Unlocking the Future of Energy

Our transition to a Customer-Led Distribution System Operator

www.northernpowergrid.com/innovation

Welcome and introductions

Patrick Erwin

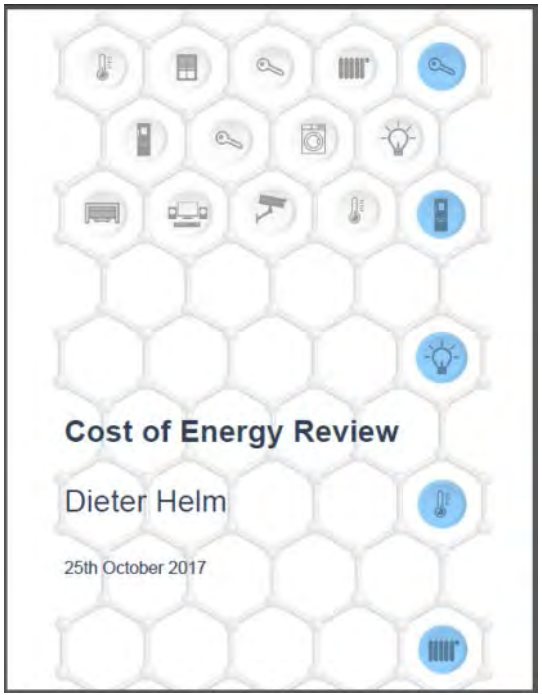
Policy & Markets Director

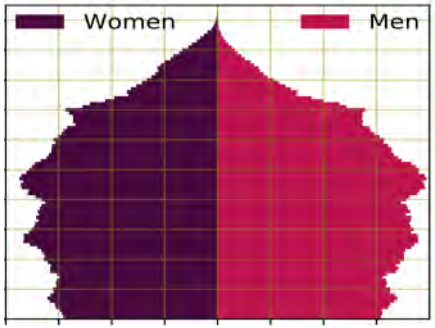
Unlocking the Future of Energy

Agenda	
Welcome and introductions	13:30
Our Distribution System Operator transition • A discussion about where we've come from, where we're going and key challenges • An brief introduction to the Customer-Led Distribution System • Q&A	13:40
Breakout sessions: • Smart Grid Enablers - Electric vehicles and losses • Distribution storage and solar study • Customer Led Distribution System - Operator transition	14:30
Panel presentation and discussion	15:15
Closing remarks and next steps	16:15
Refreshments and networking	16:30

Towards Distribution System Operation

A complicated context





Our Distribution System Operator transition

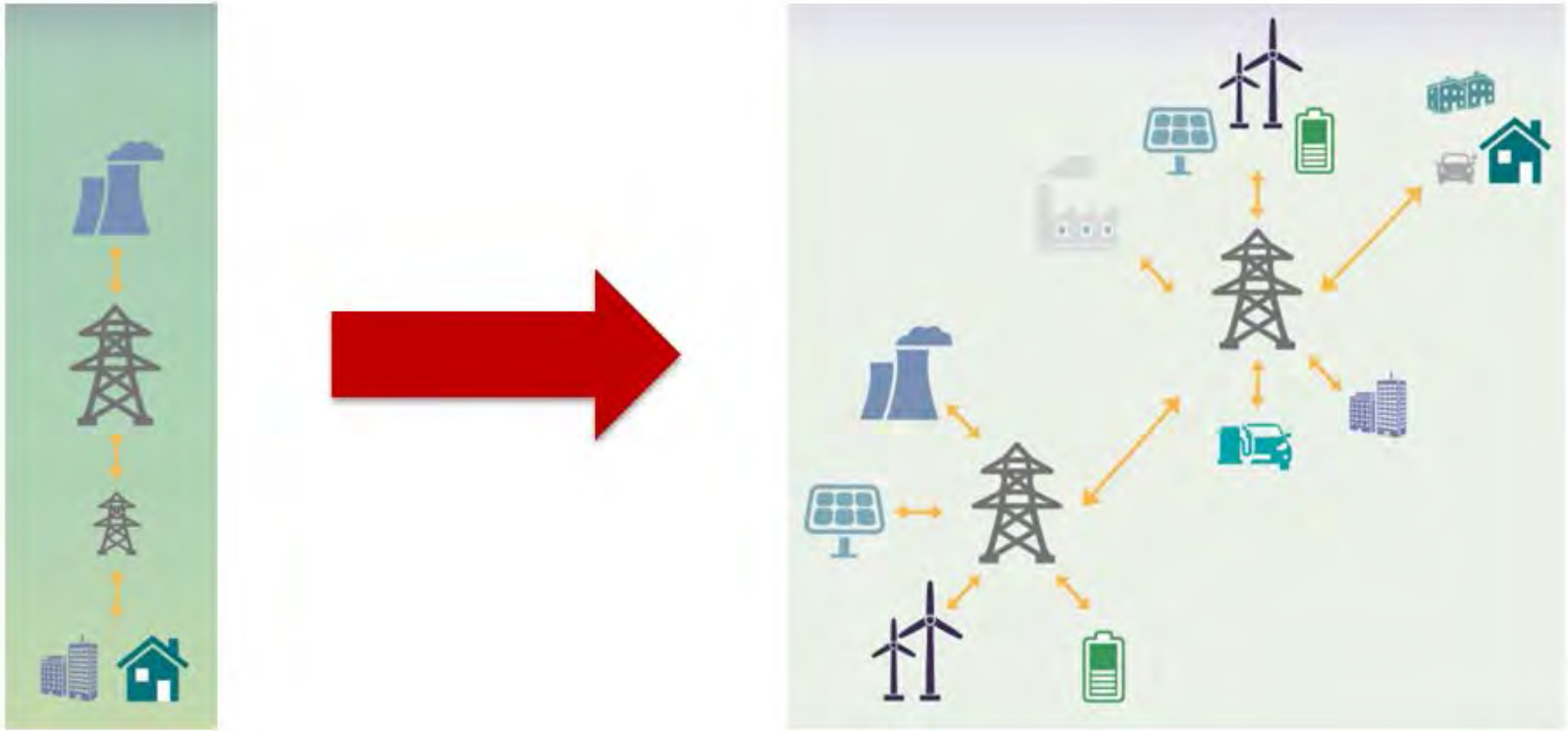
Jim Cardwell

Head of Trading and Innovation

Session Objectives

1. **Share our vision and plans** for the transition to DSO – *introducing more flexibility into the energy system*
2. **Seek views** on this way forward – *an opportunity for you to engage and shape the direction of our work*
3. **Establish a platform for ongoing meaningful dialogue** with all stakeholders – *clarifying often complex themes*

A changing system: the need for smart, flexible solutions



Our world is changing fast

UK sets ambitious new 2030s carbon target

Solar panel costs predicted to fall 10% a year

Solar Is Going to Get Ridiculously Cheap

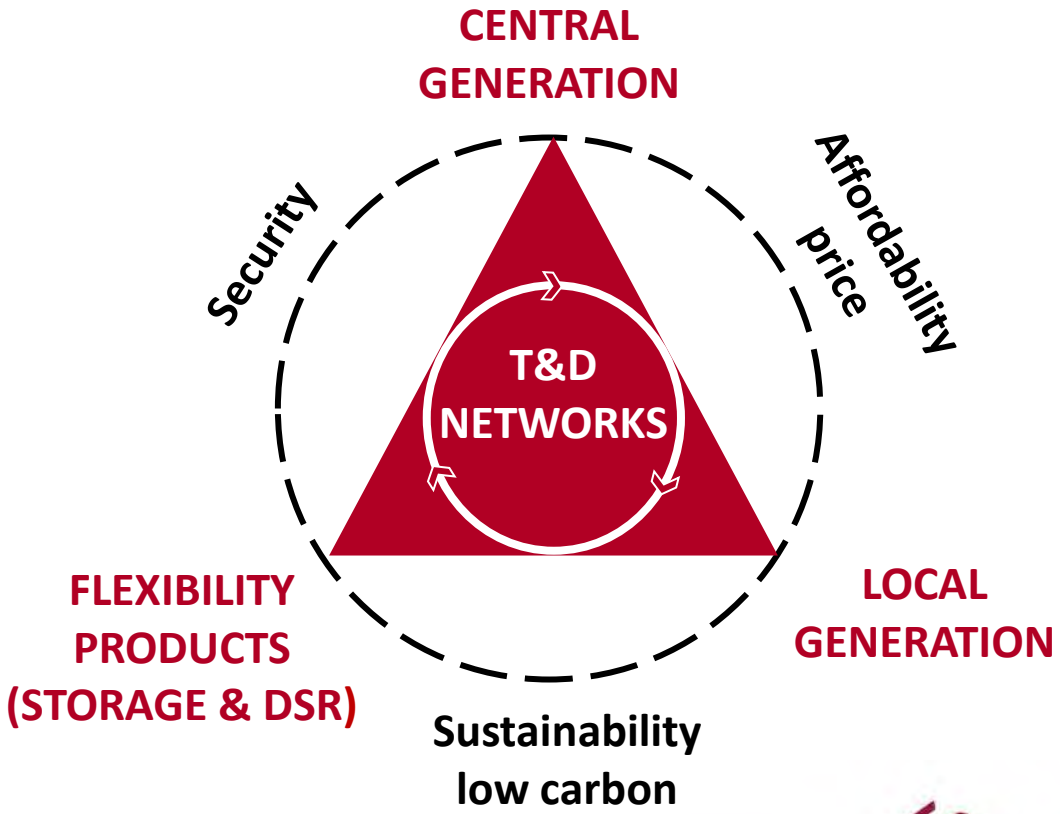
Capacity Market success evidence of 'crucial role' battery storage to play in UK grid

Electric cars will rule the future

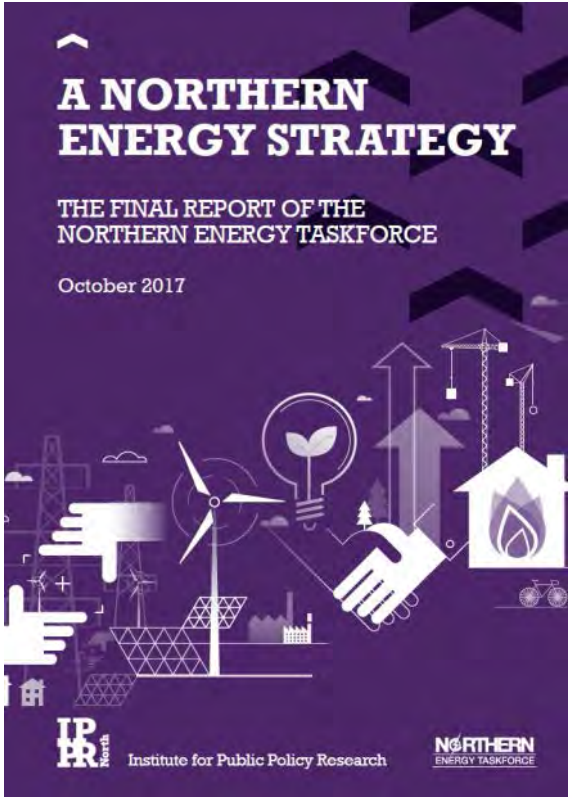
Some 147 Gigawatts of renewable electricity came online in 2015 - the largest annual increase ever and as much as Africa's entire power generating capacity.

Renewable energy smashes global records in 2015

Networks taking centre stage



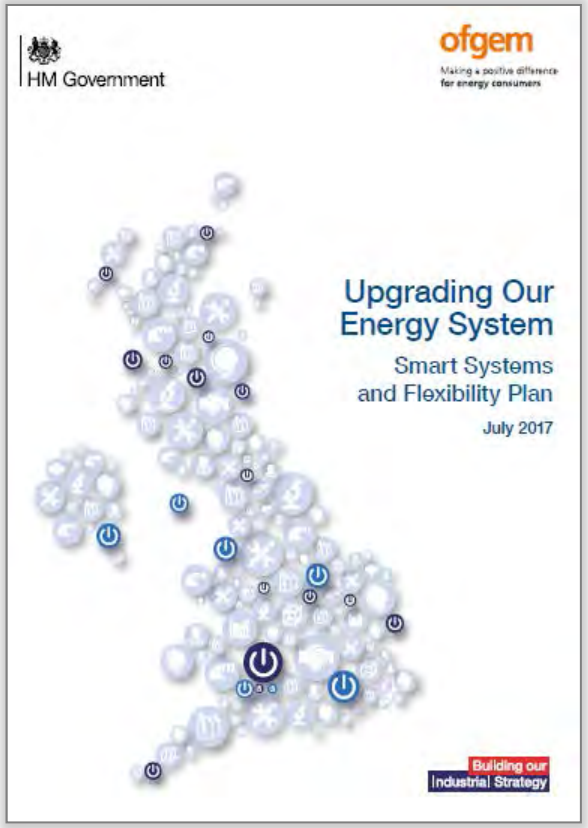
Delivering value for our stakeholders

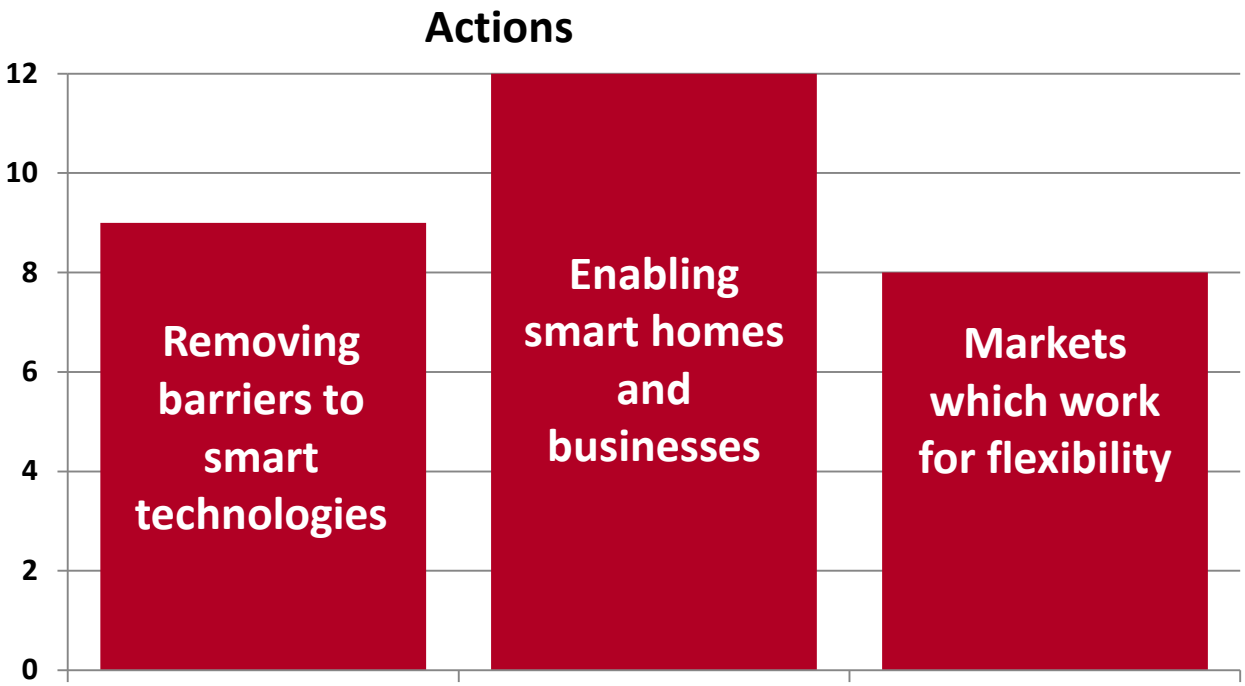


‘Our vision for the north of England is that by 2050 we will be the leading low-carbon energy region in the UK, with an energy economy worth £15 billion per annum and 100,000 green jobs providing affordable, clean energy for people and businesses across the North.’

IPPR North, Northern Energy Taskforce

Smart Systems and Flexibility plan





https://www.ofgem.gov.uk/system/files/docs/2017/07/upgrading_our_energy_system_-_smart_systems_and_flexibility_plan.pdf

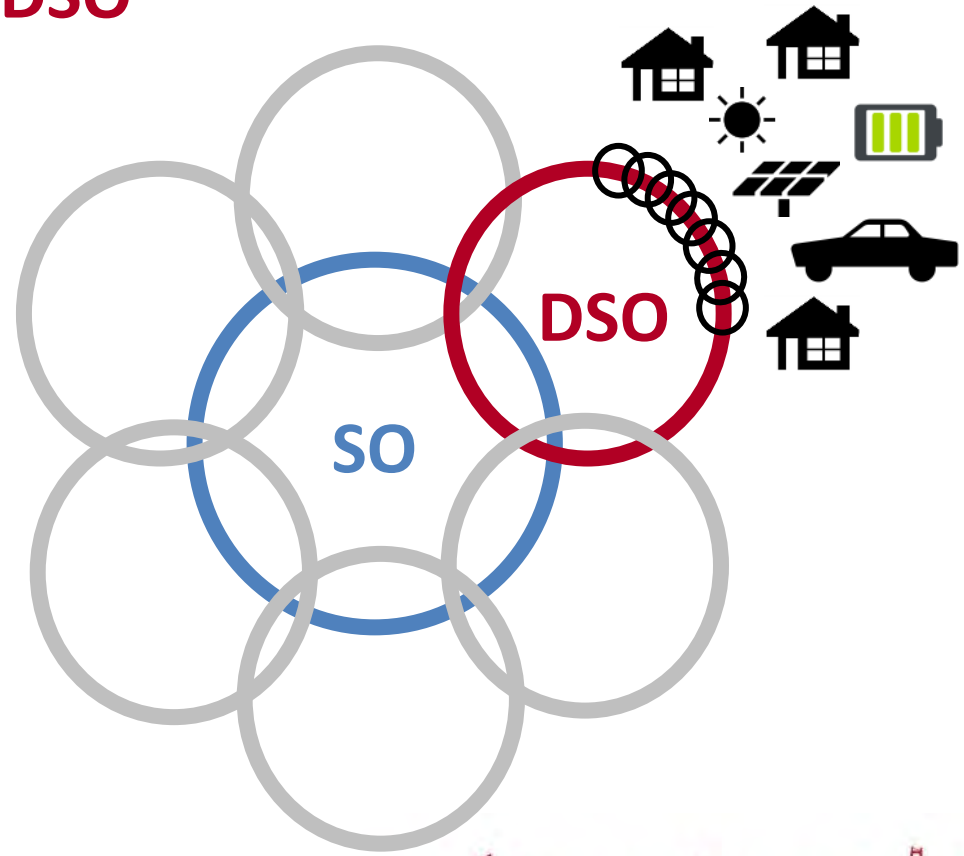
Our DSO vision

- Transition is required to a ***customer-led*** actively managed (and probably semi-autonomous) network…
- …where we are providing a cost-efficient, non-discriminatory and technology neutral physical trading platform…
- …for third parties in our region to participate in the electricity markets.

DSO must provide a compelling value proposition for customers and stakeholders

Our next steps from DNO to DSO

- Responsible for keeping the network stable and power supplies reliable.
- Regional DSOs of sufficient size and capacity to be accountable.
- Interconnection boosts physical and cyber security resilience.
- Provide the physical trading platform for other parties in the Energy Market.
- Market maker for distribution grid services.
- Enabler to access transmission grid services market.



From network services to customer services

1950s-1970s
Passive networks
Passively resilient
High headroom

1980s-2010s
Active networks
Active resilience
Medium headroom

2020s on
Semi-autonomous networks
Smart resilience
Economically optimised headroom

Smart grid hardware, remote control — **TECHNOLOGY** — Machine learning, Artificial Intelligence

Flexible connections — **MARKETS** — Open markets for grid services

GRID INVESTMENT - to maximise utility value

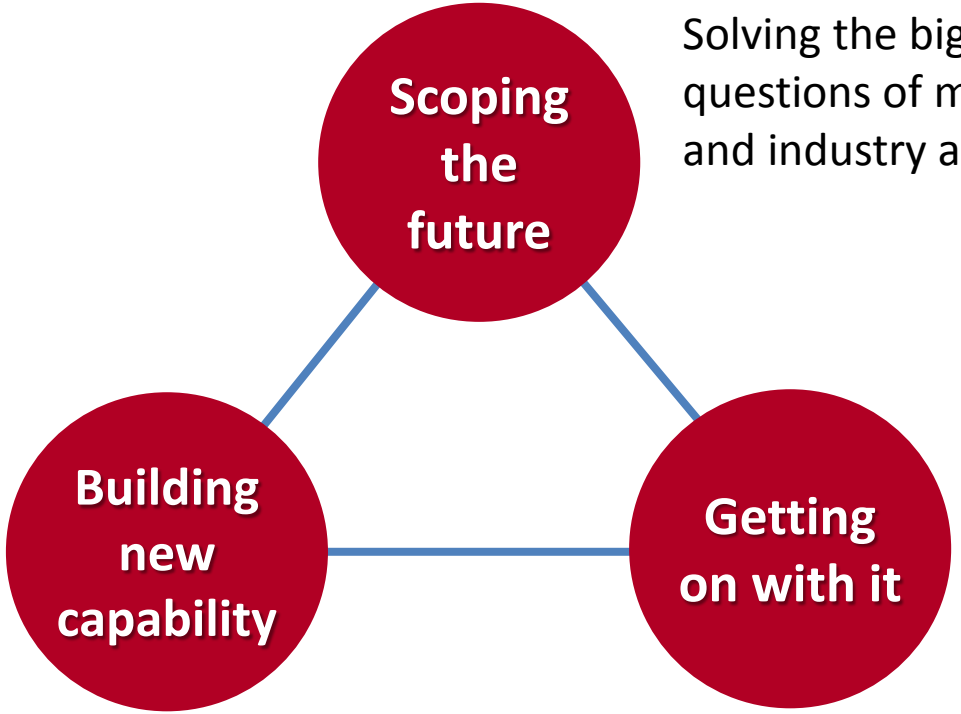
Taking forward our whole system thinking

Customer-Led Network Revolution

Customer and network solutions to connect more low-carbon generation, heat and transport

ena energynetworks association / FUTURE POWER SYSTEM ARCHITECTURE – MEETING BRITAIN'S FUTURE POWER SYSTEM CHALLENGES	• Open Networks and FPSA collaboration delivering enhanced whole *electricity* system optimisation
NORTHERN POWERGRID	• Customer-Led Distribution System - driven by network and energy services • Electric vehicle project portfolio • System losses - in the context of low marginal cost generation • Delivering fair societal outcomes
InTEGReL	• Whole *energy* system optimisation

Our DSO strategy



Solving the big open questions of market design and industry architecture

Providing new infrastructure and processes

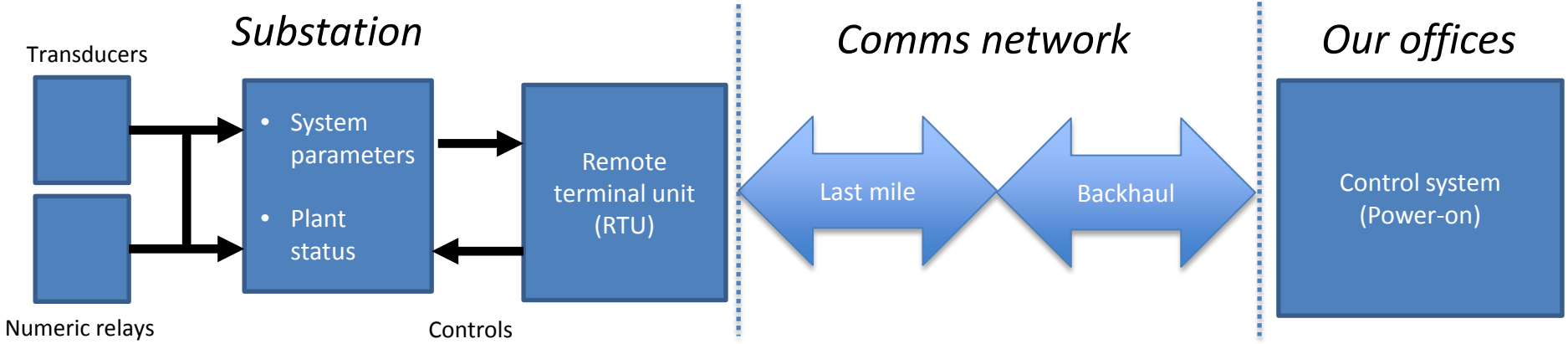
Low regrets steps to demonstrate and learn

Scoping the future: electric vehicles

- A successful transition will result from us understanding what customers want and developing solutions with the motor industry
- Strategic collaboration between Nissan and Northern Powergrid:
  - ‘Vehicle to grid’ offering new advantages to car owners
  - Innovate UK funded E4Future project developing commercial fleet opportunity
  - Grid and domestic target lower customer bills and improved grid resilience

Breakout group 1

Building new capability: example - smart grid enablers



- **Substation monitoring** - Upgrade all automatic voltage control (AVC) relays.
- **Substation RTU** – Replace time-expired RTUs with more flexible modern equivalents.
- **Comms network** – Replace the last mile radio links with modern IP radio equipment.

Breakout group 1

£83m investment that, as a minimum, pays for itself by 2031

Scoping the future: example - delivering for society

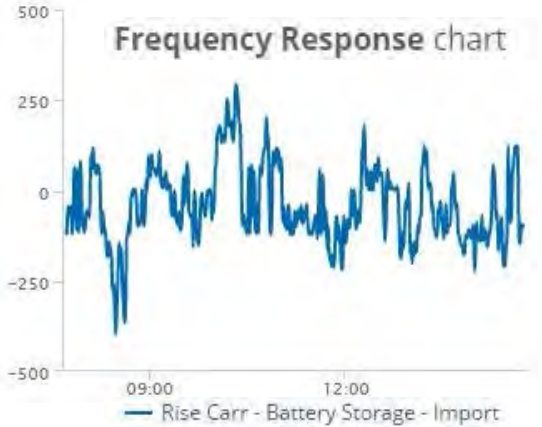
- Network charging regimes are rightly under the microscope by Ofgem
- We must avoid ‘free riders’ - particularly if those left to pick up the bill are already fuel poor
- The charging reforms must look at who receives the system benefits and who picks up the costs
- One focus of our innovation work is to ensure that everyone benefits from the transition to a smarter more flexible energy system

Breakout group 2

Getting on with it: example - battery trading

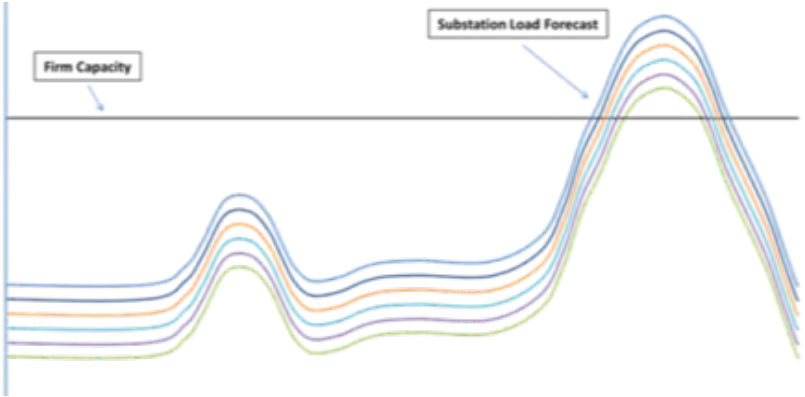
- Storage offers flexibility by smoothing intermittent generation or contributing to more active local balancing by the DSO.
- Value stacking through aggregator Kiwi Power:
  - Dynamic firm frequency response to the GB system operator
  - Triad services to an energy supplier
- Practical low-regrets innovation through a ‘learning by doing’ approach.
- Revenues earned used for innovation projects.

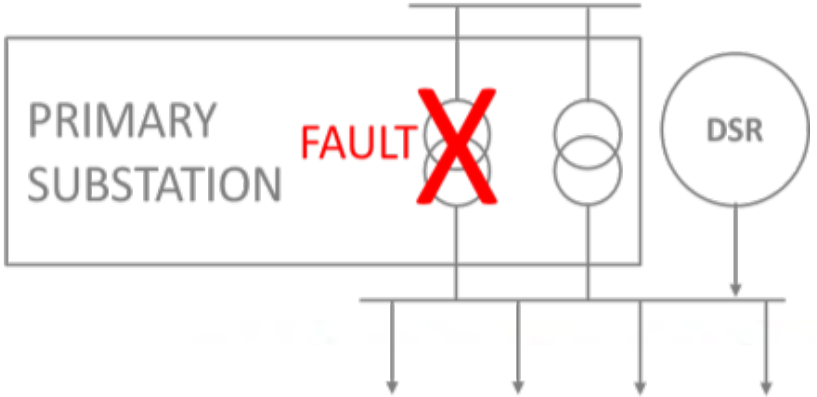
Customer-Led Network Revolution
2.5MW battery at Rise Carr



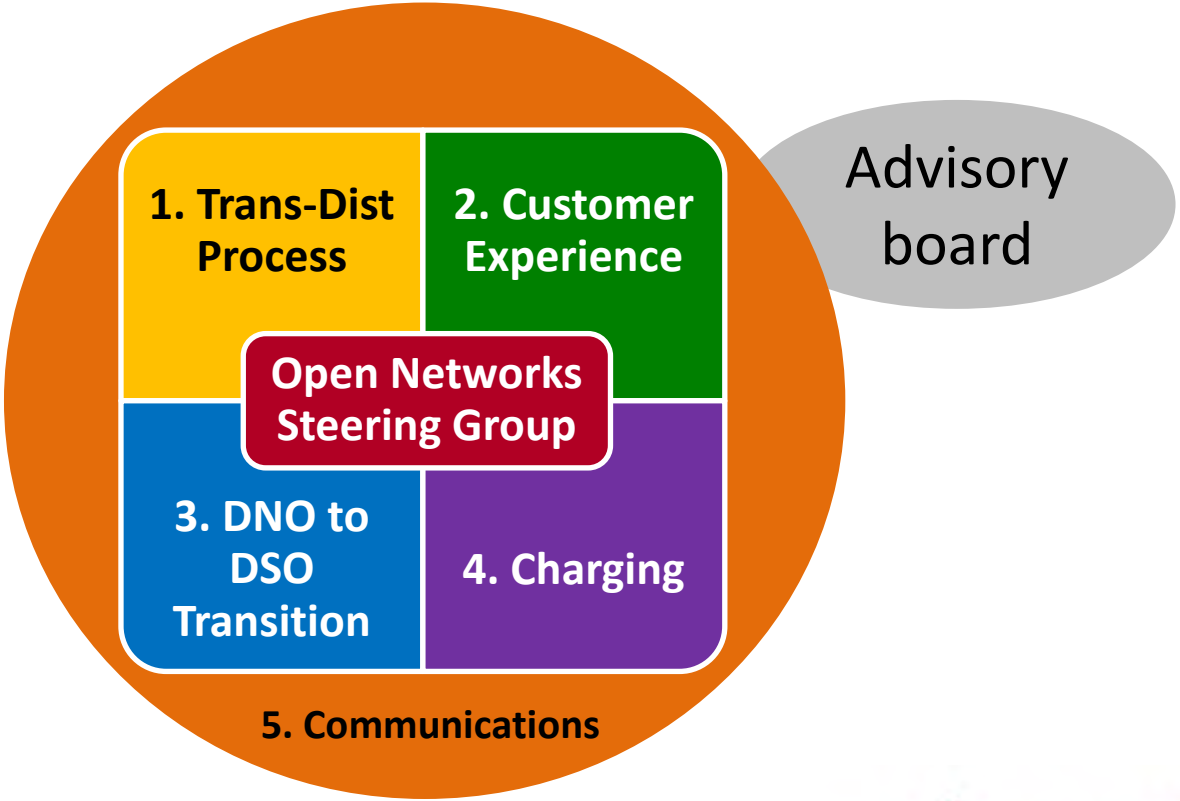
Getting on with it: example – flexibility services

- Delaying or avoiding upgrades at primary substations is a viable use case for flexibility services:
  - demand side response (DSR)
  - storage
- Two areas of our network may need interventions in the next five years
- We are targeting ‘market ready’ in 2018





Open Networks project collaboration continuing



http://www.energynetworks.org/electricity/futures/open-networks-project/

Stakeholder engagement framework

Listening to our customers' priorities

Stakeholder engagement leading to flexibility market testing

Engagement and planning on DSO

Q2/Q3 2017	***Sept 2017***	***Dec 2017***	**Jan 2018**	**May 2018**	**July – Nov 2018**
Outline DSO vision and strategy *Stakeholder panel* *Conferences*	*Twitter and webinar events*	*London event*	York event CLDS expert advisory group formed	DSO development plan • Customer benefits • Vision • Strategy • Route map • Projects	Flexibility services market testing New active network management solution implementation

Customer-Led Distribution System

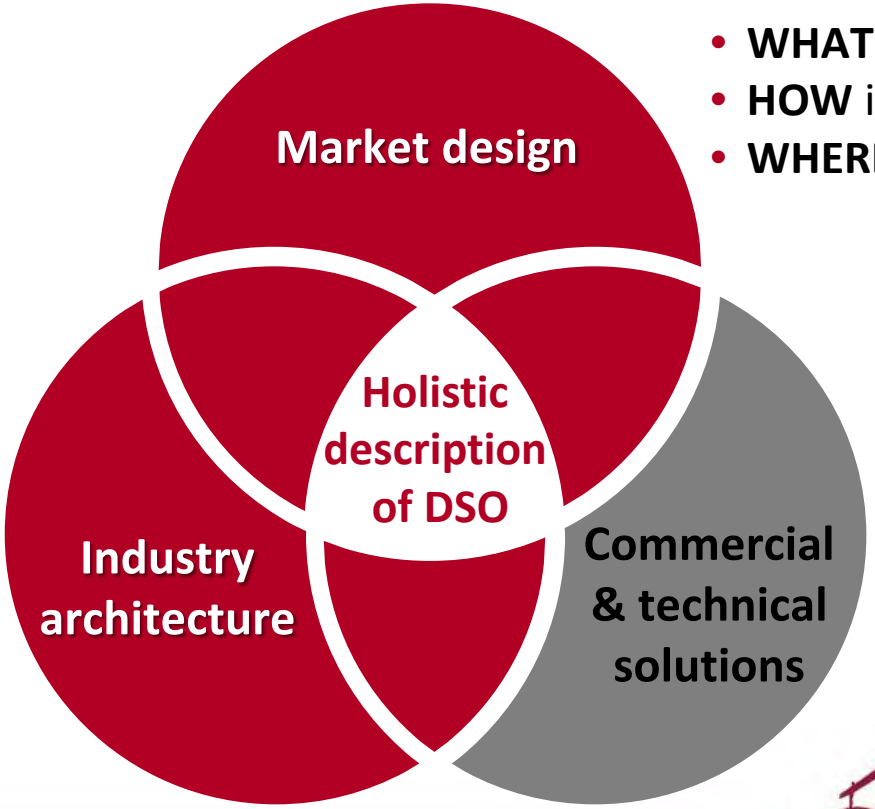
Looking to the future

- Our vision is to be the best energy company in serving our customers while delivering sustainable energy solutions.
- We will do this by **providing the platform** that enables **current and future** customers to receive **safe, secure, affordable and environmentally sustainable supplies of energy**, with **fairness and equity**.
- We maintain and build our business by creating and marketing a compelling value proposition for our customers.
- Our Customer-Led Distribution System (CLDS) project will help us understand how to do this.

Customer-Led Distribution System: Scoping the future

Solving the big open questions of market design and industry architecture

- **WHAT** is traded?
- **HOW** it is traded?
- **WHERE** it is traded?



- **WHAT** are the functions?
- **WHO** does **WHAT?**
- **WHAT** information is exchanged?

- **HOW** the functions could be executed

Customer-Led Distribution System: Approach

- Bring together a group of leading minds to provide cost efficient desktop studies and laboratory modelling and emulation.
- To collaborate with others to extend their demonstration projects through quick and low cost laboratory studies.
- Provide quantified evidence for customers, the industry and policy makers on different DSO options.
- Develop the economic evidence base for the investments needed for a DSO that truly delivers for customers.

Scoping the future: Customer-Led Distribution System

- **Examining the future structure of the distribution sector with customer front and central:**
  - Accommodating large volumes of DERs at least cost.
  - Deliver value to DERs that thrive in a flexibility market.
- **Identify and demonstrate**:
  - The most appropriate market design - what is traded, and how and where it is traded
  - Industry structure - roles of each party and the relationships between the parties
- **A virtual demonstrator** - using laboratory modelling and emulation to provide low cost extension of practical demonstrations.
- **Provide the quantified evidence base for the changes required.**

NORTHERN POWERGRID

Q&A

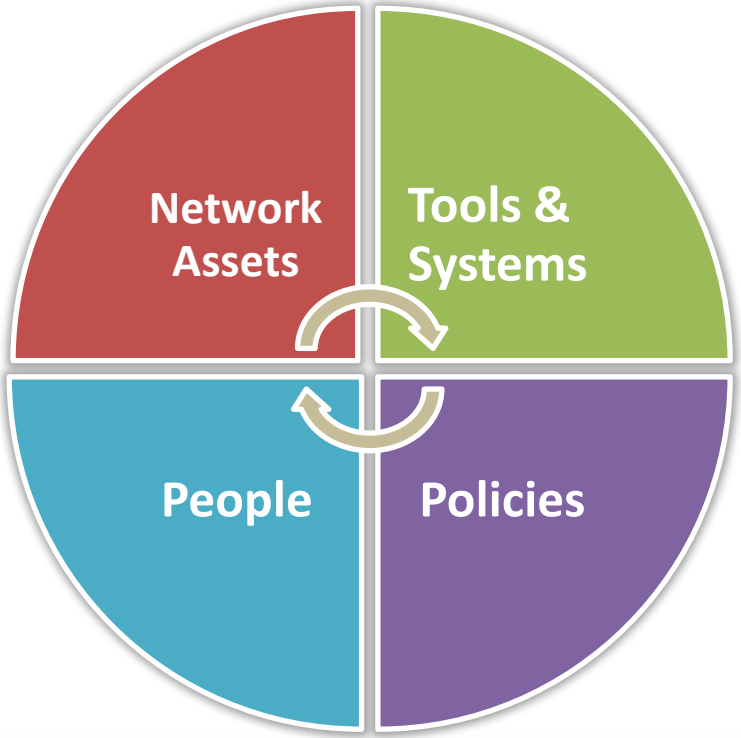
Breakout sessions

Smart Grid Enablers
Customer-Led Distribution System
Distribution Storage & Solar Study

Breakout session: Smart Grid Enablers

Mark Nicholson and Iain Miller

Our smart implementation is driving change across the business



£83m of smart grid enablement to provide:

- Better network visibility
- Ability to communicate
- More complex control

Development of new tools & processes:

- Scenario based forecasting
- Integrated planning and flexible design tools

Guidance on use of smarter solutions:

- Network flexibility
- Customer flexibility

Development of staff:

- New skills
- Being supportive & changing mentality

Network assets – biggest coordinated technical change since the 1970's

AREA	WHAT	PROGRESS
Telecoms (primary)	IP based network replacement providing more bandwidth and resilience across 800+sites	Upgrades of our core backhaul network in progress About to retender for further replacement work
Primary substation RTUs	Upgrade & replace RTUs across 800+ sites Platform for local control & IP capable	RTU upgrades complete and working on proof of concept trial with new RTU for remaining 453 sites
Voltage control and monitoring	Functionality for ANM & DSO services Improved visibility & alternative settings	Solutions developed and proved with 64 of 1273 units delivered in 2017
Telecoms (secondary)	RF mesh operating over 7000+sites	Use cases under development
Distribution monitoring	Pole mounted recloser Retrofitting of GM distribution subs	LV monitoring solution proven and delivery of initial 60 units commenced this week
IT & OT Systems	Rollout of standard ANM systems Data historians Enhanced planning and design tools using data from monitoring & smart meters	ANM framework in place and first system being rolled out at Driffield Rationalisation and updating of data historians Mobilising innovation project on use of smart metering data for network design

Electric Vehicles

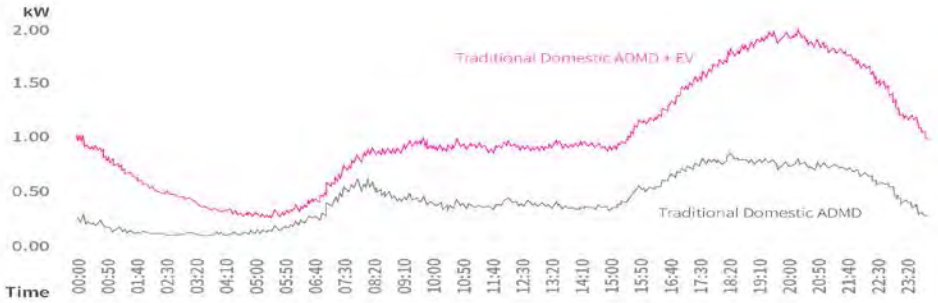
Iain Miller

The impact of EVs – a sense of scale

Power

- We have seen that 3-3.7kW chargers add 1kW to the evening peak (LCL UKPN, CLNR NPg)
- Roughly 30 million cars in the UK, so 30GW
- Hinckley Point C (due in 2025) is 3.2GW which is around 1.5-3m EVs depending on charger size
- 30GW extra load represents around a 60% increase in the UK peak loading

Doubling the load: The after-diversity-maximum-demand (ADMD) traditionally used for domestic properties is 1KW; with the inclusion of an EV this needs increasing to 2KW

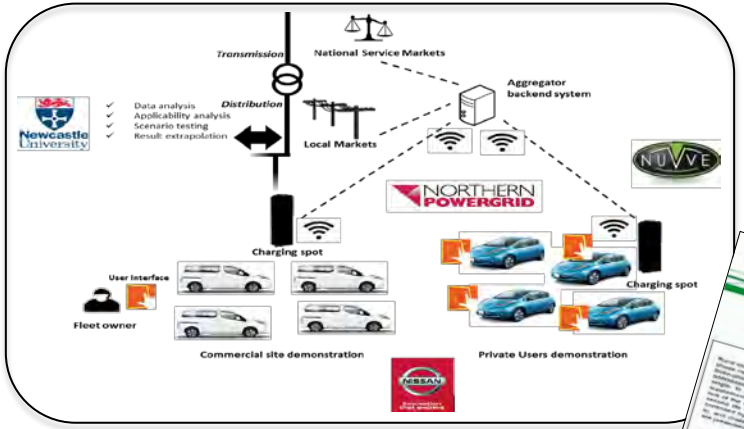


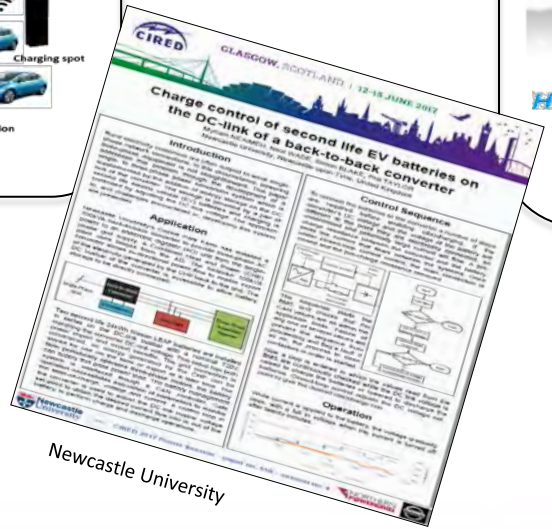
Energy

- Taking that lower Hinckley Point C figure of 1.5m EVs…
- …each covering 8000 miles pa…
- …at 3.5 miles/kWh…
- …gives 3.4TWh/annum
- Around a 1% increase on the UK's energy consumption of circa 350TWh/annum
- Or equal to the energy generated by solar generation in Q3 of 2016[1]
- For 5% of the expected EVs

1. www.gov.uk/government/uploads/system/uploads/attachment_data/file/579527/Renewables.pdf

Our response – V2G, SilentNight, Cockle Park Farm





Newcastle University

Managing Network Losses

Mark Nicholson

What we've been doing

- Understanding
  - Smart Metering data and impact on losses calculations
  - Losses on the customer side of the meter
  - Learning from other DNOs and our sister companies losses projects
- Doing
  - Upsized HV and LV cables and some distribution transformers
  - Accelerated asset replacement of pre-1958 distribution transformers
  - Provided training and guidance for our design engineers on losses assessment
  - Completed consultation on losses strategy
  - Educate customers on losses at focus groups
  - Losses animation to help stakeholders engage

What we're planning to do

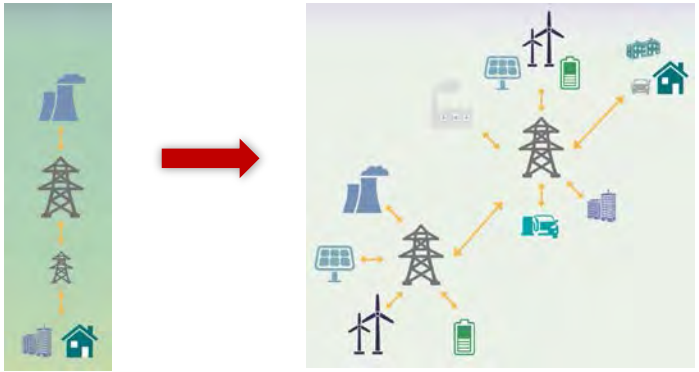
- Understanding
  - How heat can be re-used from substations for other uses
  - Enhanced modelling of network losses
  - Variable voltage set points to reduce losses
  - Time of day electricity price impact on losses assessments
- Doing
  - Targeted customer advice on improving reactive power flows
  - Trialling super low loss transformers (Amorphous Core)
  - Virtual expert group and dedicated website
  - Further staff training

Breakout session
Distributed storage and solar study

Patrick Erwin and Paris Hadjiodysseos

Background

- Electricity generated centrally
- Networks were designed with a top-down approach in mind
- Distributed Generation has changed the power flow dynamics
- Think how to manage the network better!



Scoping the future

- 2015: 32 PVs (2.7kW - 3.68kW)
  - Connected 27
- 2016: 40 Batteries (2-3 kWh)
  - 31 paired with PVs
  - 9 on their own
- Can we turn these into green?
- Provide customers with cheaper electricity through time shifting

Getting on with it!

DS3 Project

- 3 year NIA funded community project focusing on social housing
- £300k - batteries, monitoring & data analysis

What's in it for customers

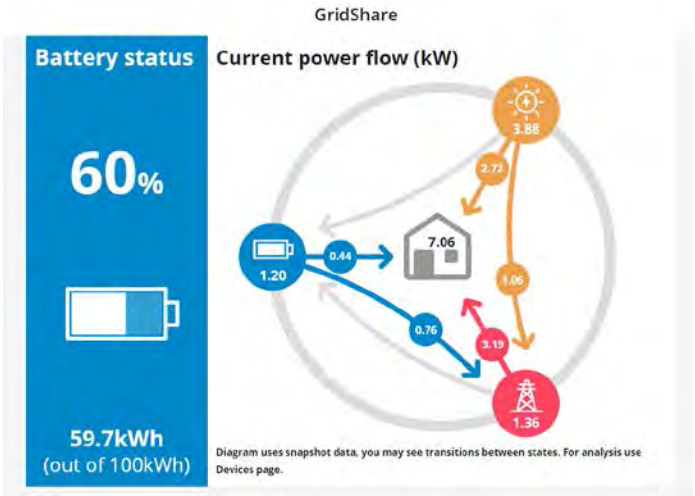
- Aims to reduce electricity bills
- Reduce reinforcement works

What's in it for Northern Powergrid

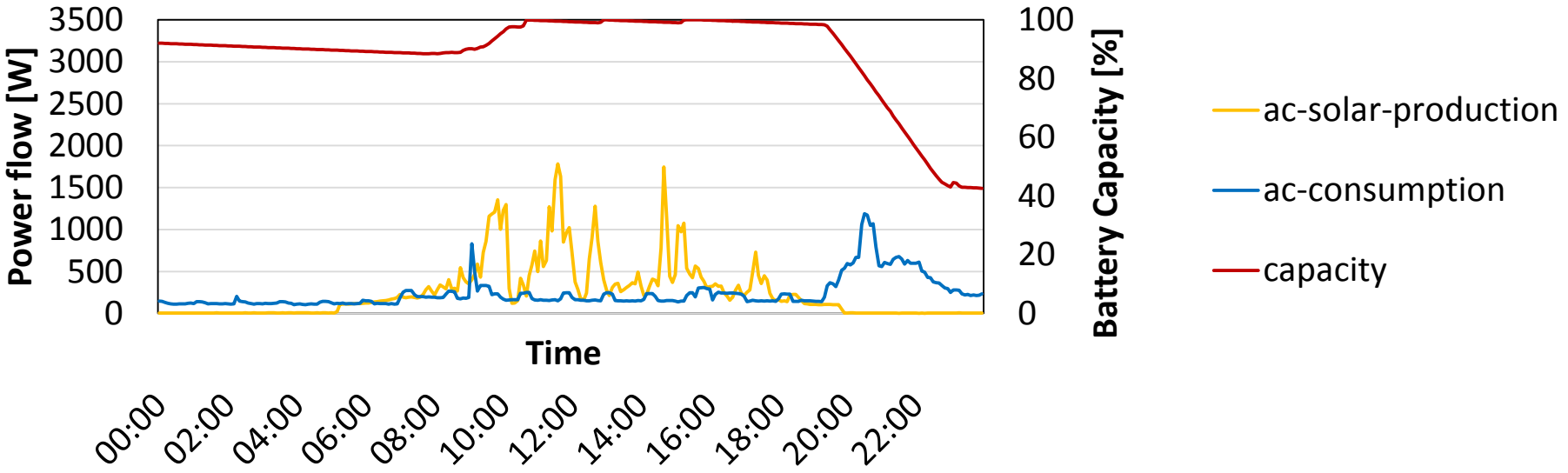
- 2030: 70-80% of rooftop PV installed with storage
- Understand impact of PV & Storage on network design
- Absorb excess generation & supply peak load

Building new capability

- Increase capacity
- Avoid reinforcement
- Dynamic control
- Behind the meter Vs network owned batteries
- Design Policies

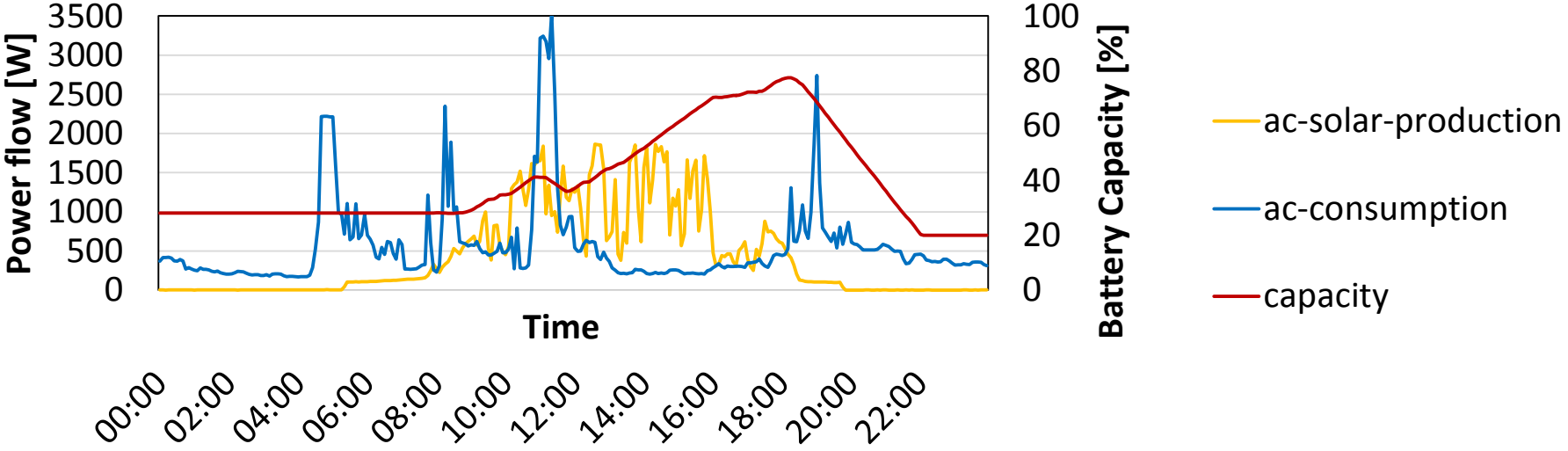


One house, two days in August – day one…



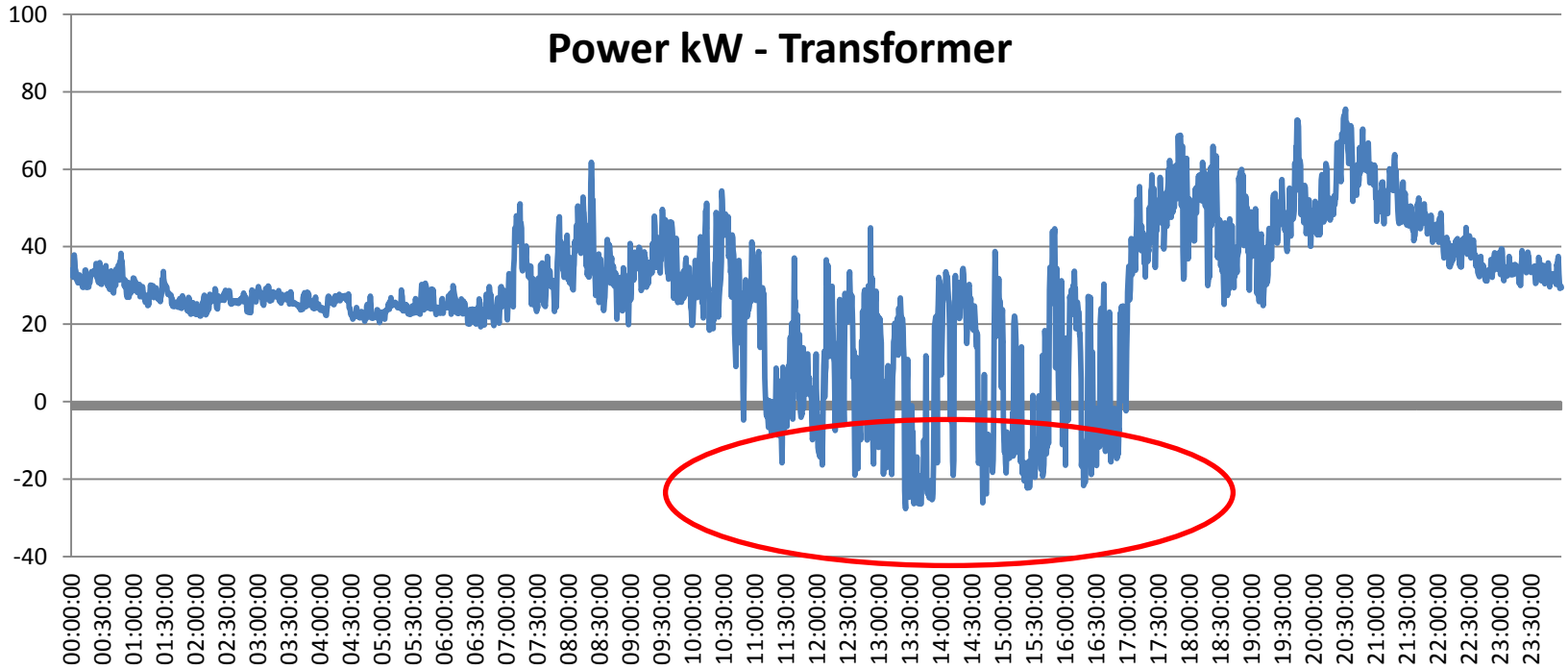
- Low consumption and high battery charge level - after 8pm powering the house
- Unable to store much of the generation resulting in daytime export to grid

…and day two



- Strong consumption and a low battery capacity in the morning
- Charging battery through day and supplying house evening load

Reverse power flow at peak generation



Breakout session: Customer-Led Distribution System

Jim Cardwell and Liz Sidebotham

Looking to the future

- Our vision is to be the best energy company in serving our customers while delivering sustainable energy solutions.
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Customer-Led Distribution System: Scoping the future

Solving the big open questions of market design and industry architecture

- **WHAT** is traded?
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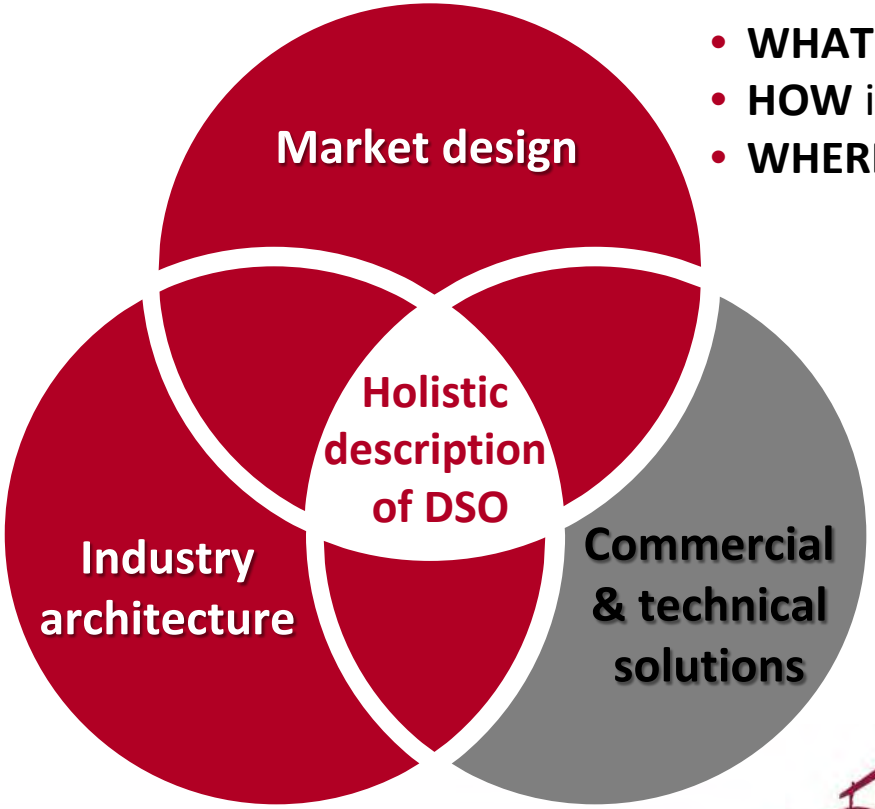

- **WHAT** are the functions?
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- **HOW** the functions could be executed

Customer-Led Distribution System: Objectives

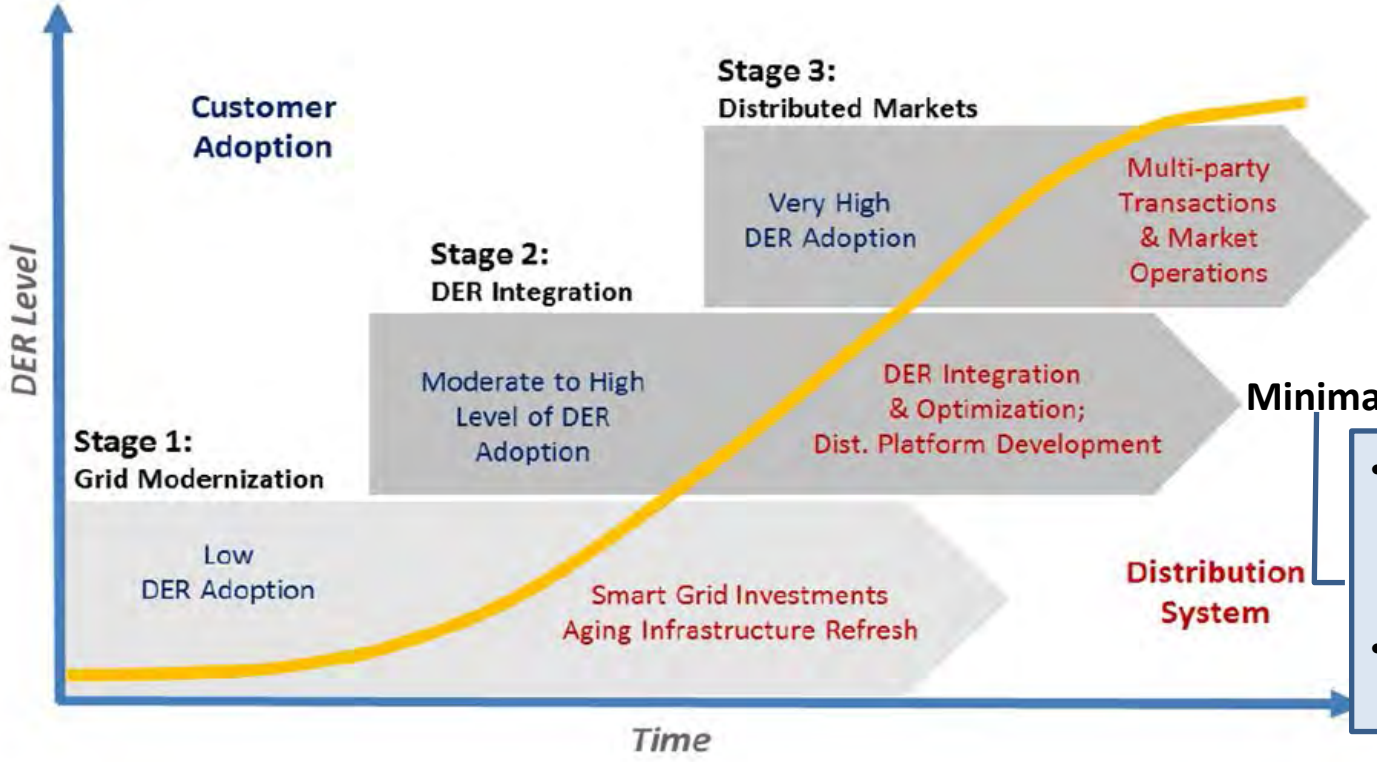
To identify and demonstrate the most appropriate market design and industry structure that will:

- Enable the optimisation of network and distributed energy resources.
- Enable 3rd party providers to realise maximum value of distributed energy resources through market-enabled energy and network products.
- Enable the uncertainty and complexity of the supply system to be substantially reduced by distributed and coordinated market and network solutions.

Customer-Led Distribution System: Approach

- Bring together a group of leading minds to provide cost efficient desktop studies and laboratory modelling and emulation.
- To collaborate with others to extend their demonstration projects through quick and low cost laboratory studies.
- Provide quantified evidence for customers, the industry and policy makers on different DSO options.
- Develop the economic evidence base for the investments needed for a DSO that truly delivers for customers.

Trends in distributed energy resources development



- Distribution level energy markets; transactions among DER
- Clearing and settlements for inter-DER transactions
- Market facilitation services

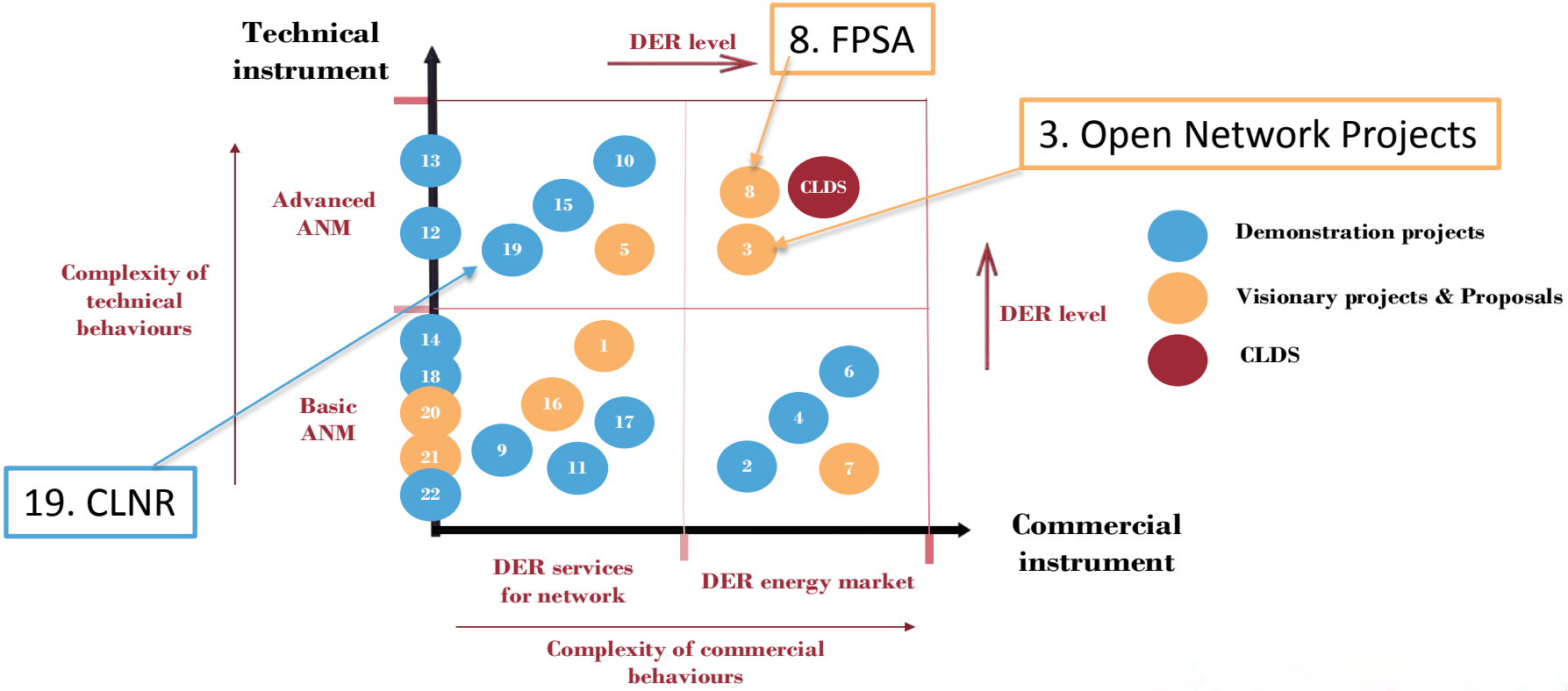
Market DSO model

Minimal DSO model

Distribution System

- Managing distributed reliability services to support distribution system operations
- T-D interface reliability coordination

Where this project sits relative to other DSO-related projects



Customer-Led Distribution System: Project timing

Year 1: Design	**Industry Structure** for an efficient and coordinated energy system	**Market Design** for energy products from DERs
Year 2: Evaluation	**How to co-ordinate DERs and optimise** to address energy and network problems	**Laboratory demonstration** of energy markets and DER co-ordination
Year 3: Route to value	**Pathways** for commercial and technical developments	Quantify **the value to customers and stakeholders** from introducing energy markets to distribution sector

Scoping the future: Customer-Led Distribution System

- **Examining the future structure of the distribution sector with customer front and central:**
  - Accommodating large volumes of DERs at least cost.
  - Deliver value to DERs that thrive in a flexibility market.
- **Identify and demonstrate**:
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  - Industry structure - roles of each party and the relationships between the parties
- **A virtual demonstrator** - using laboratory modelling and emulation to provide low cost extension of practical demonstrations.
- **Provide the quantified evidence base for the changes required.**

Panel session and discussion

Patrick Smart – RES Ltd
Jo-Jo Hubbard - Electron
Jenny Saunders – CV expert
Mark Drye – NPg

Event close and next steps

Patrick Erwin

Policy & Markets Director

Our DSO vision

- Transition is required to a ***customer-led*** actively managed (and probably semi-autonomous) network…
- …where we are providing a cost-efficient, non-discriminatory and technology neutral physical trading platform…
- …for third parties in our region to participate in the electricity markets.

DSO must provide a compelling value proposition for customers and stakeholders

Join the customer-led discussion and debate

Today, we ask you to:

- ✓ **Join our DSO Community**
- ✓ **Join our Losses Expert Group**
- ✓ **Register your interest in our stakeholder panel for a regular strategic discussion on Northern Powergrid performance, plans and priorities**
- ✓ **Help us to think through how we have meaningful discussion with our customers – via our feedback form**

Visit our innovation website and continue the debate:
www.northernpowergrid.com/innovation

Unlocking the Future of Energy

Our transition to a Customer-Led Distribution System Operator

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