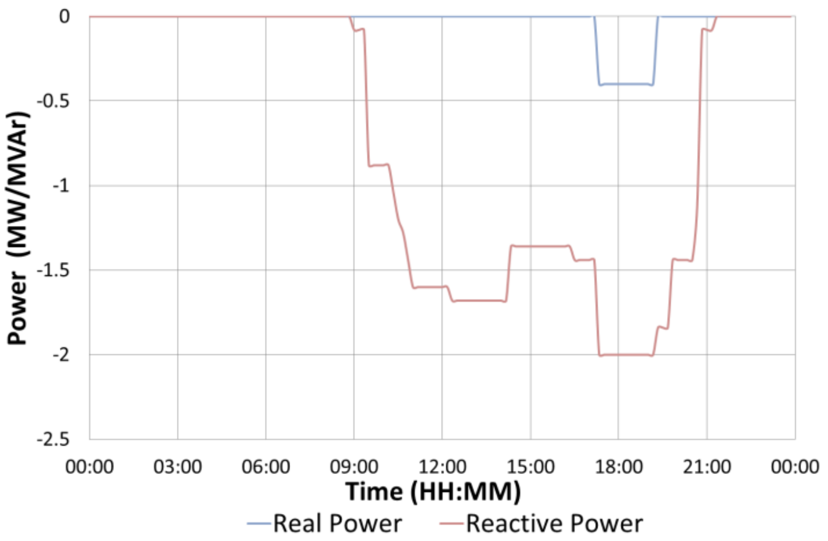
IPSA2 Simulation results with Proposed Control Scheme

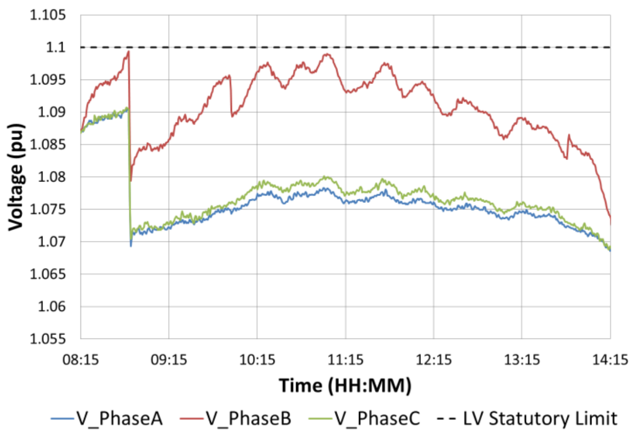
- Voltage profiles at MV feeder ends;
- Tap position of the OLTC at primary substation;
- Power output of the EES at MV Feeder 1 end



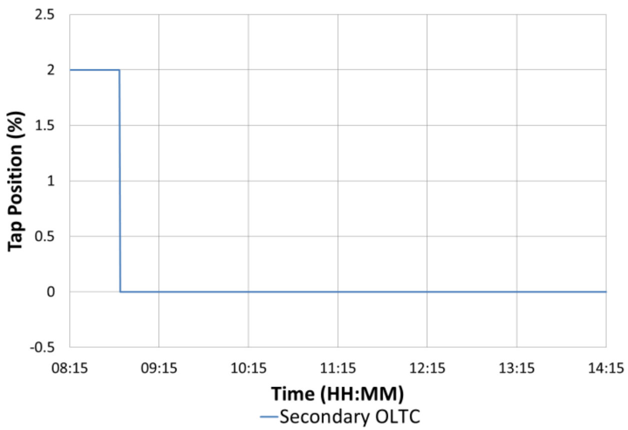




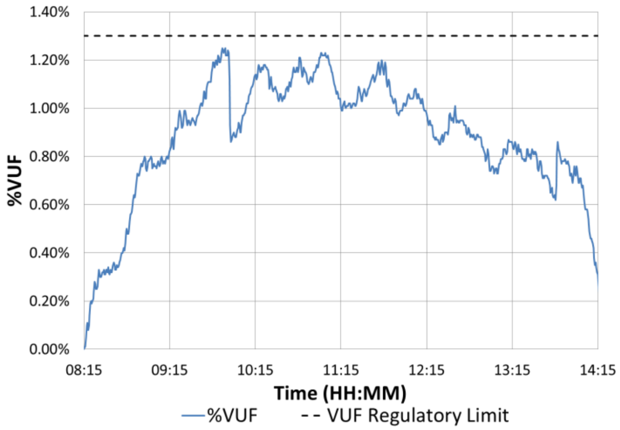
Network in the Loop Emulation Results with Proposed Control Scheme



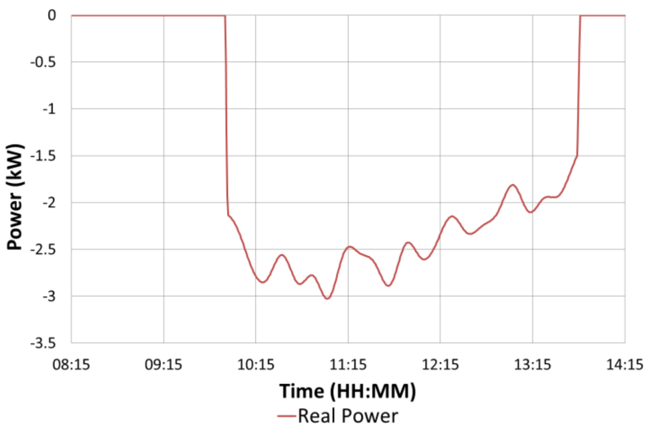
Voltage profiles at LV Feeder 1 end



Tap position of the OLTC at secondary substation



%VUF at LV Feeder 1 end



Power output of the EES at LV Feeder 1 end

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Conclusions

- Understanding load and generation profiles
  - Constraints when where for how long…
  - Reinforce ?
  - DSR
  - Storage
  - RTTR
  - EAVC
  - Optimum mix
- Update ACE 49
- Embed models/knowledge into NPADDS
- Update P2/6

Customer-Led Network Revolution

Mark Drye, Northern Powergrid

Development of practical project outputs

Development of practical outputs

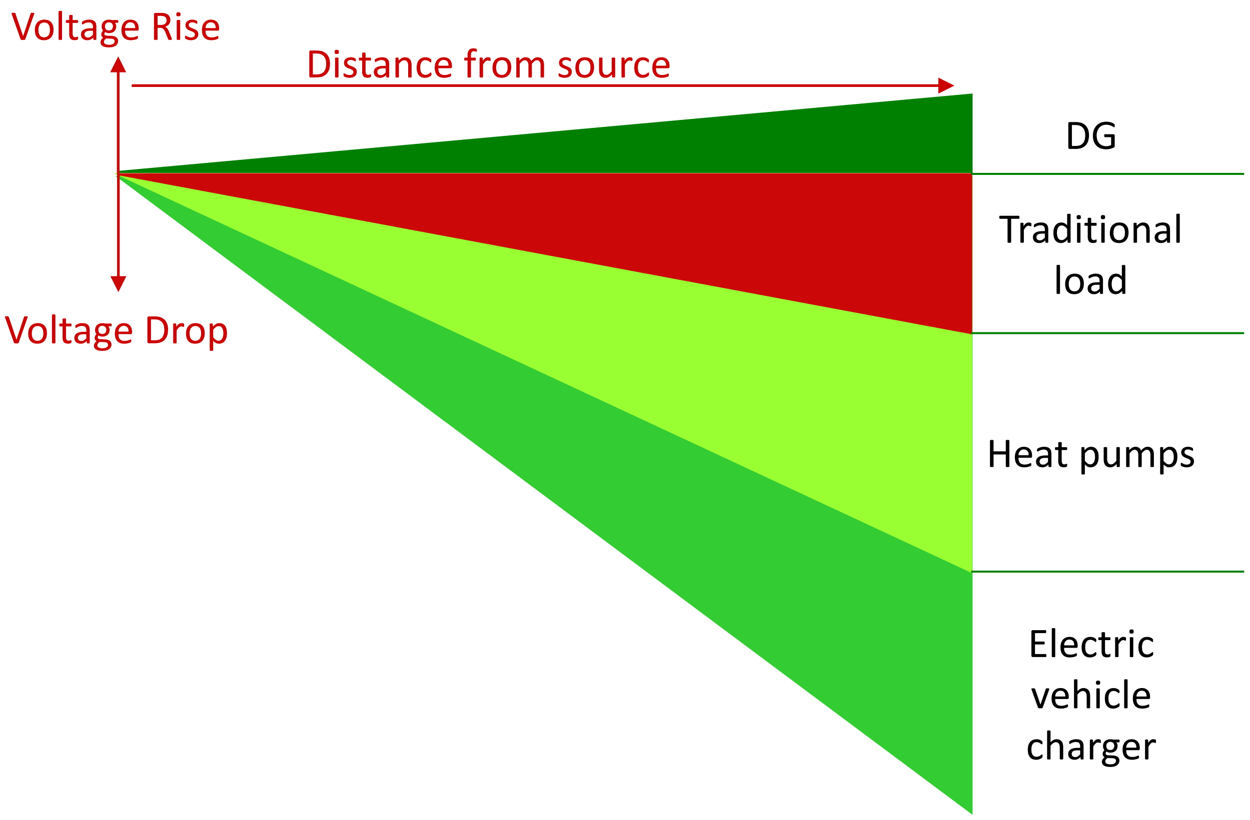
CLNR Customer trials knowledge sharing event

Mark Drye

1 October 2013

The potential future use of the LV system is the biggest change to the electricity system in living memory

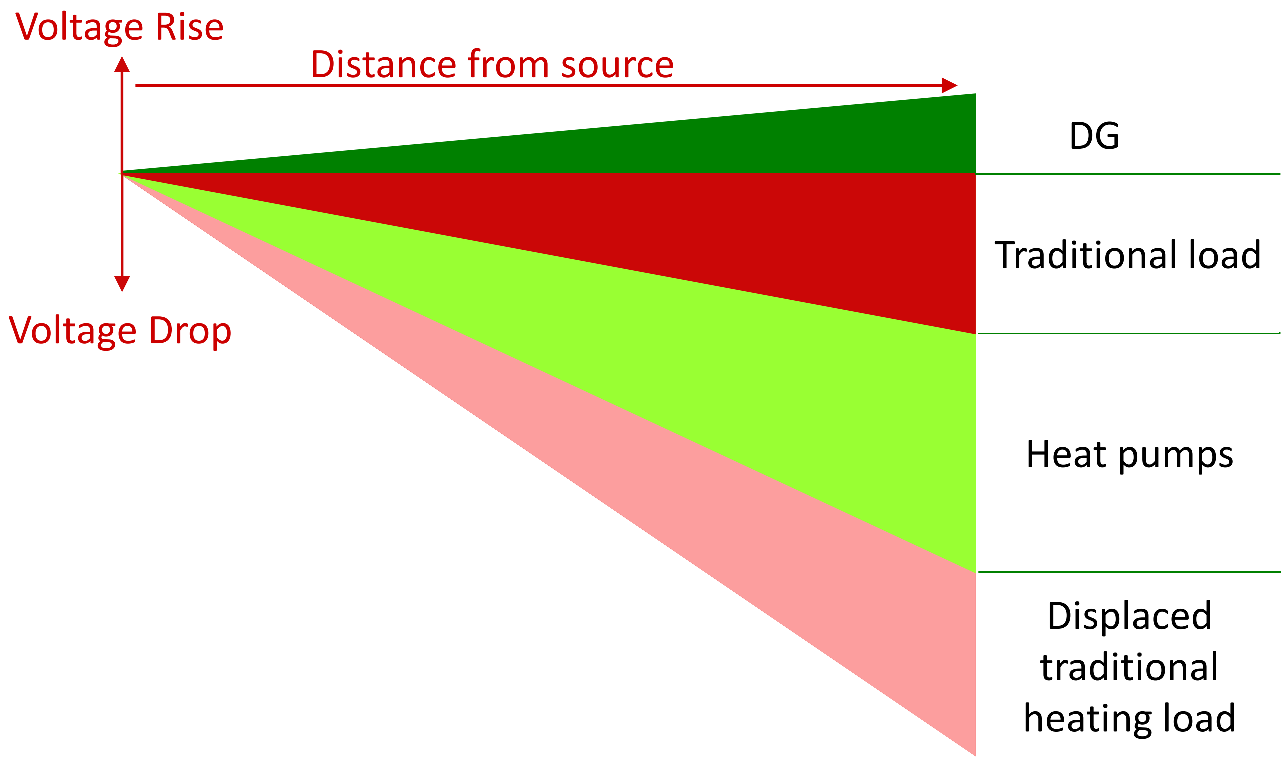
- Traditionally gas-heated houses, peaking at around 18kVA, but with an ADMD of 2kVA are becoming a thing of the past.
- New loads are changing the magnitude of the load on our system.
- But they also have different time of use profiles.



It has become essential to re-learn how the manner that customers use our system affect the quality of our supply to them

However in some locations new heating solutions may reduce load – but change load profiles

- Heat pumps produce more heat output than an equivalently rated resistive heater.
- But the load profile will also change.



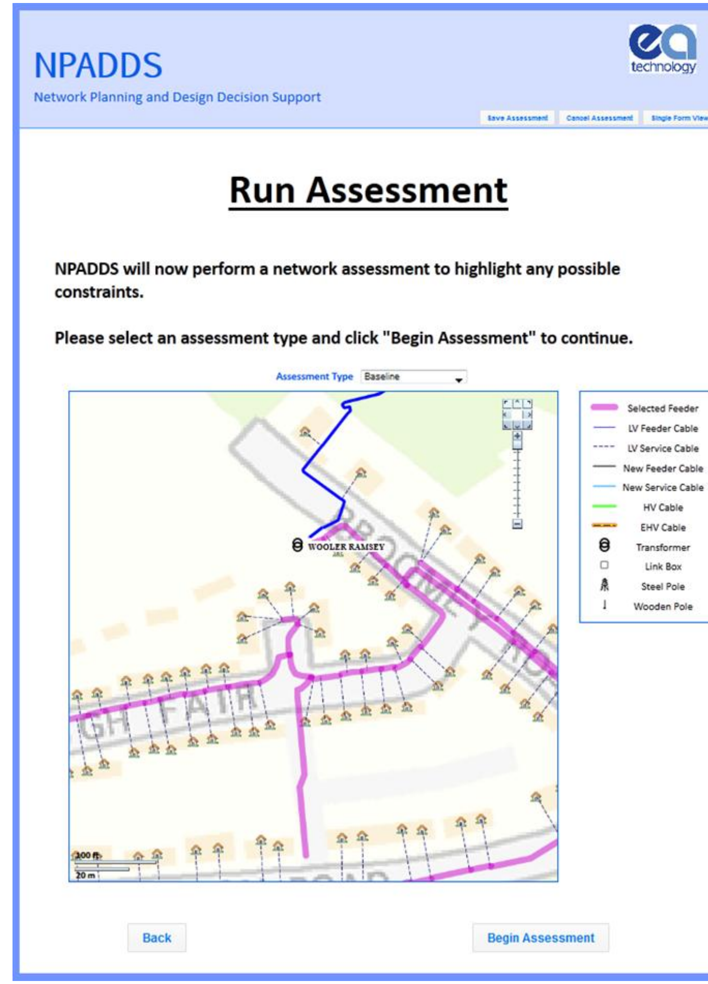
We need to understand new load profiles as well as new uses

Our test cells are producing data that is allowing us to revisit 1970s based customer behaviour assumptions

- ACE 49 (published 1981) established the benchmark for understanding LV load in– we are bringing it up to date
- Our work will improve the planning of LV networks, reducing connection and reinforcement costs
- Establishing a set of load profiles new for new customer classes and updating old classes to update ACE49 by:
  - Profiling of regular smart meter customers
  - Urban, suburban and rural locations
  - Establishing growth rates
- The work will culminate in a new set of design guidance, rules and techniques covering thermal, voltage earth impedance and load growth aspects
- Tailored design and reinforcement will allow more cost effective design

We are using this understanding to build tools to target investment on a modern system

- NPADDs is a software tool that will use network data straight from corporate records systems
- It will identify issues (V, I, Ω) and propose solutions
- Demand growth and LCT take up can be modelled
- Uses in connections assessment, reinforcement design and network planning



This is of no use if the new solutions that NPADDS proposes are not available – so we are working on those too

Wooler Bridge Distribution Substation

HV/LV transformer with on-load tapchanger (±8% in 2% steps)

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Switch on to the Customer-Led Network Revolution

Customer Trials Knowledge Sharing Event
October 1st 2013