Active Network Management (Orkney)

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Scottish and Southern Energy
Power Distribution

Overview

- Introduction to the Orkney Registered Power Zone (RPZ)
- Orkney Electrical Network
- Orkney Network Development
- Orkney RPZ Timeline
- Design of the Orkney ANM
- What is deployed on Orkney?
- Commercial overview
- Customer experience
- Lessons Learned from R&D Project

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The Orkney Registered Power Zone

- High interest in further renewable generator connections
- Traditional reinforcement solution would be very expensive
- Spare capacity available due to patterns of load and generation
- Ofgem incentives: DG, IFI and Registered Power Zone (RPZ)

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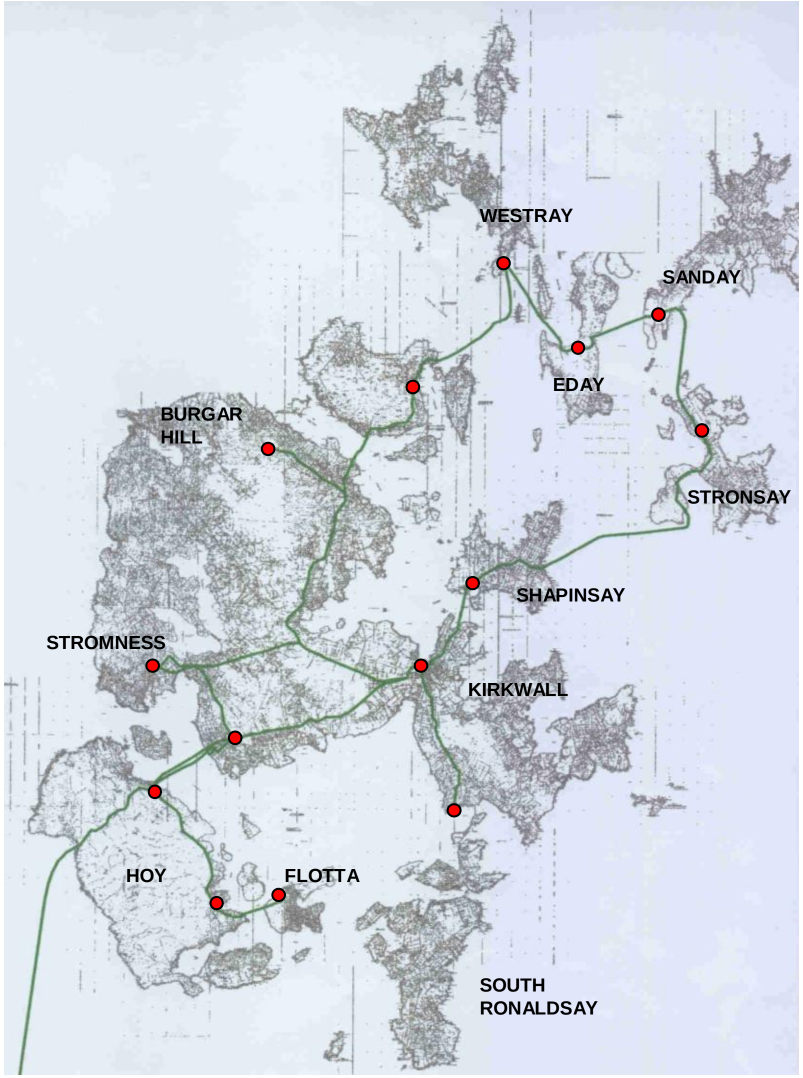
Orkney Electrical Network

- 6 miles off north coast of Scotland
- 11,500 customers
- Min/Max demand: 8/31 MW
- 33 kV submarine cables: 2 x 20 MW import/export
- Existing generation a mix of wind, wave and gas
- Reactive compensation equipment installed (including DVAR)
- Existing protection-based network management:
  - Firm Generation (FG)
  - Non-Firm Generation (NFG)
  - Load shedding



Orkney RPZ Timeline

1. DTI funded study – 2004:

   www.ensg.gov.uk/assets/kel003110000.pdf

   – Established benefits of ANM, details of technical solution and estimated potential economic generation connection

2. RPZ application – 2005

   – Sets out the generators involved, connection barriers, traditional solutions, innovative solutions, costs, etc.

3. IFI funded development activities – 2006/07 onwards
4. ANM Scheme Trial – November 2006
5. Connection of first two ANM generators – Nov 2009
6. Improvements of the ANM scheme in service

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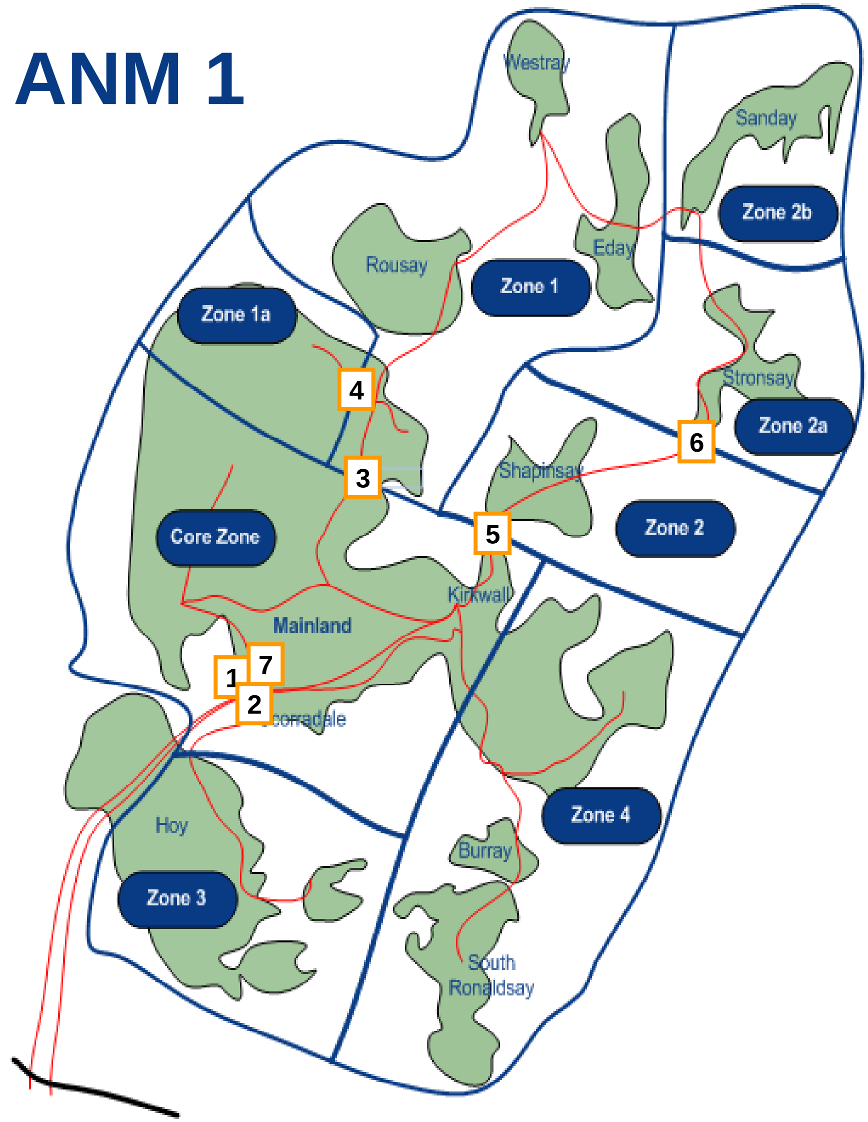
Design of the Orkney ANM 1

- ANM scheme monitors load on critical circuits (Constraint Locations)
- Adjusts power flow through constraint locations by issuing control signals to generators
- System based in Kirkwall Power Station
- Communicates to controllers at each generator and constraint location



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Orkney Generation Portfolio

Total Generation (MW)	Name	Type	Size	
65.94	Braefoot (Shapinsay)	WIND	0.9	
	Burgar Hill Renewables	WIND	2.3	
	Cleat	WIND	0.08	
	Dale Spot	WIND	0.08	
	Eday Community (Eday)	WIND	0.9	
	Fea	WIND	0.08	
	Hammars Hill	WIND	4.5	
	Hatston	WIND	0.9	
	Holodykes	WIND	0.9	
	Kingarly (Rousay)	WIND	0.9	
	Ore Brae (Hoy)	WIND	0.9	
	Rothiesholm (Stronsay)	WIND	0.9	
	Spurness 2 (Sanday)	WIND	2.5	NEW NON-FIRM GENERATION TOTAL (MW)
	Thorkell	WIND	0.9	18.54
	Tuquoy (Westray)	WIND	1.8	
47.4	Burgar Hill	WIND	6	*
	Burray (St Marys)	WIND	0.9	
	Gallow Hill (Westray)	WIND	1	NON-FIRM GENERATION TOTAL (MW)
	METC (Eday)	TIDAL	4	* 21.4
	Spurness (Sanday)	WIND	7.5	*
	West Hill (Flotta)	WIND	2	
26	Bu Farm (Stronsay)	WIND	2.7	
	Flotta	GAS	10.5	FIRM GENERATION TOTAL (MW)
	METC (Wave)	WAVE	7	* 26
	Siguird (Burgar Hill)	WIND	1.5	
	Thornfin (Burgar Hill)	WIND	4.3	
0				
	Diesel Back-up	*Diesel*	*15*	

* Intertrip Installed for loss of regulator at Scorradale and if export > 20MW

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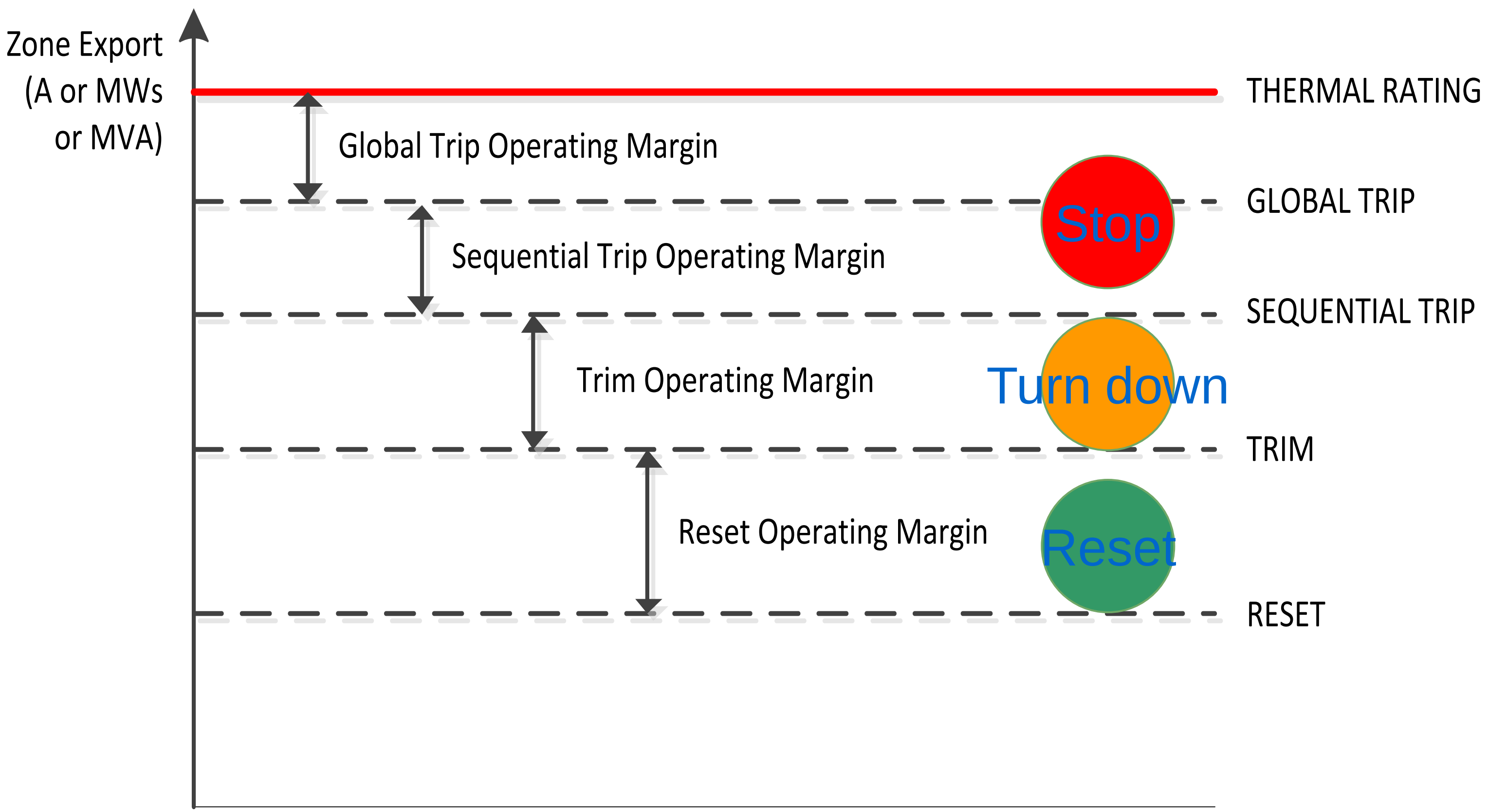
Data correct @ Jan 2013

Design of the ANM scheme 3



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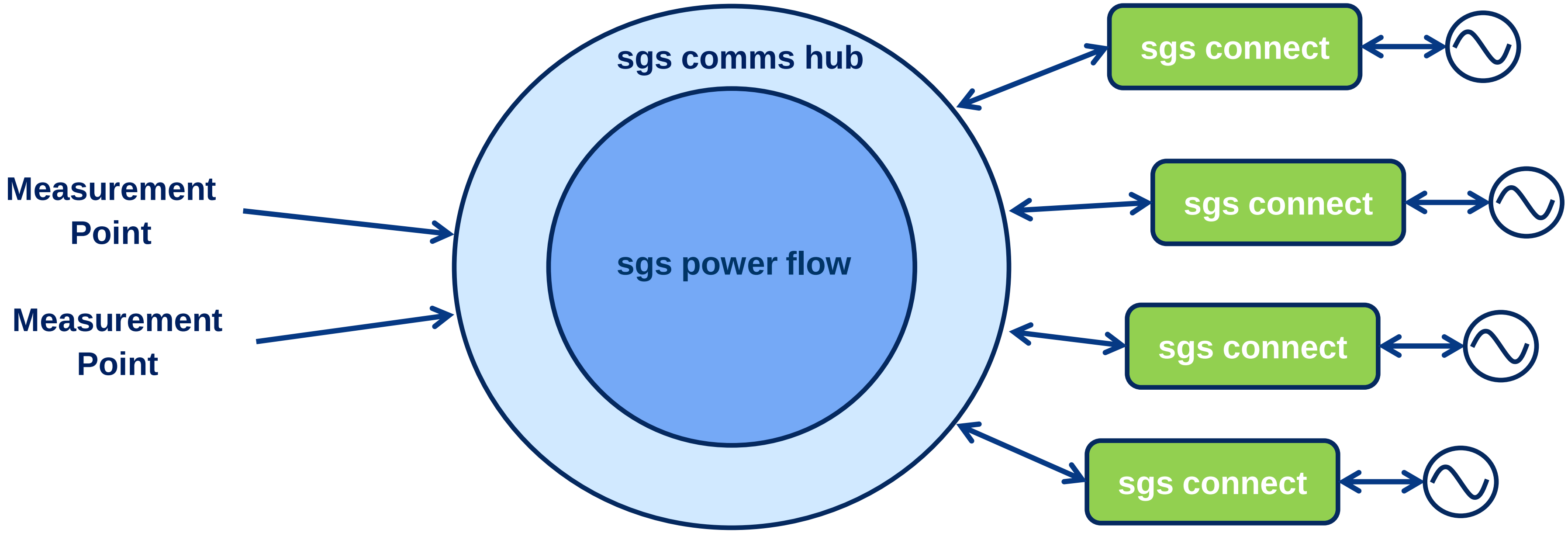
What is Deployed on Orkney?



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Commercial Overview - The Challenge

1. Need to avoid speculative applications and the sterilisation of capacity

2. Allocation of capacity needs to be fair and equitable

3. From a generators perspective it must be commercially viable

4. Technically feasible to implement without creating hardware/software "monster"

   – Application Process

   – First come first served

   – Principles of Access (PoA)

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Principles of Access

- What are the available options?
- We are going to explore 3 broad options then evaluate them
  - Option 1: Pro-rata
  - Option 2: Last In First Off (LIFO)
  - Option 3: “X” Factor - cheapest, greenest, most efficient etc

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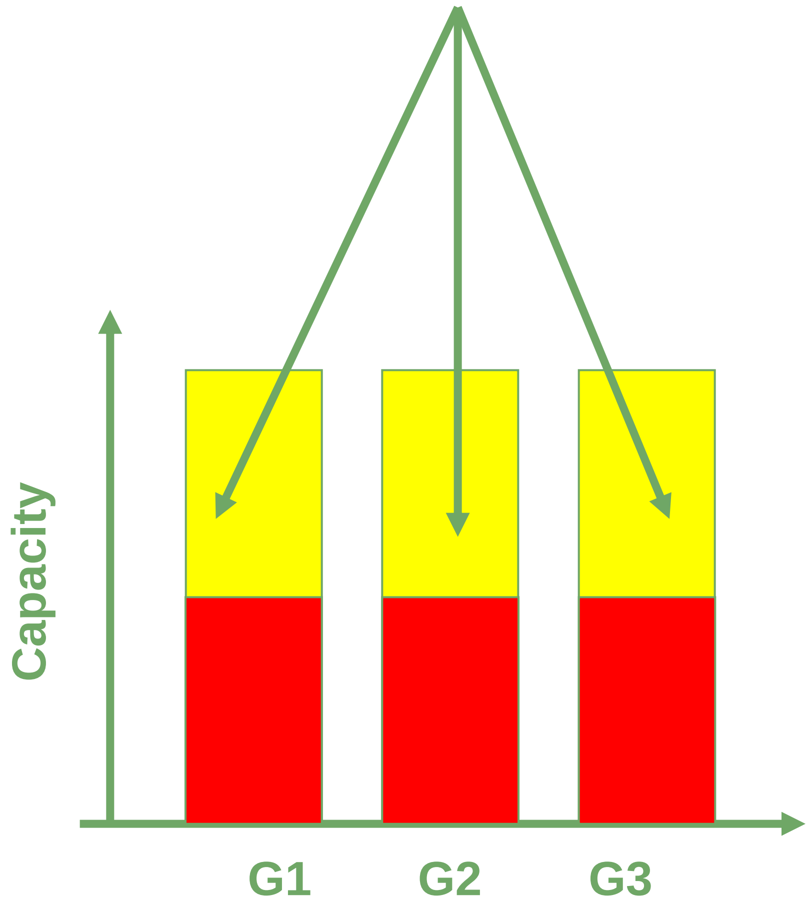
Option 1: Pro-rata

- Network constraint = all constrained



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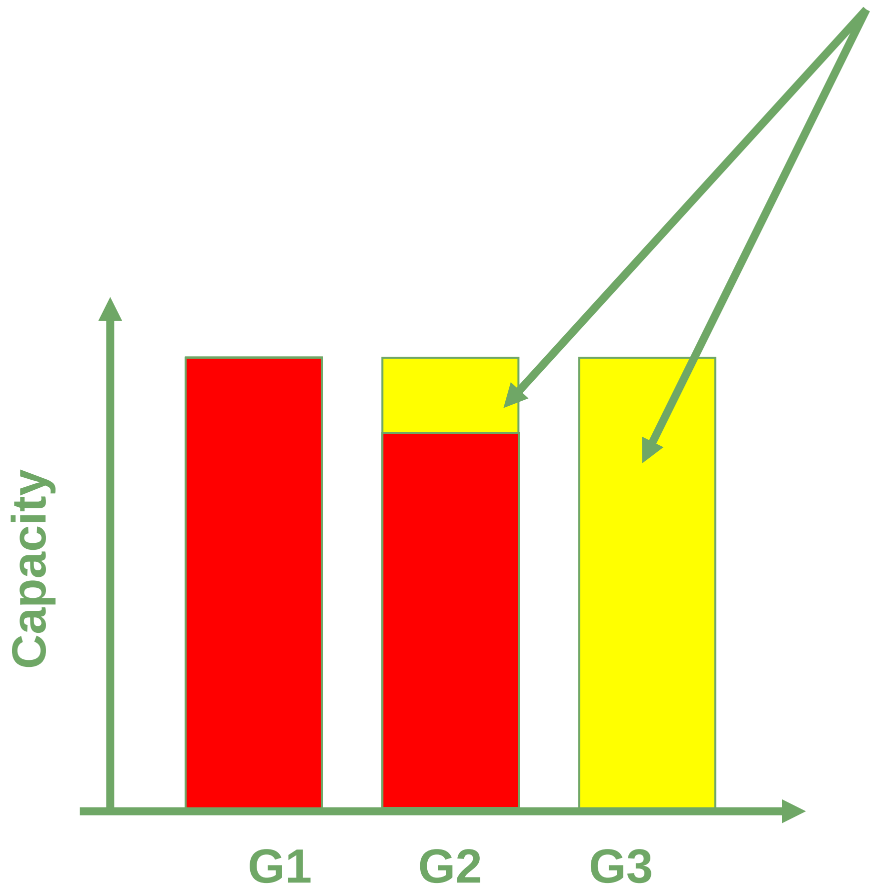
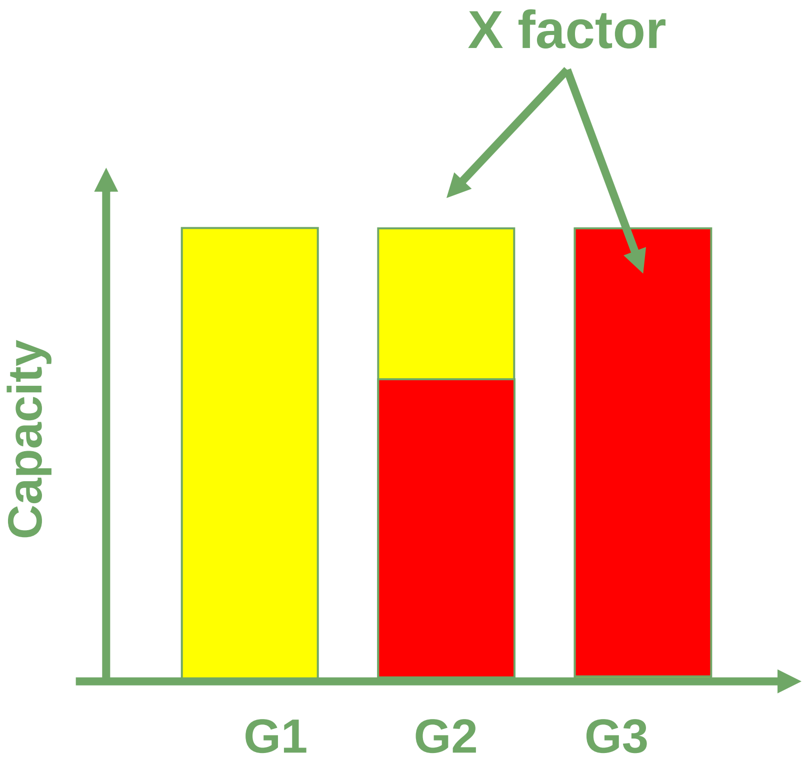
Option 2: Last In First Off (LIFO)

- Network constraint = Curtail G3 then part G2



Option 3: "X" Factor

- Network constraint = X factor then X-1 factor



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The Results

Option	Pros	Cons
Option 1 (%)	Fairer in terms of equal constraint impact; Could pro-rata be also linked with LIFO – subsets?; Simple;	Uncertainty – constraint and financial; Not as simple as it looks;
Option 2 (LIFO)	Predictable and fixed constraint level specific to RPZ scheme; Certainty of investment;	Disadvantage to new generators – high constraint levels; Not greenest or economically best overall;
Option 3 (X Factor)	Maximising green, efficient generator market approach – onus is on generator to implement; Could tune to be economically best or greenest;	Uncertainty in terms in constraint; Discrimination; Limits diversity; Unpredictability;

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System Analysis

- 2 separate reviews
- SGS 2011
    - ANM comms highlighted as a significant cause of curtailment
    - Generator overproduction also a factor
- KEMA 2012
    - ANM comms again highlighted
    - Real Time architecture shown as crucial
    - LIFO shown to work commercially

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Customer Experience

Generator Unit	Actual Production Factor after curtailment (%)	Estimated Production Factor High Wind Year (%)	Estimated Production Factor Low Wind Year (%)
NNFG x	35.5	42.1	35.2
NNFG y	44.1	36.6	35.5
NNFG z	41.2	43.8	38.9

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Sub 50kW

- Eroding network capacity
- Closed door in September 2012
- Looking to include within ANM system
- System must have similar principles
    - Not affect existing generators
    - Must failsafe
    - Must be commercially viable for generators

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Lessons Learned from R&D Project

- Orkney shows a least cost scalable ANM solution to enable connection of additional renewable generation to a constrained network
- NNFG connections limited by economic rather than technical factors
- NNFG units benefit from diversity of DG output and demand
- Smart Grid technologies can be integrated with existing systems
- Importance of communications
- Real world experience of control approach is invaluable
- Off-the-shelf ANM systems were not available

Questions?

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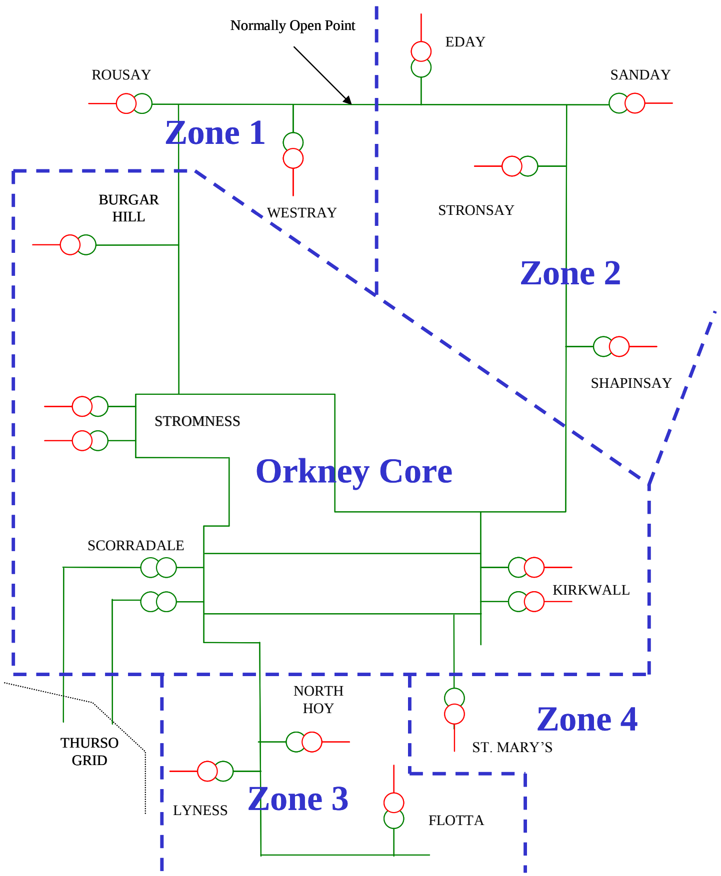
Design of the Orkney ANM 1

- Reactive compensation equipment solves almost all voltage problems
- Each zone has a thermal limitation on generation output at any given time
- Whole Orkney system has a further thermal limit on generation output
- Real time control of wind and marine generating units based on measurements and control logic.
- Existing generation unaffected



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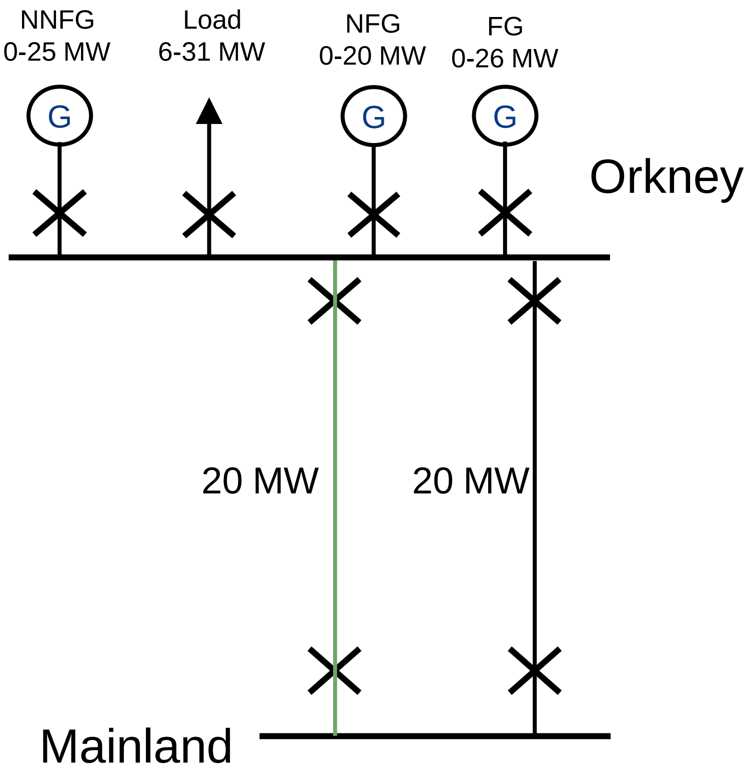
Orkney Network Development

- High levels of generation wishing to connect - reinforcement too expensive
- NNFG = Capacity of both circuits + local maximum demand - FG - NFG = ANM MW
- NNFG = 20 + 20 + 31 - 26 - 20 = 25 MW



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Flexible Plug and Play

Engaging with Distributed Generators

Smart Grid Forum: Workstream 6

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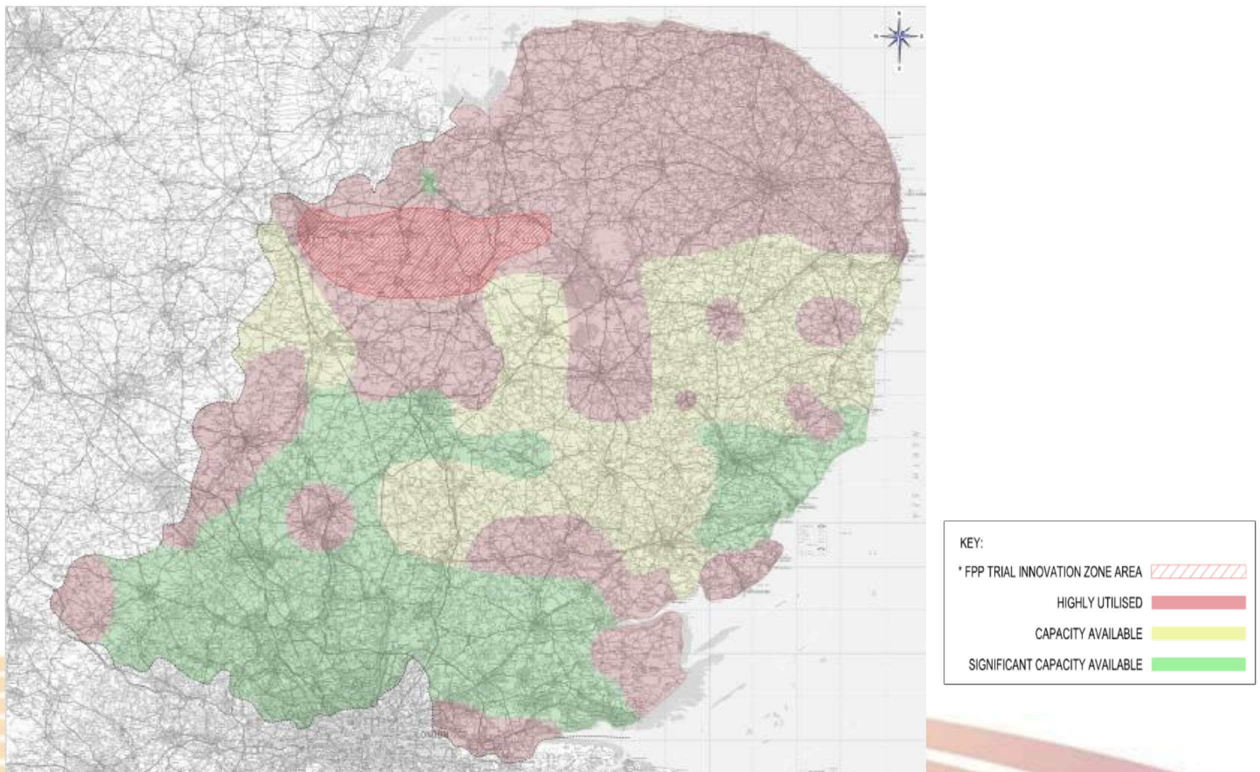
LCN Fund Low Carbon Networks

UK Power Networks Delivering your energy

What types of generation is this applicable to (including new or existing customers)?

Flexible Plug and Play potential customers

- New distributed generation (11kV and 33kV)
- Working with wind, solar, and CHP (anaerobic digestors)



Connection costs

- Focus on constrained networks where “firm” connection costs that make their projects unviable

Gen Name	MVA	Gen Type	BAU offer	FPP offer
A*	7.2	Wind	£3,508,930	£881,611
B	0.5	Wind	£1,891,200	£234,779
C	10	Wind	£4,827,000	£590,818
D	5	Wind	£1,185,000	£649,788
E	2.5	Wind	£1,950,000	£157,137
F	1	Wind	£2,050,000	£384,711

***Accepted offer**

FPP method consistent in delivering savings of 80%-90% on cost of sole use assets

Does this approach resolve particular network constraints that other constrained connection offers do not, and under what circumstances will generation be controlled?

Types of constraints

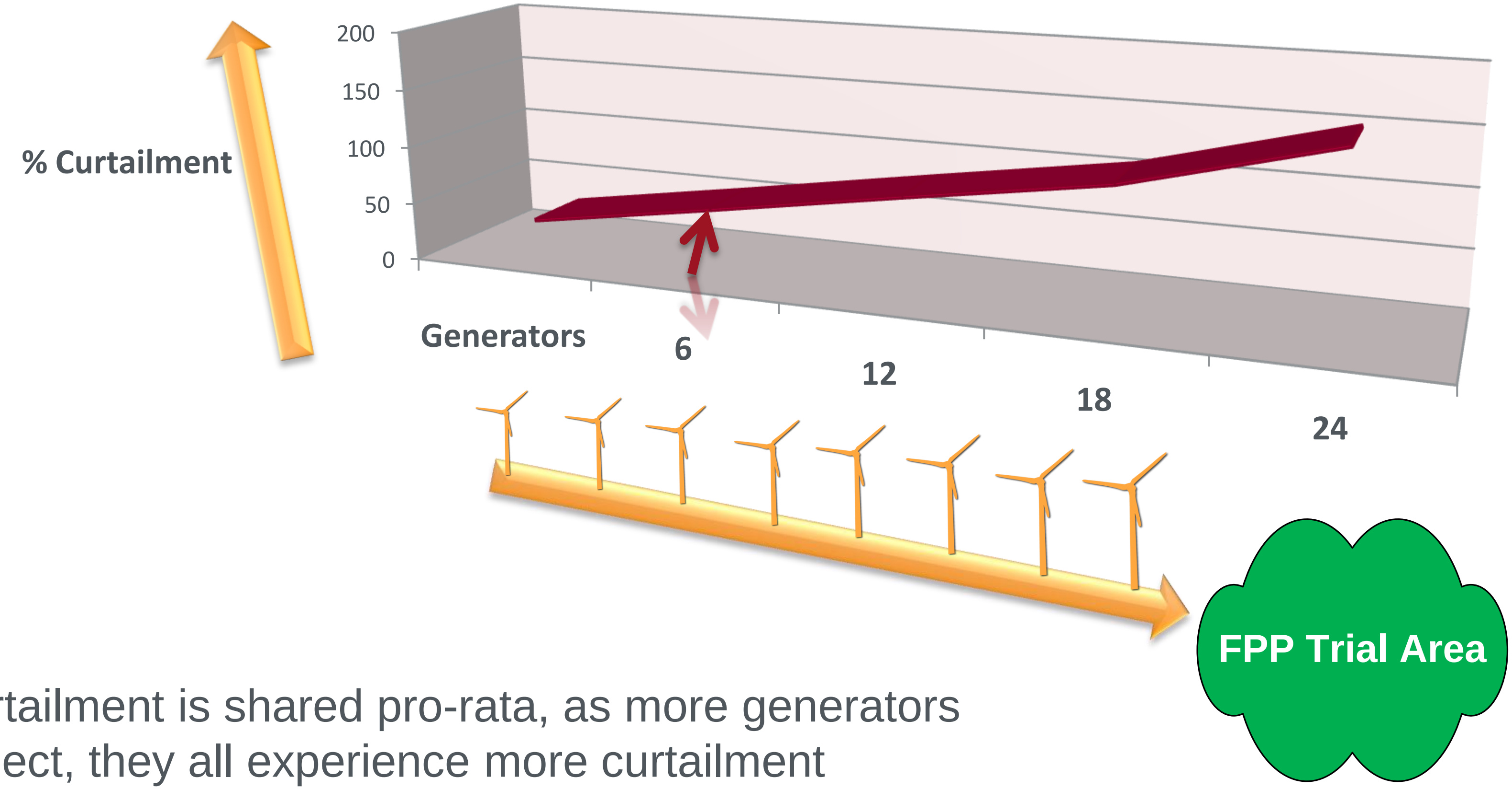
- Thermal constraints
- Voltage constraints
- Reverse Power Flow across Grid transformers

Solutions

- Active management of generation output and voltage through the implementation of an Active Network Management scheme
- Dynamic Rating of OH lines
- Novel protection schemes
- Quadrature-booster transformer

What were the key features of the commercial arrangements and how are constraints allocated across connected generators?

Generation and curtailment

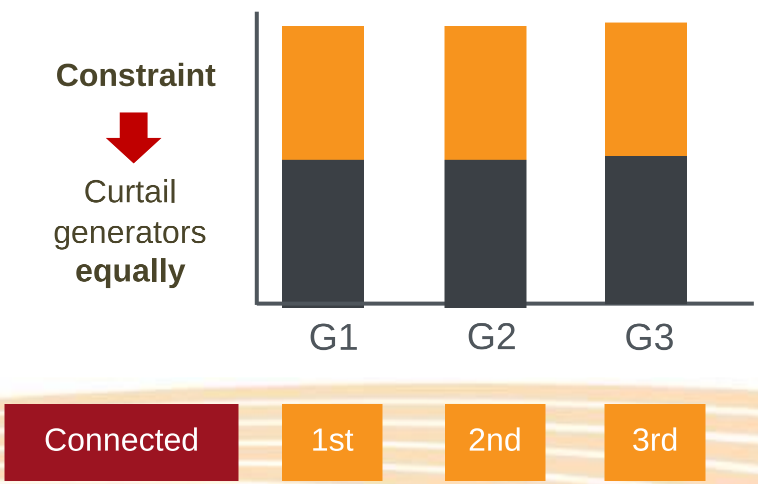


If curtailment is shared pro-rata, as more generators connect, they all experience more curtailment

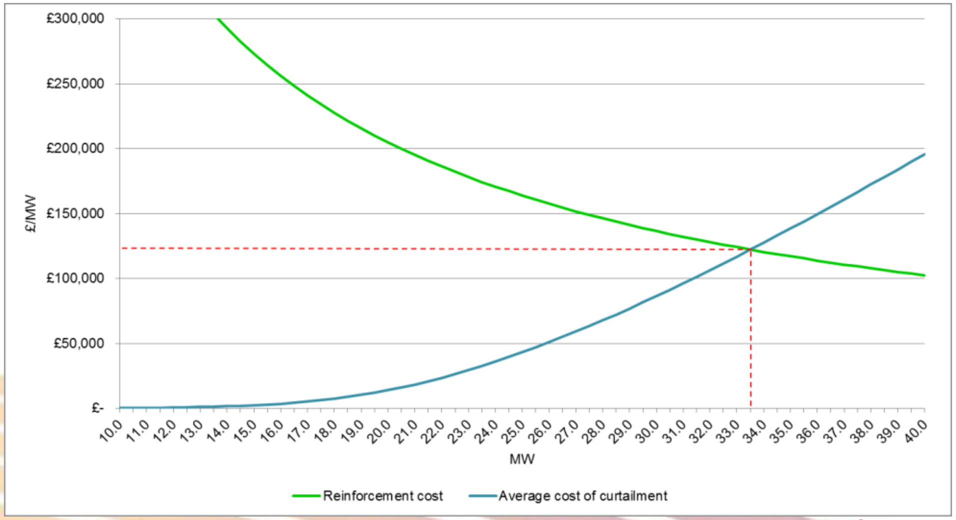
Case Study 1: March Grid – several customers requesting connections behind the same constraint

- Capacity Quota based on pro-rata
  1. Calculate the reinforcement cost (**£4.1m**)
  2. Curtailment modeling results (MWh curtailed / MW connected behind the constraint)

PRO – RATA



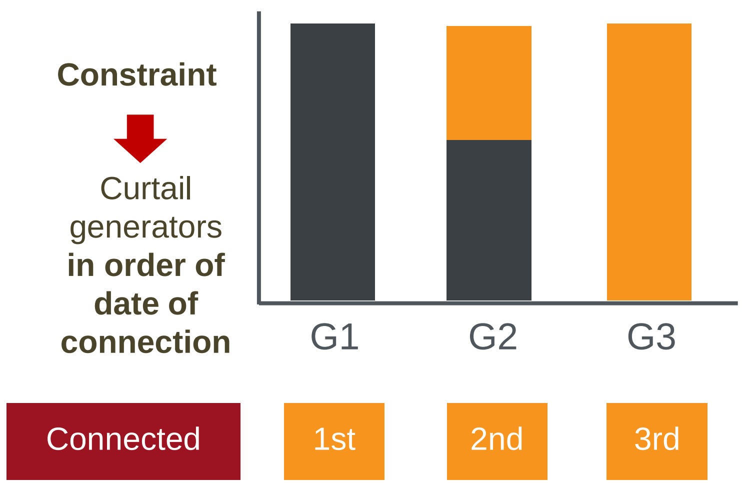
March Grid calculations indicate a quota of 33.5 MW

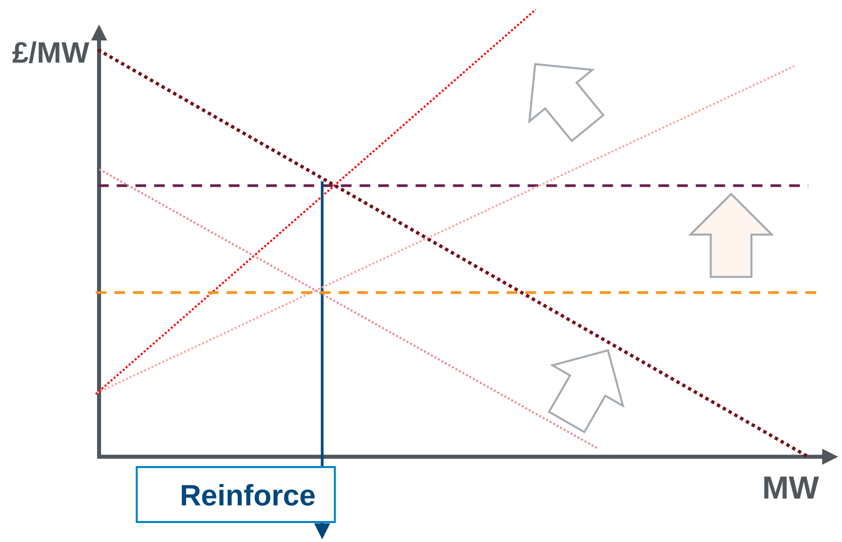


Case Study 2: Single wind farm and high or no reinforcement alternative

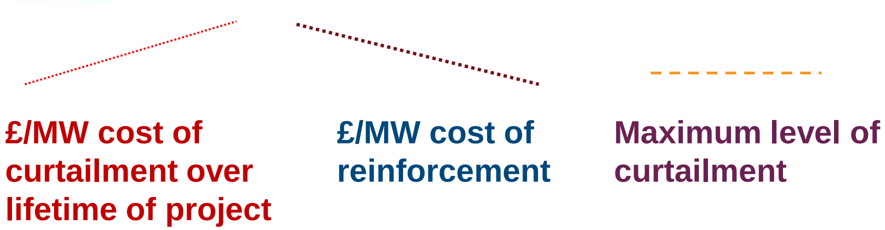
- Capacity quota not applicable

❑ LAST IN FIRST OUT



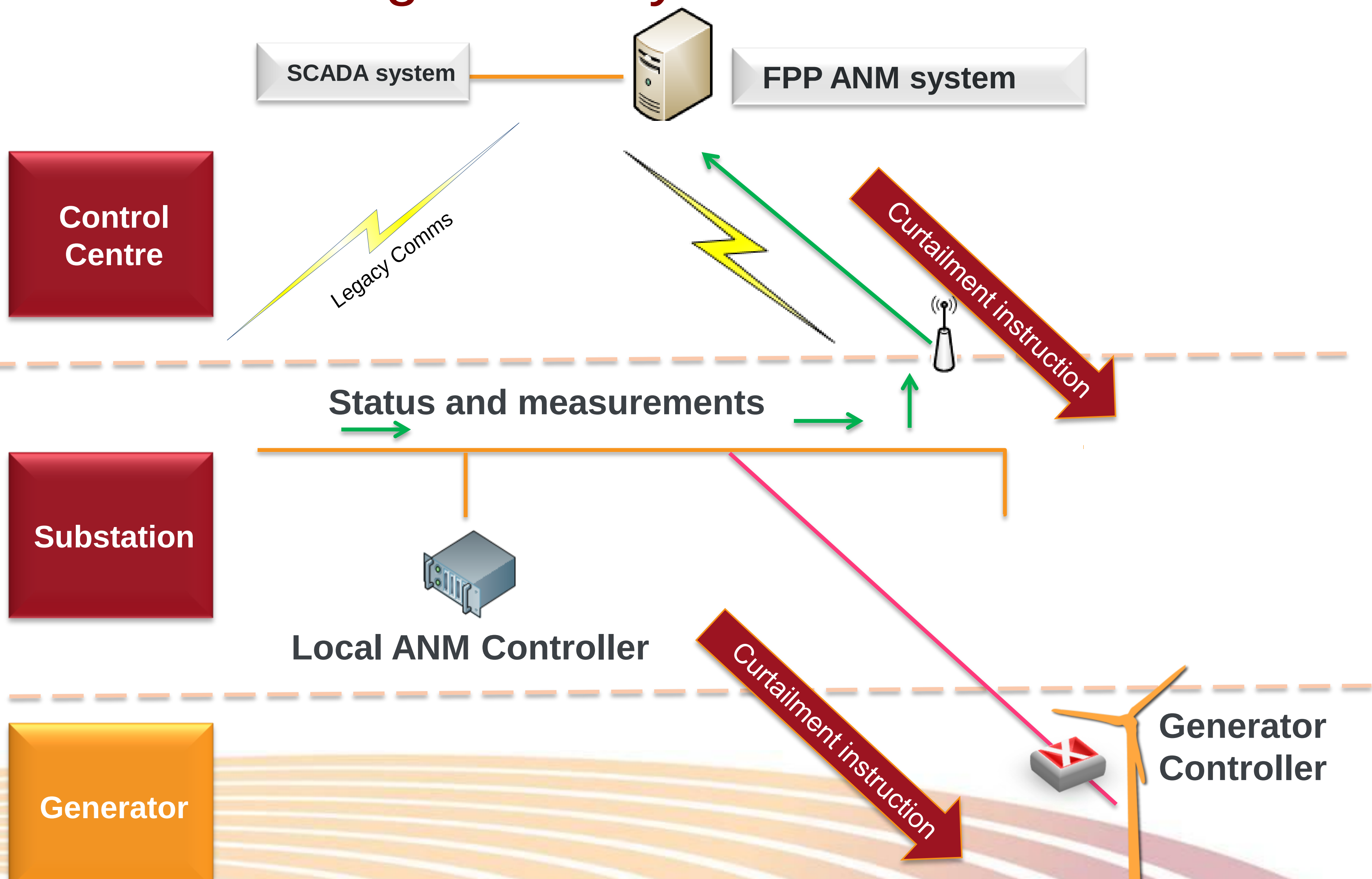


▶ Less headroom in the existing assets, and more expensive reinforcement, returns intolerable levels of curtailment prior to reinforcement



What is being controlled and what are the technical requirements?

Flexible Plug and Play: Architecture



Technical requirements for ANM

- Requirements for any type of generation:
  - Interface with generator to communicate to **Local Control System**
  - **Supported Physical Communication:** The appropriate connections are chosen based on the specific requirements of each installation. Serial, ethernet, analog I/O, Digital I/O
- Other considerations:
  - Solar: inverters or control system needs to be sophisticated enough to be able to be controlled.
  - CHP: engines are able to ramp up and down; however need to consider excess heat or gas (avoid waste of gas, produce more heat)

What information have customers requested as part of the process?

Information Provision

Information provided with offer	Customer Response – additional request
Briefing Document: • context of the FPP project • overview of the technical challenges and proposed solutions • high level description of the ANM • high level description of the communications	• Detailed description of how ANM operates • DLR technical assumptions • Any technical requirements for turbines in order to work with ANM
Interruptible connection agreement: • commercial implications of interruptible terms • concept of the Capacity Quota • rules by which developers will be curtailed	Specific project questions regarding their connection
Curtailment Estimate by ANM provider: • results • assumptions that underpin estimates	• Model to replicate curtailment estimates - Long Term Development Statement data is key • Original source for all assumptions
Capacity Quota Calculation for March Grid	Satisfied with content

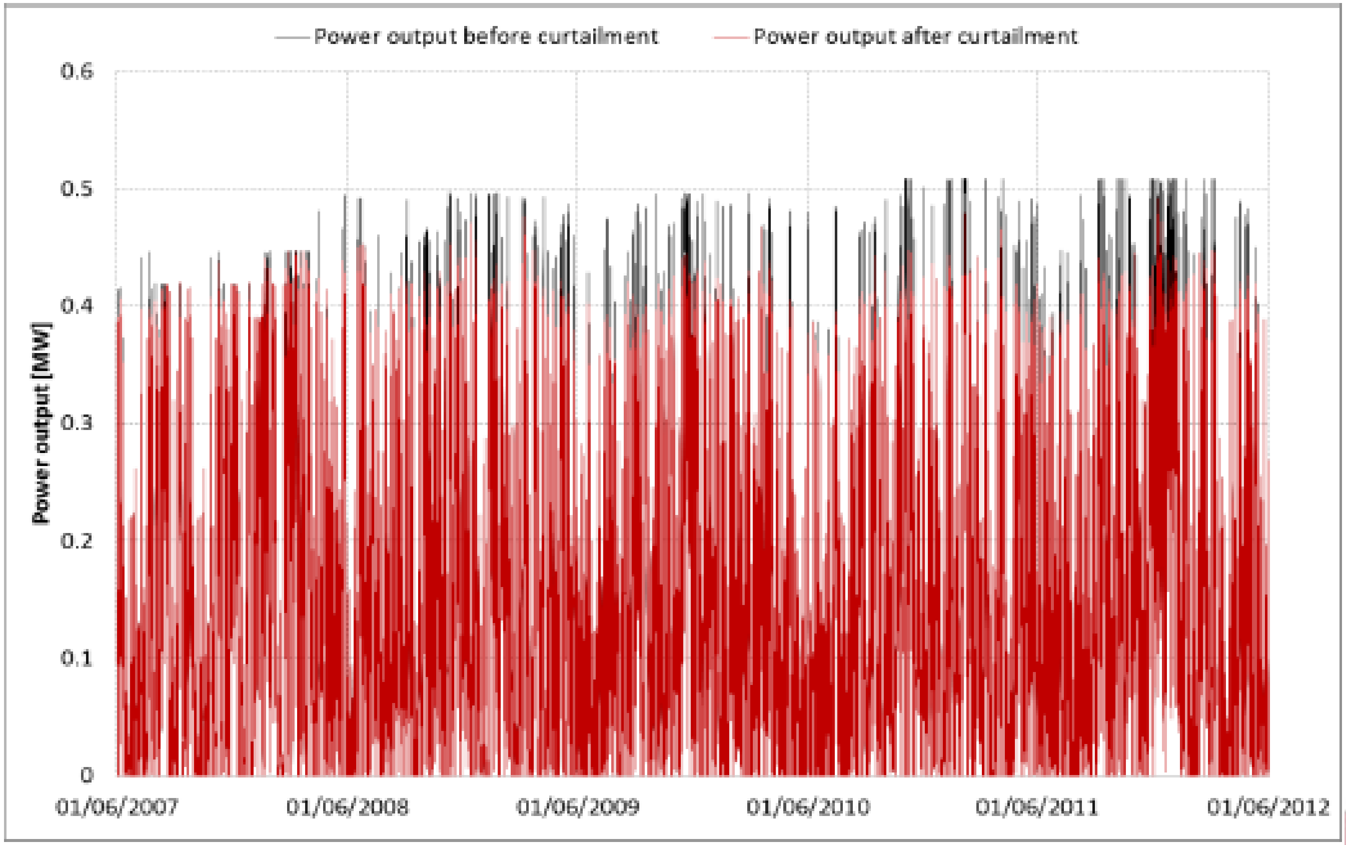
How much certainty do generators have over constraints, and how do the arrangements ensure that the generator can manage the risk of potentially unpredictable constraints?

Providing certainty to the customer

- Certainty is provided to customers by defining the maximum capacity we will connect under the pro-rata terms, corresponding to a worst case curtailment scenario (i.e. when the “Quota” is full)
- Significant CAPEX savings on connection costs but no financial compensation for curtailed output or exceeding specific values
- Generator community expresses strong views in favour of a financial mechanism to provide certainty, however
- If curtailment is low then it becomes part of the financial variability of the project and can be banked

Building confidence

- ANM is applied only when reaching operational limits
- All assumptions that underpin this analysis is shared with customers

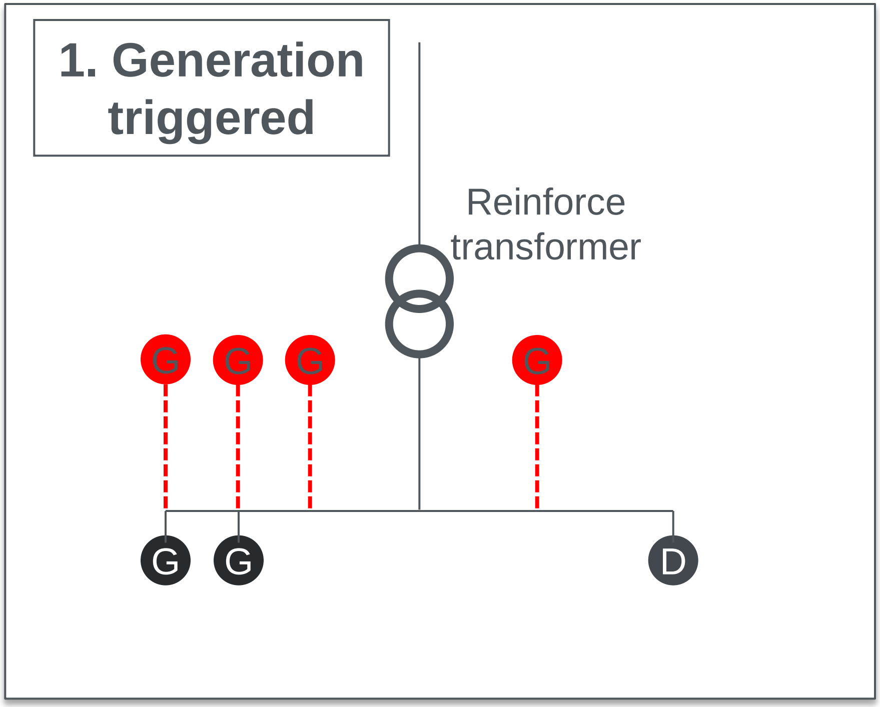


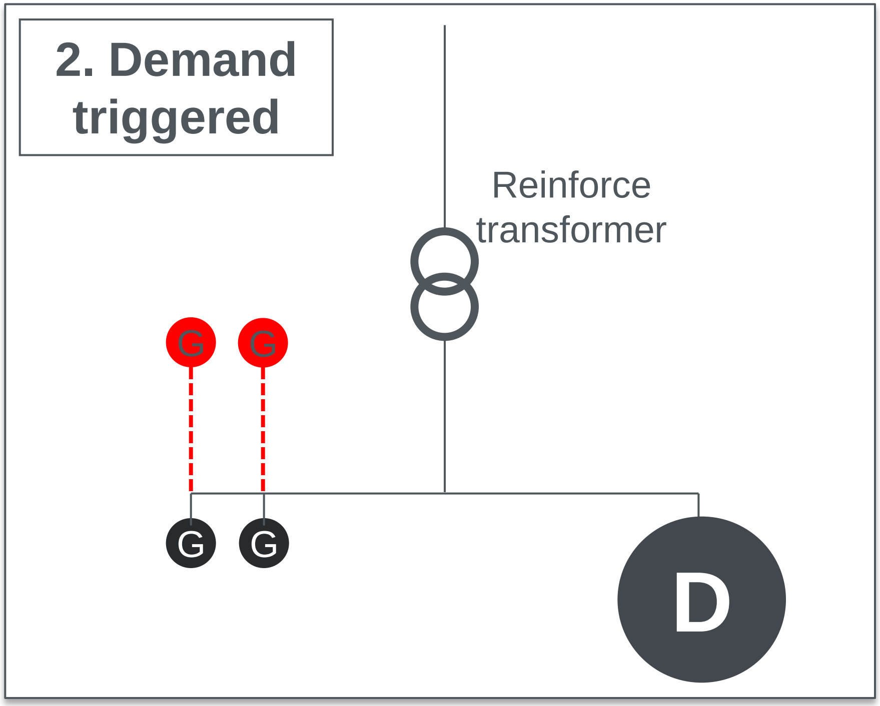
Managing risks of unpredictable constraints

Risk	Mitigation
Mal-operations in communication systems resulting in fail safe curtailment actions	Resilient and redundant communications Importance of demarcation
Modelling errors	All assumptions that underpin this analysis is shared with customers
Outages due to network events or maintenance	As Business-as-usual

What happens when the constraint is relieved through reinforcement?

Reinforcement trigger





- This option would allow generation connected to pay their share of reinforcement if they required a firm connection
- Currently, all demand driven reinforcement is socialised

Treatment of Reinforcement

- Non-Firm generators could pay the cost of reinforcement if they want a firm connection once reinforcement has been triggered
- This is a **voluntary** arrangement – if generators wish to remain non-firm, they can do so
- If non-firm generators refuse option to reinforce, then they take risk on the size of the next quota and long term curtailment risk
- **Mandatory** reinforcement was considered as an option for FPP but presented too high of an uncertainty to customers.

Reinforcement alternatives explored

	Pros	Cons
Mandatory	✓ Economic trade-off between cost of curtailment and cost of reinforcement applied at contractual level ✓ Forces actual assessment of curtailment at time quota is full	✓ Uncertainty for generators, liability that has no effective date
Optional	✓ No liability uncertainty for non-firm generators ✓ Non-firm generators do not have to fund oversizing	✓ Some incentives on generators to "free-ride" ✓ Non-firm generators potentially funding oversizing ✓ Potential inefficient network build-out if some generators refuse to fund

How can this and other constrained connection offers be standardised across DNOs into a single, standard connection offer or a limited number of standard connection offers?

Standardised interruptible connection offers

- Technical requirements for offering interruptible connections:
  - ANM application software and Communications platform
- EDCM and CDCM DUoS arrangements should reflect interruptibility
- Incorporating interruptibility arrangements into standard terms of connection.
- UK Power Networks currently embedded key terms within bilateral connection agreements, which reference the National Terms of Connection. Specifically:
  - Maximum Export Capacity...................................... kVA
  - Protected Export Capacity...................................... kVA
  - Planned Interruptible Export Capacity.....................kVA
  - Voluntary Interruptible Export Capacity....................kVA
- Avoid standardising to an extent that stifles innovation and flexibility.

Conclusions

- Interruptible connections can deliver significant cost savings to DG customers looking for connection in constrained parts of the network – as interim or permanent solution
- Pull from the generation community (certainty is key)
- Quota calculation can be applied to a specific constraint where a reinforcement cost can be derived and/or calculated.
- Pro-Rata curtailment can drive generators to share curtailment costs and hare the reinforcement cost at a given point in
- Further analysis needs to be carried out on cost recovery mechanisms

Thank you

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Distributed Generation Customers

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Low carbon LONDON Energising change

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UK Power Networks – I&C DSR Trials

DG DSR – Trial & Contract Design

What types of generation is this applicable to?

- ***Both new and existing customers***
- ***Objectives:***
  - Trial Active Network Management (ANM) equipment
  - Monitor & quantify the output distributed generation (DG)
  - Understand how to facilitate and manage DG on the network
  - Understand how active control of DG can be utilised by the DNO
- ***General framework:***
  - Small set-up costs met and utilisation fees paid
  - Opportunity to replace existing inter-trip
  - Monitoring solution first

UK Power Networks – I&C DSR Trials

DG DSR – Trial & Contract Design

Does this approach resolve particular network constraints that other constrained connection offers do not, and under what circumstances will generation be controlled?

- ***Issue control signals based on managing local constraints such as:***
  - Thermal constraints
  - Fault level
  - Voltage Management
  - DG output utilisation
  - Trial Active Network Management
- ***Specific to particular network constraint***
- ***Two real world examples in 2013!***
- ***Aggregator intermediary***

UK Power Networks – I&C DSR Trials

DG DSR – Trial & Contract Design

What is being controlled and what are the technical requirements??

- ***Parallel connected generators and CHP***
- ***PV (mid/large scale)***
- ***Voltage and reactive power output control***
- ***Load reduction***

What information have customers requested as part of the process?

- ***Impact on BaU / general operation is primary concern***

UK Power Networks – I&C DSR Trials

DG DSR – Trial & Contract Design

How much certainty do generators have over constraints, and how do the arrangements ensure that the generator can manage the risk of potentially unpredictable constraints??

- ***Risk vs Reward of flexible connections***

What happens when the constraint is relieved through reinforcement?

- ***Retain as replacement for inter-trip scheme***
- ***Increased visibility***

- ***Review existing Connections, Planning, and Control assumptions around DG output***
- ***Quantify the benefits of these DG control strategies, based on observed effectiveness***

Thank you

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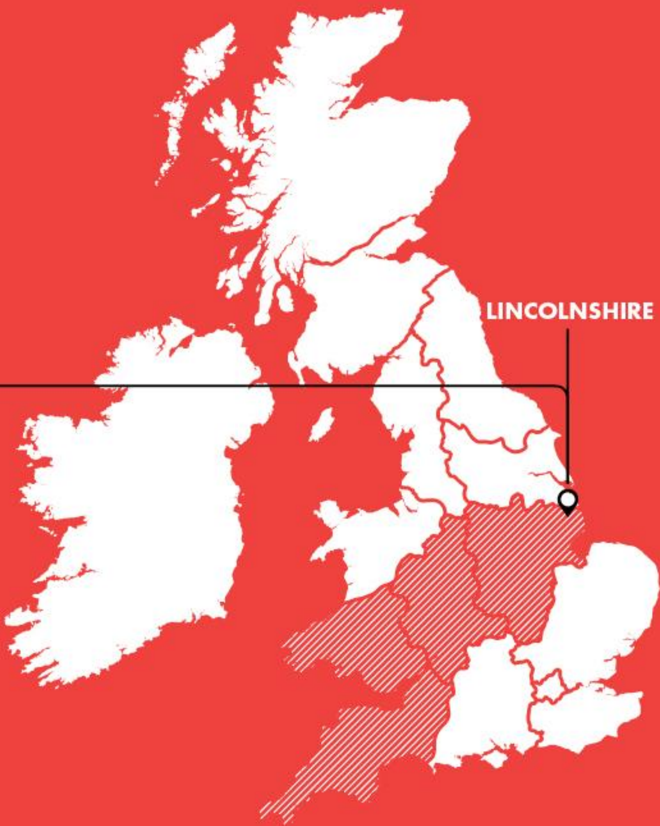
WESTERN POWER DISTRIBUTION

LOW CARBON HUB

CONNECTING RENEWABLE ENERGY IN LINCOLNSHIRE



Propositions For Distributed Generation Customers

Work Stream 6 – Learning Event Part 3

LCN Fund
Low Carbon Networks

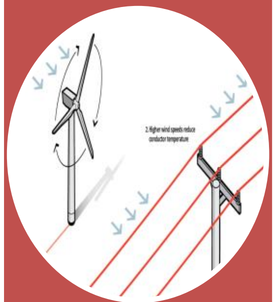
Lincolnshire Low Carbon Hub

What types of generation is this applicable to (including new or existing customers)?

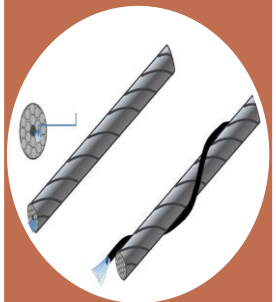
As part of the LLCH, Innovative commercial arrangements will be offered to new DG connections. This will provide an alternative to a passive "Fit and Forget" connection.

Lincolnshire Low Carbon Hub

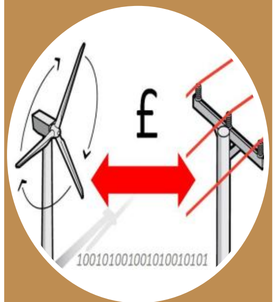
Project Techniques



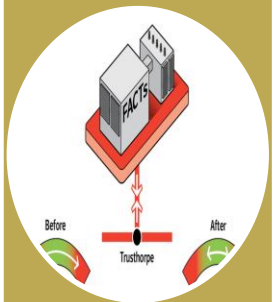
Dynamic Line Rating



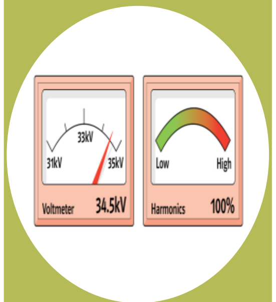
Network Enhancements



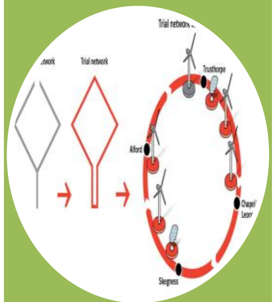
Commercial Agreements



FACTs



Dynamic Voltage Control



33kV Active Ring

WPD are already offering constrained connections as Business As Usual in the South West, mainly single generators, with one constraint. The LLCH will develop and demonstrate the coordination of multiple generators with both voltage and thermal constraints.

LLCH Innovative Commercial Connections

Does this approach resolve particular network constraints that other constrained connection offers do not?

The connection of generation to the Skegness Primary network can require significant conventional network reinforcement and delay new DG connections.

There are currently two main constraints:

- Voltage rise at the end of long 33kV feeders
- Thermal restrictions on the associated higher voltage networks.

The LLCH Innovative commercial arrangements will facilitate both voltage and thermal constraints in one universal connection agreement.

Under what circumstances will generation be controlled?

Passive or "Fit and forget" networks are modelled for the worst plausible scenarios:

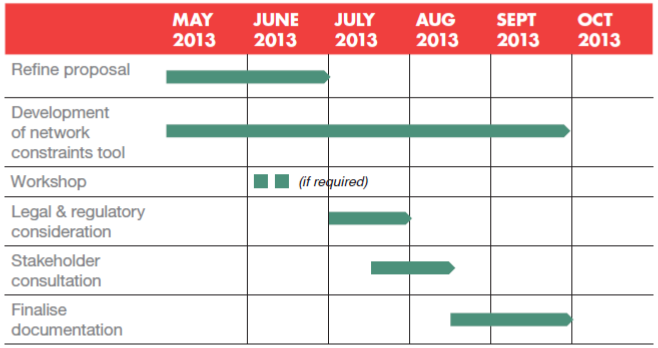
- Connected DG are all simultaneously operating at their full outputs
- Whilst the distribution network is at minimum demand
- Whilst the distribution network is operating at the upper voltage bandwidth

During these circumstances and abnormal network scenarios, Distributed Generation will be controlled.

- Voltage constraints will first (when appropriate) be mitigated by changing a generators unity power factor at the point of common coupling, absorbing reactive power to reduce voltage.
- Further voltage and thermal constraints will be resolved by an active reduction in generation output.

What were the key features of the commercial arrangements?

The development of the LLCH's innovative commercial arrangements are being supported by Engage Consulting and being developed in conjunction with WPD's connection team. These are expected to be offered to DG Developers along with access to the "Network intervention tool" in Q4 2013.



What is being controlled and what are the technical requirements?

Innovative commercial arrangement requires an Active Network Management scheme to be in place. This will be integrated into WPD's systems.

- DG often operates with a unity power factor at the point of common coupling, where available, the innovative commercial connection will alter the target PF to reduce the effects of voltage rise.
- The electrical output will be controlled to reduce the effects of voltage rise and thermal constraints.

How are constraints allocated across connected generators?

The feedback from the LCH Distributed Generator workshop means WPD and Engage Consulting are continuing to develop the commercial arrangements around **LIFO, Last In First Off.** The project is also developing ideas around ways in which DG developers could trade constraints between each other, with a "light touch" from the DNO.

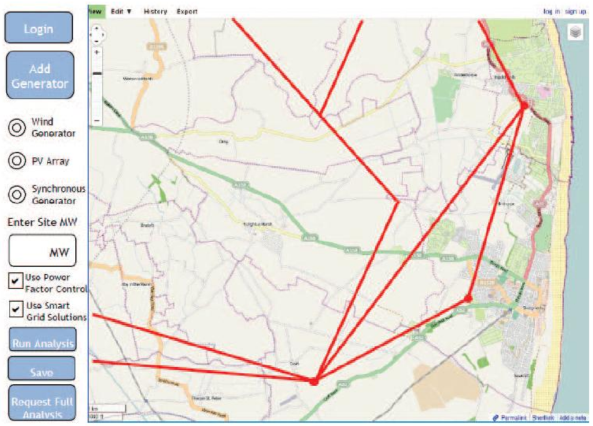
What information have customers requested as part of the process?

Key outputs from WPD's Innovative commercial workshop – 13th June 2013

- Constrained offers would need to be very clear in terms of any dependency or interactivity with other connections - needs to be covered within the agreement.
- Accurate data is the most important aspect of any development - developers questioned whether the Web constraints tool will provide all the information needed.
- Information regarding likely constraints is most valuable when detailing the level of constraints in either monthly or quarterly time periods. An overall estimated percentage level of constraints with a tolerance would be useful, but more granular data (based on the estimation tool) would help developers determine whether an innovative connection was suitable.
- Constrained and or innovative commercial arrangements should highlight the assumptions in both the offer letter and the connection agreement. This may be best captured by including the offer as an appendix to the connection agreement.
- Developers requested further information on how the system would work to ensure that offers remained valid, i.e.: if the DNO had numerous enquires at the same time how do we reserve a place in the connection queue and ensure that the position remains valid when they do come to connect, depending on how long it takes to start generation.

Managing Innovative Commercial Arrangements

How are the DNO's requirements predicted and activated,



WPD have commissioned TNEI and Smarter Grid Solutions to develop a bespoke constraints modelling tool as part of the LLCH. The number and level of constraints are being modelled and predicted using historic network data, future predicted changes in demand and iterative modelling. This tool is being shared with DG developers .

How is this communicated to the customer

- A simplified version of the constraints tool will be made available through the project website .
- WPD primary planners will have a full version of the constraints tool for system modelling and constraints estimation.

What are the technical requirements for the proposition?

An Active Network Management system is required to manage the interactive control of generation. This will be integrated into WPD's systems.

Managing Innovative Commercial Arrangements

How much certainty do generators have over constraints?

- The capacity of the network to support generation is often limited by plausible network scenarios,
- These scenarios will only occur rarely,
- However when they do occur, constrained connections may be called upon.

DG developers will have access to the historic network data and WPD's predicted changes in demand through the modelling tool. Through this tool, DG developers will have the best information to decide if an innovative commercial arrangement or a conventional network reinforcement connection is the most appropriate.

How do the arrangements ensure that the generator can manage the risk of potentially unpredictable constraints?

Through Last In First Out (LIFO) developers will be aware of their order in the generation queue, the impact their generator has on the distribution network and the changing network conditions. Generation owners will not be adversely effected by the addition of new generators.

Generators can use the innovative commercial arrangements as a temporary or permanent connection.

What happens when the constraint is relieved through reinforcement?

WPD are continuing to develop this aspect of LLCH commercial arrangements, this will be further disseminated when the Innovative commercial arrangements are finalised.

Moving into Business As Usual

What is the learning on the uptake, customer reaction, changes in behaviour and network impact?

- There is a considerable amount of interest from DG developers in the spare capacity "freed up" by the use of constrained connections. Customers preference was for LIFO due to the certainty this provides. This has been confirmed by other DNOs' research.
- In order for generators to accept a constrained connection, they need to be able to estimate the impact of a constrained connection on their business case.

How can this and other constrained connection offers be standardised across DNOs into a single, standard connection offer or a limited number of standard connection offers?

- WPD are reviewing how the innovative commercial arrangements can used with minimal changes to the existing connection documentation. This was supported by DG developers .

How can this approach be combined with other novel commercial arrangements (including constrained connections) into a single, standard connection offer or a limited number of standard connection offers across DNOs?

WPD will consider this as the LLCH Innovative commercial arrangements are developed. We intend to disseminate further information on the Innovative Commercial Arrangements and overall project progress, this event is provisionally being planned for Thursday 3rd October 2013.

Workstream 6: DG connections

Steve Cox Future Networks Manager

July 2013



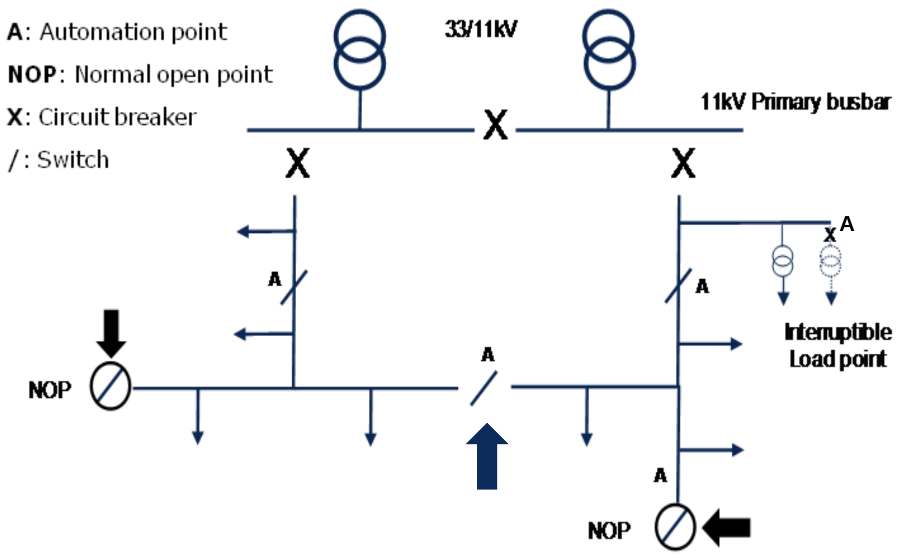
Agenda

- Innovating for Distributed Generation

Innovation Trial	Techniques	Type of Managed Contract	Potential Customer Benefits
Capacity to Customers	Adaptive Network Management	Post fault Demand Response	Lower connection costs
Connect & Manage	Active Network Management	Voltage Managed Output	Lower connection costs

Background – Network Design and Operation

- Current EHV and HV network design philosophy promotes redundancy to achieve continuity of supply standards
- For example, standard primary substation has N-1 capability of 23MVA
- HV circuits run as radial feeders but interconnected by a normal open point (NOP)
- HV circuits typically operate at 50% of rated capacity in order that for the worst-case fault affected customers can be re-supplied from alternative circuit

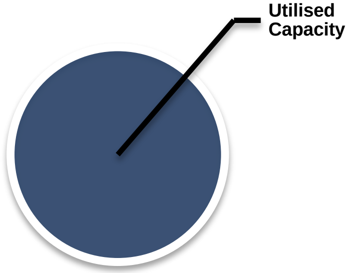


- Network design has inherent latent network capacity
- Access latent network capacity by enabling post-fault DSR

Innovatively releasing Capacity to Customers

Capacity to Customers

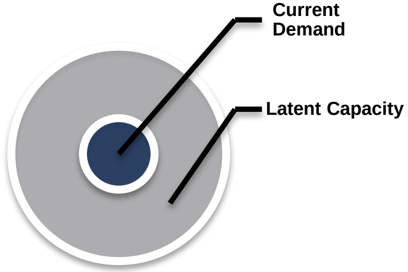
Total available network capacity



- Combining proven technology and new commercial contracts
- Allows ENWL to release significant network capacity back to customers
- Facilitating connection of new demand and generation without reinforcement

Technical innovation

Total available network capacity



- Apply remote control equipment to the HV circuit and close normal open point
- Enhance network automation software
- This effectively doubles the available capacity of the circuit negating the need for traditional reinforcement

New commercial contracts

- To retain customers' security of supply we will utilise innovative demand side response contracts
- These contracts will allow ENWL to control the consumption of customers on a circuit at the time of fault

Innovative, low risk and facilitates delivery of low carbon targets

DG ‘Connect & Manage’

Existing Arrangements

All new connections designed so statutory voltage / harmonic level / n-1 thermal limit never breached	Many new DG connections faced large costs to connect

Connect & Manage

Recognises the intermittent nature of several forms of DG & the sparsity of extreme conditions	Actual or close term forecast network parameters are used to control outputs	Reduction in the number of hrs output reduced or disconnected	Additional control/ comms equipment but marginal in comparison

Examples & Terms

- Large Fellside
  - 179MW CHP, 125MW firm
  - Output dependant on:
    - Air mass
    - Group DG interaction heavily influenced by wind output
    - Heat demand
  - £2.5m reduction in connection charge, minimal actual constrained output
- Large Ormonde 250MW off shore
  - £2.5m cost for harmonic filters for extremely unlikely (but credible) set of Transmission and DNO outage and simultaneous fault conditions.
  - Harmonic monitoring could now have been used to control output
- Medium Manx Interconnector
  - 69MW Demand DG
  - Operated on day ahead forecast
  - Output dependant on system conditions, voltage for n-1
- Small - Apply North / Risley . . . .
  - 2-4MW Biomass
  - Voltage constraint under low load and n-1
  - Automatic reduction scheme

Examples & Terms

- Terms
  - Controls enabled by Technical and Operating agreement as part of connection offer
  - Other than that all as per national standard terms

  - Operational liaison
    - Typically contains a close ahead forecast for known conditions; outages etc
    - Formal outage notifications
    - Requires regular face to face meetings until bedded in.

  - Controlled by SCADA composite alarms to operator
    - Provides a DG output target or
    - A signal to pull back within a defined time to a pre determined (but variable) level
    - Initial fears over SCADA reliance but it is extremely reliable in practice.

  - Backed up by a unilateral right to disconnect if non compliant.
  - Scheme operating costs recovered.

- Connection process
  - Customer / developer / consultants focused on DNO flexibility
  - Initially reluctant to sacrifice potential output revenue
  - Concerns on frequency and duration
  - Initially require caps on usage which don't work.
  - Confidence established through face to face discussions on actual event frequencies and greater understanding of interaction with 'Grid' issues.

Low Carbon Network Fund Learning Workshop

Generation Session

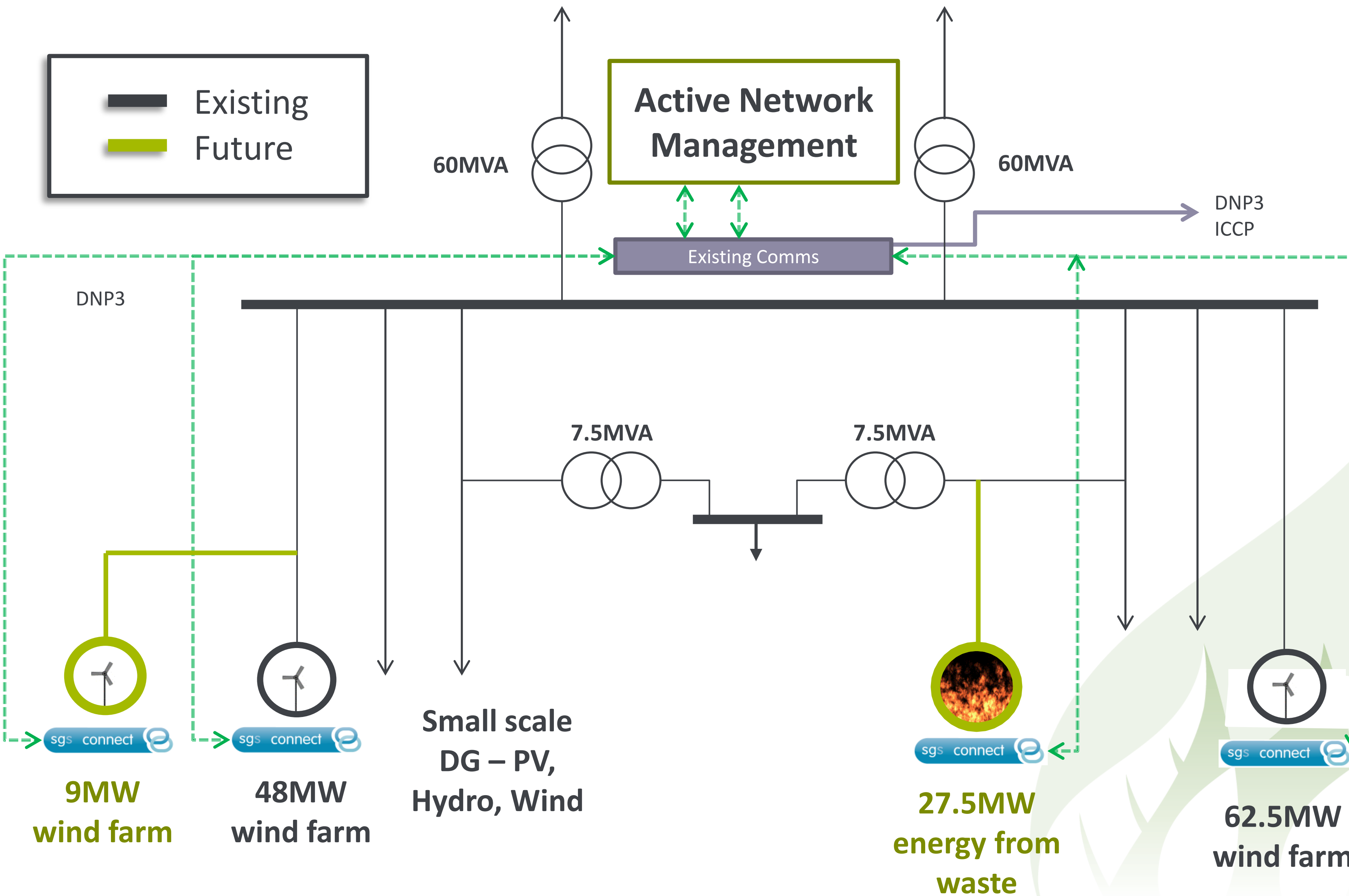
OFGEM – 4th July 2013

Questions for Presenters

- What types of generation is this applicable to (including new or existing customers)?
- What network constraints will this approach help resolve, and under what circumstances will generation be controlled?
- What were the key features of the commercial arrangements?
- How are the DNO's requirements predicted and response activated, how is this communicated to the customer and what are the technical requirements for the proposition?
- How can this approach be combined with other novel commercial arrangements (including constrained connections) into a single, standard connection offer or a limited number of standard connection offers across DNOs?
- What is the learning on the uptake, customer reaction, changes in behaviour and network impact?

What Generation Can Join The Scheme?

SP ENERGY NETWORKS



New commercial arrangements

Grid interface

- Management of distribution connected generation (below 30MW limit) within the capabilities of the GSP
- Generation visibility operation provided to SO via ICCP. Masked load to be analysed to provide increased understanding of the impact of smaller DG.

Community scale generation

- DG facilitated on the basis of matching demand being available e.g. heating load to create local demand side response
- Interactive demand and generation considered as a whole rather than as two separate components

Commercial Arrangements – Key Features

- Principles of Access – Last In First Off (LIFO)
- Non-Firm Generation Access assessed based upon curtailment analysis of wider system activity at the point of connection
- Clear view of maximum firm access availability on an annual basis – generators need a bankable connection offer!
- Connection offer provides clear forecast of expected curtailment at conception of agreement – provides greater clarity to generators vs. Pro-Rata Approach
- Generators are incentivised to sign onto non-firm access arrangements based upon receiving more timely access to the distribution network which is delivered at a more efficient cost

Empowering customers