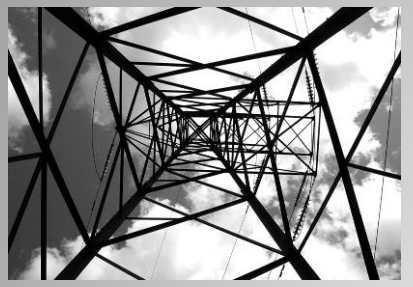



Distribution Network Operators

Main Session

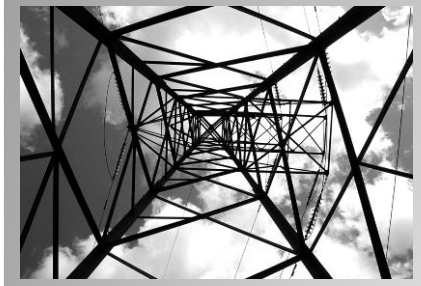
DNOs - Who are we and what do we do?

Electrical Distribution

- We don't make, own, buy or sell electricity, though for some of us other parts of our groups do.
- Analogous to a courier, where suppliers are analogous to mail order companies

DNO business has been about establishing and maintaining connections to its customers – first load, more recently generation

Period	Era	Activities
Post war	Wiring Britain	- Expansion of the networks - Rural electrification
1960 - 1980	Catering for demand growth	- Construction of large generation stations, closure of smaller local generators - Growth and development of networks to cater for growing demand - Harmonisation of voltages, phasing and standards - Development of maintenance programmes
1980 - 2000	Birth of distributed generation (DG)	- 1983 Energy Act paves the way for DG, albeit with low uptake; Grid & distribution codes and ER G59 & 75 formalise connection requirements - Focus on cost reduction - Quality of supply requires intelligent lower-voltage networks
2000 - 2010	Site-specific DG issues	- Understanding of technical & commercial issues and simplifying DG connection process - Domestic scale connection standard (ER G83) and standard connection arrangements (DCUSA)
2010 - 2020	Enabling smart grids	- R&D focused on establishing solutions to deal with greater DG penetration - Rolling out smart metering - Shifting to more active network operation - Initial prototype smart grid implementation e.g. Demand Side Management for larger users
2020 on	Smart grids go live	- Active network management with significantly enhanced customer engagement - Customers are either “informed and engaged” or “uninformed and disengaged”

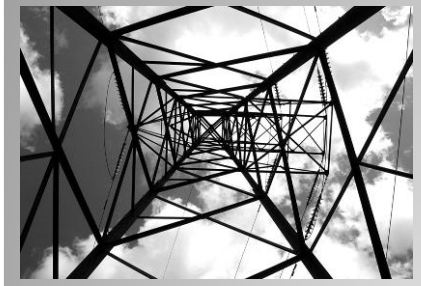



Regulatory Standards & Legal Framework

Main Session

Regulatory Standards & Legal Framework

- ECSG (Electricity Connections Steering Group)
- ESQCR
- Electricity Act
- D Code
- G Code

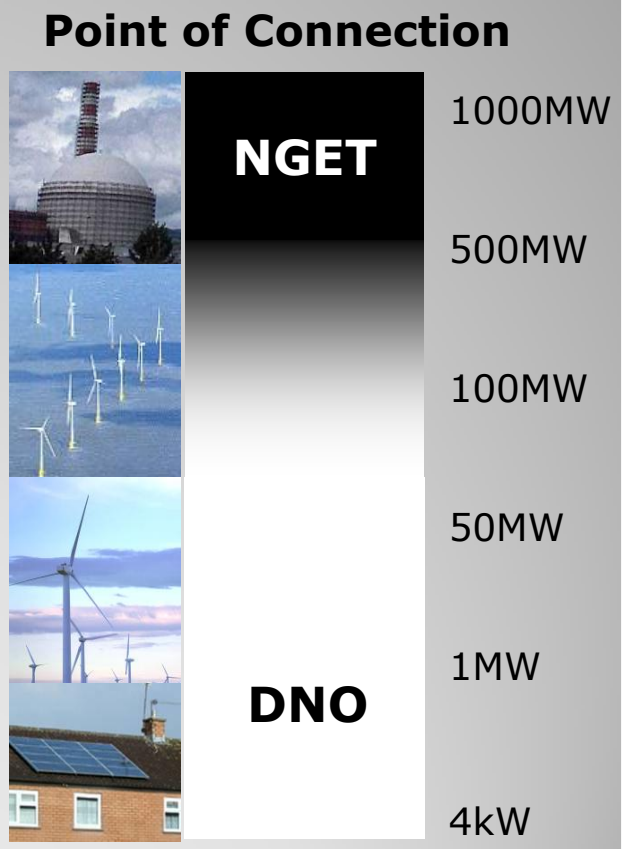



Electricity Network Challenges

Main Session

All Technical Challenges can be Resolved

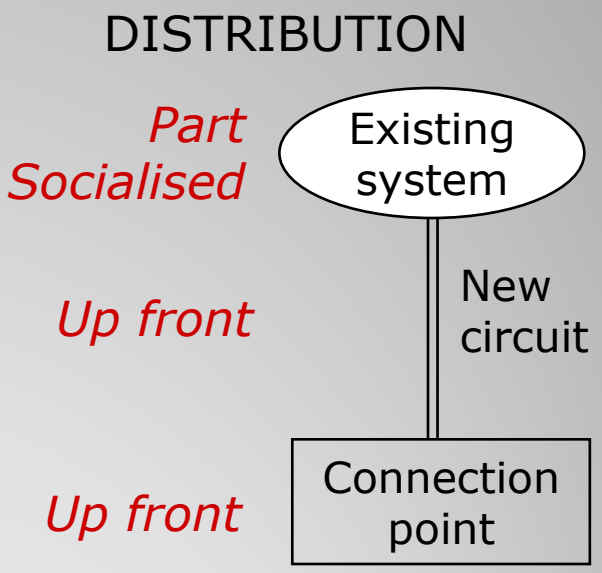
- Some challenges are easier than others
- Resources are an issue across the industry
  - changing connection skills as sector expands
  - development of new distribution service offerings
- DG can improve losses & defer reinforcement
  - when located in the right place
  - planning standards need to recognise DG



Beware: The solutions of the past may be the problems of the future

The impact of connecting generation at lower voltages is different to the impact were it at traditional supergrid points

- DNO equipment lower capacity but more abundant
- Incremental infrastructure costs lower
- Predominantly radial networks
- Capacity issues more localised
- Broadly similar security standards, but distribution more demand-centric
- No significant queues for connection
- No automatic entry rights to the transmission system
- Deeper connection charging methodology



Typical Connections Process

There are a number of basic challenges associated with connecting distributed generation to the wider electricity network

Electrical Issues

–Voltage
- Rise & Step

–Protection
- Interface protection is not sufficient to prevent overvoltages – it should protect the generator.
- RoCoF can not always discriminate between loss of mains and system disturbances. For safety it should be slightly trip happy. This becomes an issue with increasing generation penetration.

–Harmonics, Distortion and Unbalance

–Fault level
- Varies by technology and location, but customer has a significant control over their contribution to the issue

–Reverse power flow

–Thermal ratings
- We are now seeing 11kV connected generation exporting to NGET.

Contextual Issues

–Clustering
- Where it is good to develop one renewable generator, due to resources, ease of planning etc, it is normally good to develop others.
- Generator applications cluster, overloading one area, leaving others untouched and leading to commercial queuing issues.

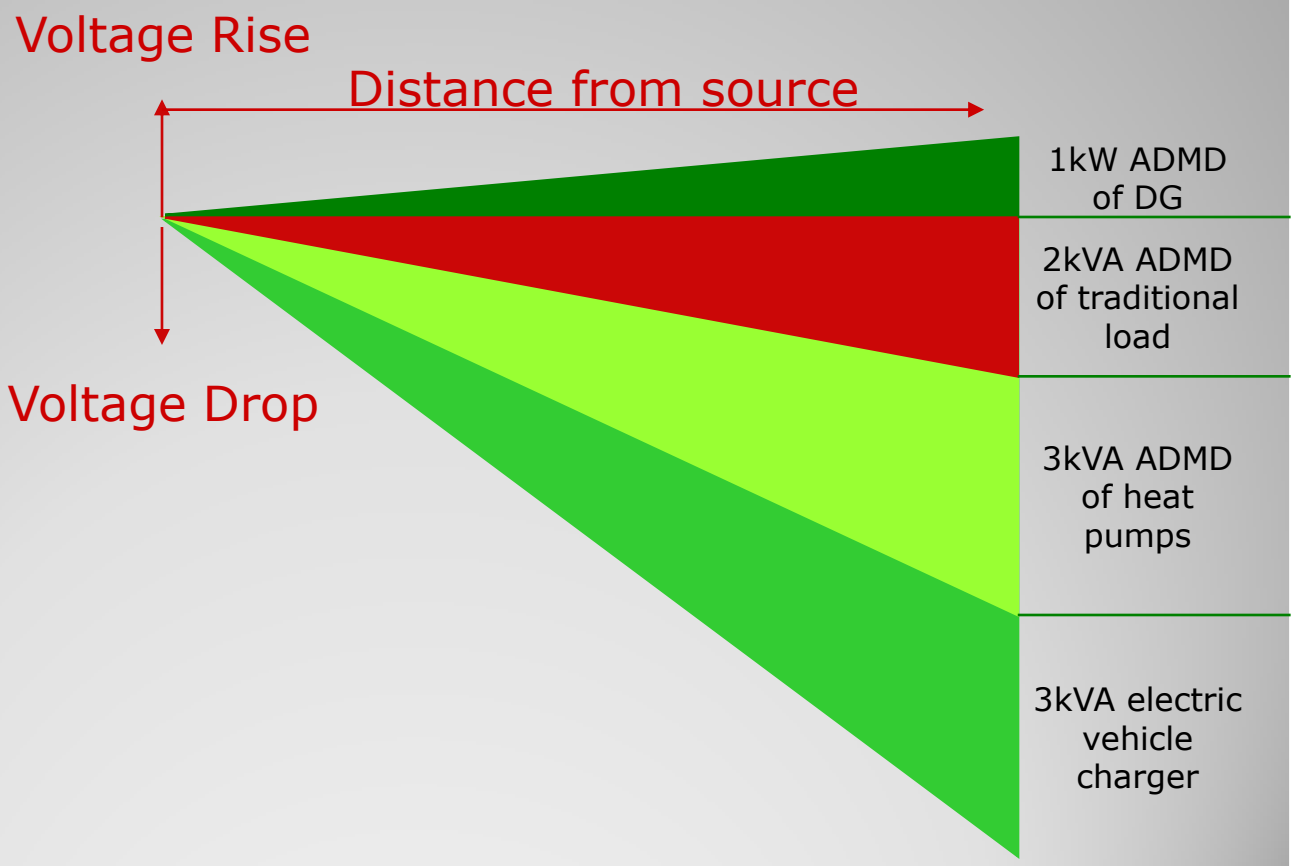
–Planning consents
- Particularly for overhead lines but also for connection point substations

–Land rights
- Wayleaves, easements and statutory rights

–Existing network
- Single phase lines may not be suitable for your generator

The LV system was designed for a thermal rating and voltage drop caused by a domestic load of 2kVA ADMD (after diversity maximum demand)

- Although an individual house might take up to around 18kVA, a hundred houses would only take a maximum of around 200kVA.
- To minimise the costs to customers, the system was traditionally designed such that the maximum length of cable and the minimum cross section were utilised.
- To optimise this the “no-load” voltage was set as high as possible within the statutory limits.



Our network were originally designed to be passive & supply load in one direction, it was not designed for any voltage rise. Cleaner energy is pushing our system beyond their designed parameters.

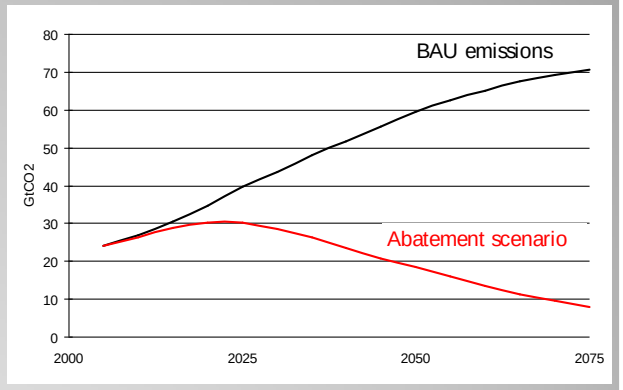
Going forward we will have to innovate to meet these challenges DG and the environment pose

Some things may change…

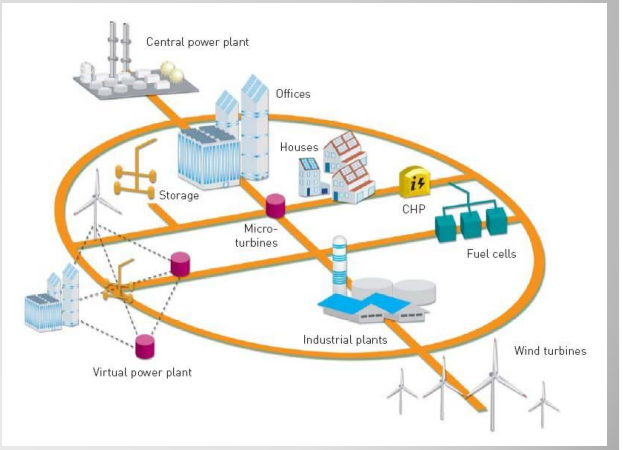
- Significant changes to consumers' energy usage patterns
- Dynamic local generation and demand balance
- More frequent and direct interaction between network users
- 'Fit and forget' networks will no longer be sufficient
- More Demand Side Management (but will the customer notice?)
- Distribution networks may become the natural hub for the new trading environment
- Grid interface arrangements will become bi-directional

but some things may not….

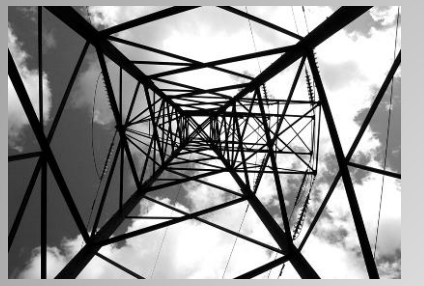
- The laws of physics
- Competitive pressure, or its proxy, will continue to be the best way to make businesses improve and innovate
- Cultural resistance to change
- What really interests people



Source: Stern Review



Source: EU SmartGrids



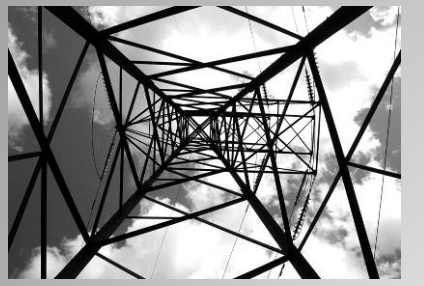

Generic Connection Process

Main Session

Generic Connection Process

- G83 Stage 1 Single Application - Legal Obligation for installers to notify the DNO within 28 days of commissioning
- G83 Stage 2 Multiple Applications - The application for connection sheet below must be completed, along with the associated equipment test certification in line with G83/1-1, and forwarded to the appropriate address. We will consider the application and advise of any work, cost and associated timescales. There may be a charge for the work associated with evaluating this connection.
- G59 Larger Applications - In general for generators in excess of 16A per phase (3.68kW)
- There may be a charge for the work associated with evaluating this connection.

Typical Connections Process

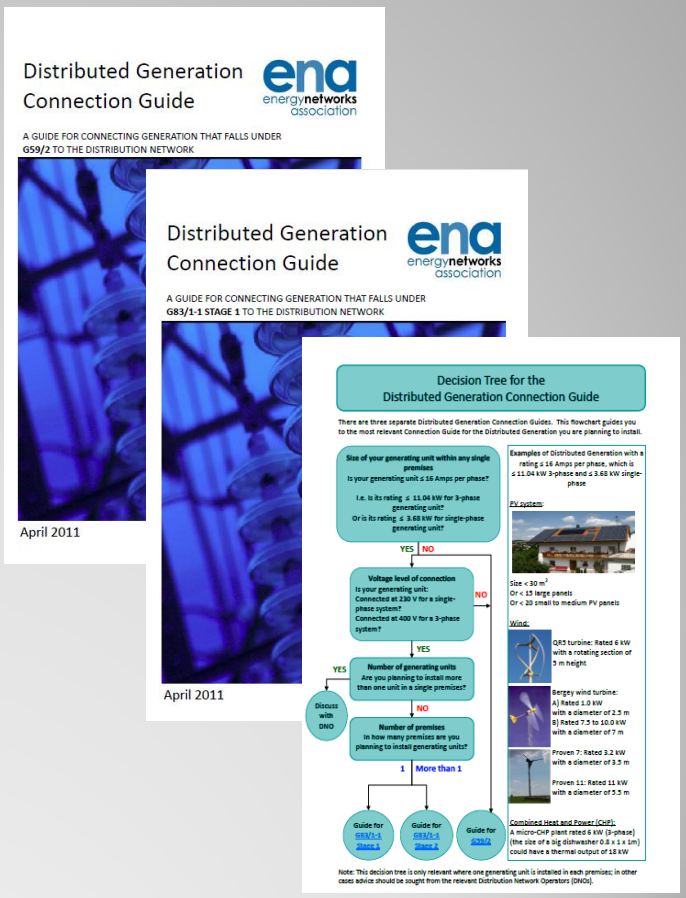



National Technical Policy Work & Developments

Main Session

National Technical Policy Work & Development

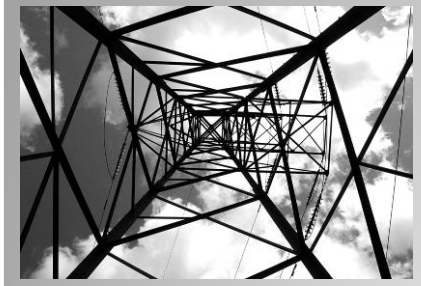
- UK Electricity Networks Strategy Group
  - P2/6 Revised P2/5
  - G59 Revised
  - DG connections guide
  - DG Information Strategy
  - Common application form
  - G83 Standardised application, under review
- DG Active Network Management
- EU Directives, Code
  - European technology platforms



Breakout Sessions

- Micro-generation up to 50kW
- Generation > 50kW
- Costs and charging
- Application Process
- Transmission

Thank You




Microgeneration Challenge

Breakout Sessions

Microgeneration - G83 & ≤50kW G59

- What is it?
- Technical Constraints
- The Application Process
- Generator Connection Agreements

What is G83 generation?

- G83 is an industry standard for Small Scale Embedded Generators (SSEGs)
  - Energy Networks Association Engineering Recommendation G83/1-1 *"Recommendations for the Connection of Small–scale Embedded Generators (Up to 16A per Phase) in Parallel with Public Low-Voltage Distribution Networks"*
  - Stage 1 – a single unit within a single customer's installation
  - Stage 2 – multiple units in a "close geographic region, under a planned programme of work"
  - The stage 2 definition is being clarified in the next issue of G83

- Small Scale Embedded Generator (SSEG)
  - *"A source of electrical energy and all associated interface equipment, rated up to and including 16 A per phase, single or multi phase 230/400 V ac and designed to operate in parallel with a public low voltage distribution Network."*
  - 16A at 230V is 3.68kW
  - Note; that the definition is currently under review and will be included the review of G83.

G83 Stage 1 - Connect and Notify – If using MCS registered contractor

If entire installation is 3.68kW or below per phase

Inform DNO within 28 days using a fully completed G83/1 Appendix 3 form. Must include MPAN

Charges: Nil charge

G83 Stage 2 - Multiple Installations

G83 Multiple Installations (<16 amps per phase, 3.68kW): Must be applied for

Charges: Charges will apply for work required.

What is G59 generation?

- G59 is an industry standard for generators greater than 16A per phase
  - Energy Networks Association Engineering Recommendation G59/2-1 *"Recommendations for the connection of generating plant to the Distribution System of Licensed Distribution Network Operators - Amendment 1"*
- Up to 50kW there is a provision for type tested equipment similar to G83; however
- Applications greater than 17kW per phase must use G59 approved relays unless G59 type tested inverters are available
- G59 applications must be submitted for system studies and associated network reinforcement where necessary prior to connection.

Charges: Charges will apply for work required.

Why is the break point at 16A per phase?

- In UK law the 16A requirement is from the Electricity Safety, Quality and Continuity Regulations – Regulation 22
  - 22.—(1) Without prejudice to regulation 21, no person shall install or operate a source of energy which may be connected in parallel with a distributor's network unless he—
    - (a)has the necessary and appropriate equipment to prevent danger or interference with that network or with the supply to consumers so far as is reasonably practicable;
    - (b)has the necessary and appropriate personnel and procedures to prevent danger so far as is reasonably practicable;
    - (c)where the source of energy is part of a low voltage consumer's installation, complies with British Standard requirements; and
    - (d)agrees specific requirements with the distributor who owns or operates the network.
  - (2) Sub-paragraphs (b) and (d) of paragraph (1) shall not apply to a person who installs or operates a source of energy which may be connected in parallel with a distributor's network provided that sub-paragraphs (a) and (c) of paragraph (1) are complied with; and
    - (a)the source of energy does not produce an electrical output exceeding 16 amperes per phase at low voltage;
    - (b)the source of energy is configured to disconnect itself electrically from the parallel connection when the distributor's equipment disconnects the supply of electricity to the person's installation; and
    - (c)the person installing the source of energy ensures that the distributor is advised of the intention to use the source of energy in parallel with the network before, or at the time of, commissioning the source.

There are a number of basic issues associated with connecting distributed generation to the wider electricity network

Electrical Issues

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- Rise & Step

–Protection
- Interface protection is not sufficient to prevent overvoltages – it should protect the generator.
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–Harmonics, Distortion and Unbalance

–Fault level
- Varies by technology and location, but customer has a significant control over their contribution to the issue

–Reverse power flow

–Thermal ratings
- We are now seeing 11kV connected generation exporting to NGET.

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- Where it is good to develop one renewable generator, due to resources, ease of planning etc, it is normally good to develop others.
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- Particularly for overhead lines but also for connection point substations

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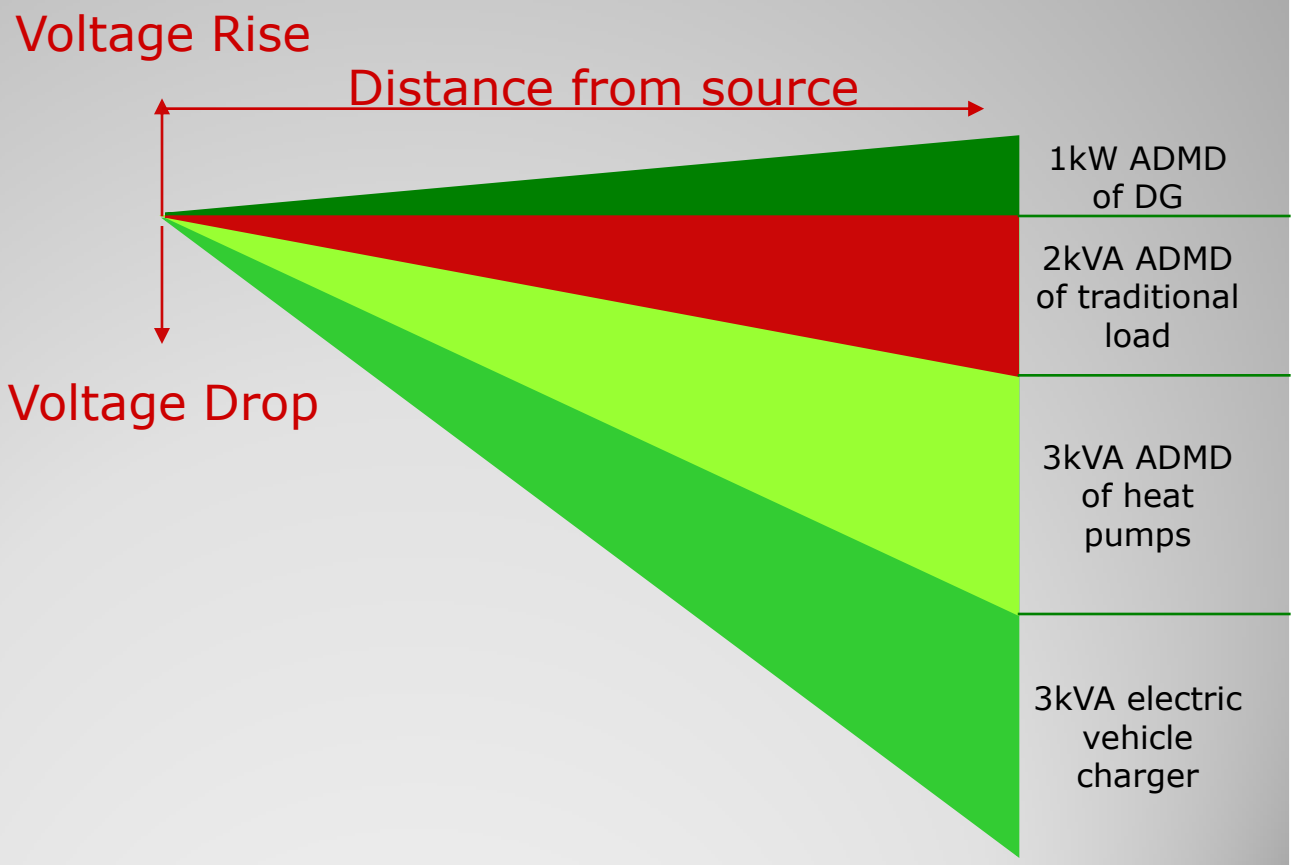

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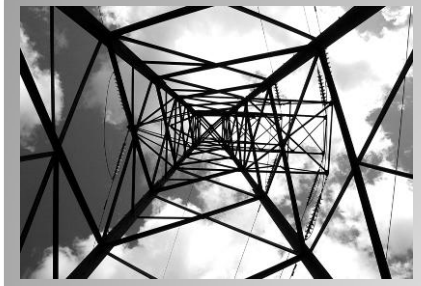


G59 Generation over 50kW

Breakout Sessions

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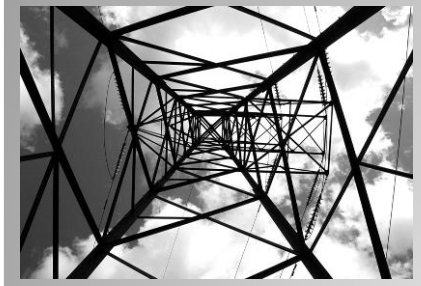



Cost Issues

Breakout Sessions

OBJECTIVES

- Who Pays for What ?
- Contestable & Non-Contestable Works
- Common Connection Charging Methodology
- Cost Apportionment
- Lower Cost/Innovative alternatives to Reinforcement
- Main Factors affecting cost + delivery timescales
- Open Questions

Transmission v DNO connections

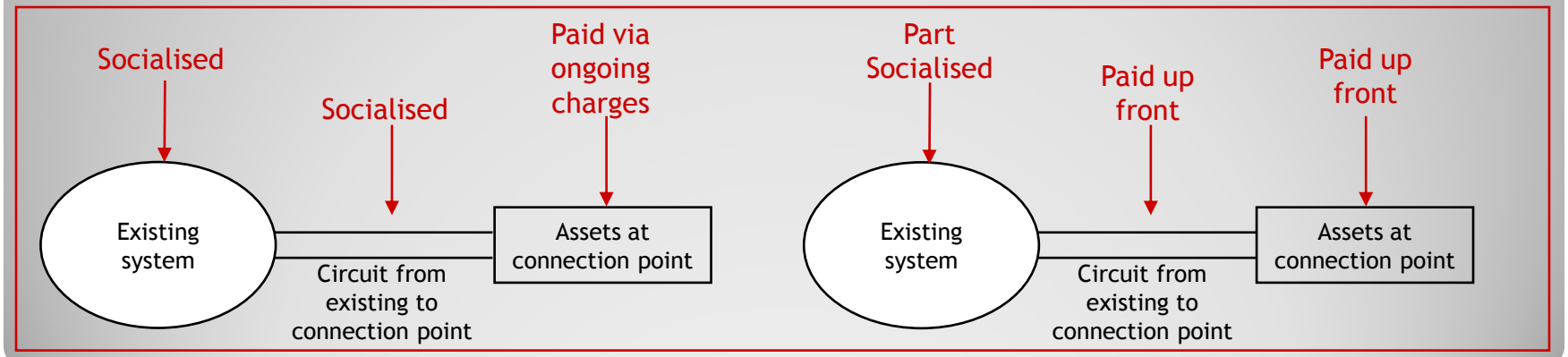
NGET (132 kV & above in Scotland)

- High capacity networks (particularly in areas of high population density)
- High asset infrastructure cost
- Significant capacity issues in the generation rich areas (most of Scotland)
- High MW but lower volume of generation connections
- Lengthy queues for new generation connections

DNO (below 132 kV in Scotland)

- Lower capacity networks (especially in rural areas)
- Lower asset infrastructure cost
- Capacity issues/queues more localised
- High volume of lower MW connections now has significant collective impact on associated transmission networks.
- No automatic entry rights to transmission system (managed by NGET)

Cost allocation



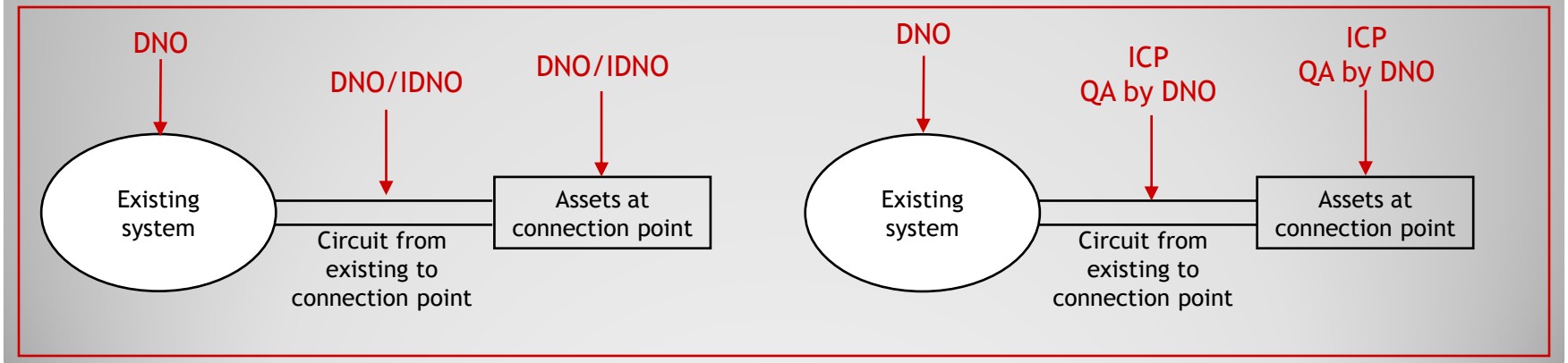
The connection is open to Competition

DNO construction

- Can be provided by DNO
- Independent Distribution Network Operators (IDNOs) also provide connections

ICP construction (Independent Connections Provider)

- Lloyds Accredited
- Constructed to DNO specifications
- DNO adopts network on completion
- Some non-contestable work still carried out by DNO
  - infrastructure reinforcement
  - connection & energisation work within existing DNO substation/sites
  - QA of ICP work



Common Connection Charging Methodology (CCCM)

- Sets common framework for determining and publicising charging methodology for all DNO's in GB - approved by Ofgem.
- Application Process – Budget, Feasibility Study & Formal Offer options defined.
- Capacity only allocated via formal Offer on first come first served basis, irrespective of status of project.
- Requirement for DNO to design connection based on minimum cost engineering solution that meets all technical requirements of DNO, industry codes, etc & customer request.
  - Means DNO NOT allowed to speculatively reinforce networks if no formal connection request in process.
- Defines margin to be applied to cost of minimum engineering solution and how costs are split between DNO & Generator.
- Process for dealing with Interactive Quotations when more than one party competing for access to network with limited capacity at same time.
- Rebates for any future party connecting to any of network fully funded by earlier developer (5 year time limit).
- Consistent application of Cost Apportioned Reinforcement.

What is Cost Apportionment ?

from the CCCM….

> "Reinforcement is defined as assets installed that adds capacity to the existing shared Distribution System. The cost for reinforcement shall be apportioned between you and us."

As reinforcement is driven by either Circuit Capacity or Fault Level the formulas are:

1. Security CAF = Required Capacity/New Network Capacity *100%, or
2. Fault Level CAF = 3 * Fault Level Contribution from generator/New fault Level Capacity *100%.

- 2nd Comer charges – future connecting parties pay same £/kW rate for their share of the reinforcement.
- DNO contribution recovered through future UoS charges but capped at £200/kW.
- Could have significant delivery timescale implications in addition to cost.
- Extensive worked examples given in CCCM derived from UK wide sub-group.

Alternative Solutions to Minimise Reinforcement

Distribution Solutions:

- Adjustment of transformer ratios to lower voltage levels.
- Voltage Regulators.
- Generators operating in Voltage Control.
- Active Network Management/Smart Grid (constrained connection).
- DSTATCOMS.
- Provide connection to higher voltage network.
- Energy Storage/Controllable Demand

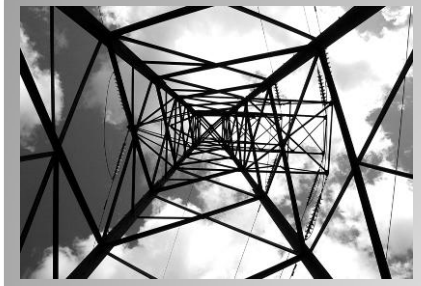
And For Transmission Constraints:

- Active Network Management/Smart Grid.
- Connect and Manage.

Main Factors Affecting Costs + Timescale

- Location, Location, Location…
- Costs and timescale for the same Generator may vary substantially at different locations due to:
  - Distance to nearest part of network.
  - Capacity of existing network in vicinity.
  - Other generators already connected to circuit.
  - Capacity already “booked” by other parties on circuit (even although their project is less advanced in terms of Planning Consent, ability to connect).
  - Interactivity with other generators in process.
  - Transmission dependency. (particularly in Scotland)
  - Volatile Metal Price fluctuations.
  - Cost of 3rd party landowners granting wayleave consent for most direct route at standard rates.
  - Requirements of other statutory bodies. eg Planning Conditions, Environmental Impact Assessment, Archaeological watching brief, etc.

Questions?




Applications Process

Breakout Sessions

Which Application Should I Complete?

GENERATION TECHNOLOGY

Is your generating unit one of the following technologies:

- Domestic Combined Heat and Power (CHP)
- Photo-Voltaic (PV)
- Fuel Cells
- Hydro power plant

YES | NO

SIZE OF YOUR GENERATING STATION

Is its rating ≤ 11 kW for a 3-phase generating station?

Or is it rating ≤ 3.66 kW for a single-phase generating station?

NO

YES

VOLTAGE LEVEL OF CONNECTION

Is your generation plant:

Connected at 230 V for a single- phase system?

Connected at 400 V for a 3-phase system?

NO

YES

NUMBER

How many generators are you planning to install?

ONE | MORE THAN ONE

Go to Single Small Generator InstallationGuide

Go to Multiple Small Generators InstallationGuide

Go to Guidance for Larger Generators

EXAMPLES

Examples of 3-phase DG with a rating < 11 kW, and of single-phase DG with a rating < 3.66 kW (< 16 Amps per phase)

PV SYSTEM
size < 30 m2
or < 15 large panels
or < 20 small to medium PV panels

NOTE FOR SMALL-SCALE WIND
If you are planning on installing wind generation, even if it meets the size requirements described (left), it does not fall under G83/1-1. Instead, you will have to refer to the G59/2 connection process. Following a discussion with your DNO you may be permitted to follow the G83/1-1 process-your DNO will indicate which process you will follow. In this case, the G83/1-1 Guides may be more appropriate for you.

Type of Application

- G83 Stage 1 Single Application - Legal Obligation for installers to notify the DNO within 28 days of commissioning
- G83 Stage 2 Multiple Applications - The application for connection sheet below must be completed, along with the associated equipment test certification in line with G83/1-1, and forwarded to the appropriate address. We will consider the application and advise of any work, cost and associated timescales. There may be a charge for the work associated with evaluating this connection.
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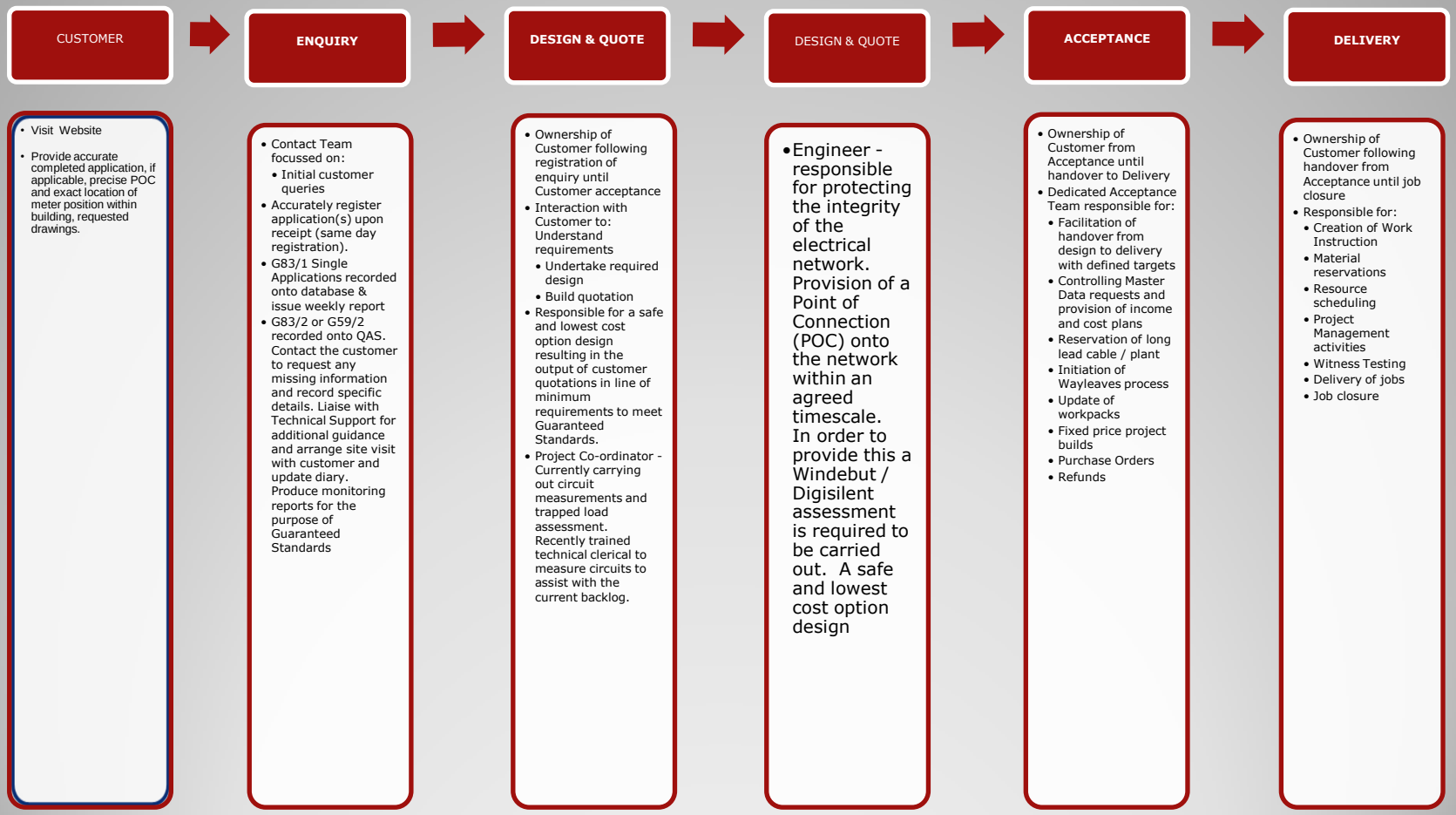
Process Overview



Competent Application

For an application to be deemed valid the following information will be required :

•Completed standard application form containing all appropriate technical details
•A detailed one-line schematic diagram of the proposed installation.
•A schematic drawing showing the protection systems associated with the automatic disconnecting devices for additional sources of electrical energy including loss-of-mains protection and trip-circuit supervision.
•A clear narrative description of the scheme that describes the scheme operation for Normal Mains Healthy, Loss of Mains, Returns of Mains and Paralleling (where applicable)
•A scale drawing detailing the layout of the earth electrode system(s) associated with each source of energy.
•A location drawing and a (1:500 preferred) scale development site plan indicating the location of the proposed generator(s) clearly identifying six figure X,Y co-ordinates of the proposed generator(s), inverter and controls plus an indication of proposed connection point
•For wind turbine developments, a detailed dimension drawing of the tower and turbine assembly

And once you have accepted your Offer…

- We will start to progress your works…acceptance is a commitment to construction for both parties.
- Should you then wish to vary the location, number or capacity of your connection a re-quote will need to take account of the network at that time, including any other connections applied for or accepted.
- Remember though that you can terminate your construction contract right up to energisation and we will return any sums that are either unspent or uncommitted at the point of termination.

Questions?