Charging Tutorial

Patrick Hynes June 2010

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Charging high level objectives

- a) Facilitate ' …effective competition in the generation and supply of electricity..'
- b) Reflects, '…as far a reasonably practicable, the costs …incurred by transmission licensees in their transmission businesses
- c) The methodology ' consistent with ..a) and b)… as far as reasonably practicable, properly takes account of the developments in transmission licensee businesses'
- These set a level playing field which facilitates effective competition
- Ensures users take account of the cost they impose and that only efficient cost are passed through to end consumers
- The need to be kept under review and evolve

Additional objectives

- Transparency
- Simplicity
- Stability
- Predictability

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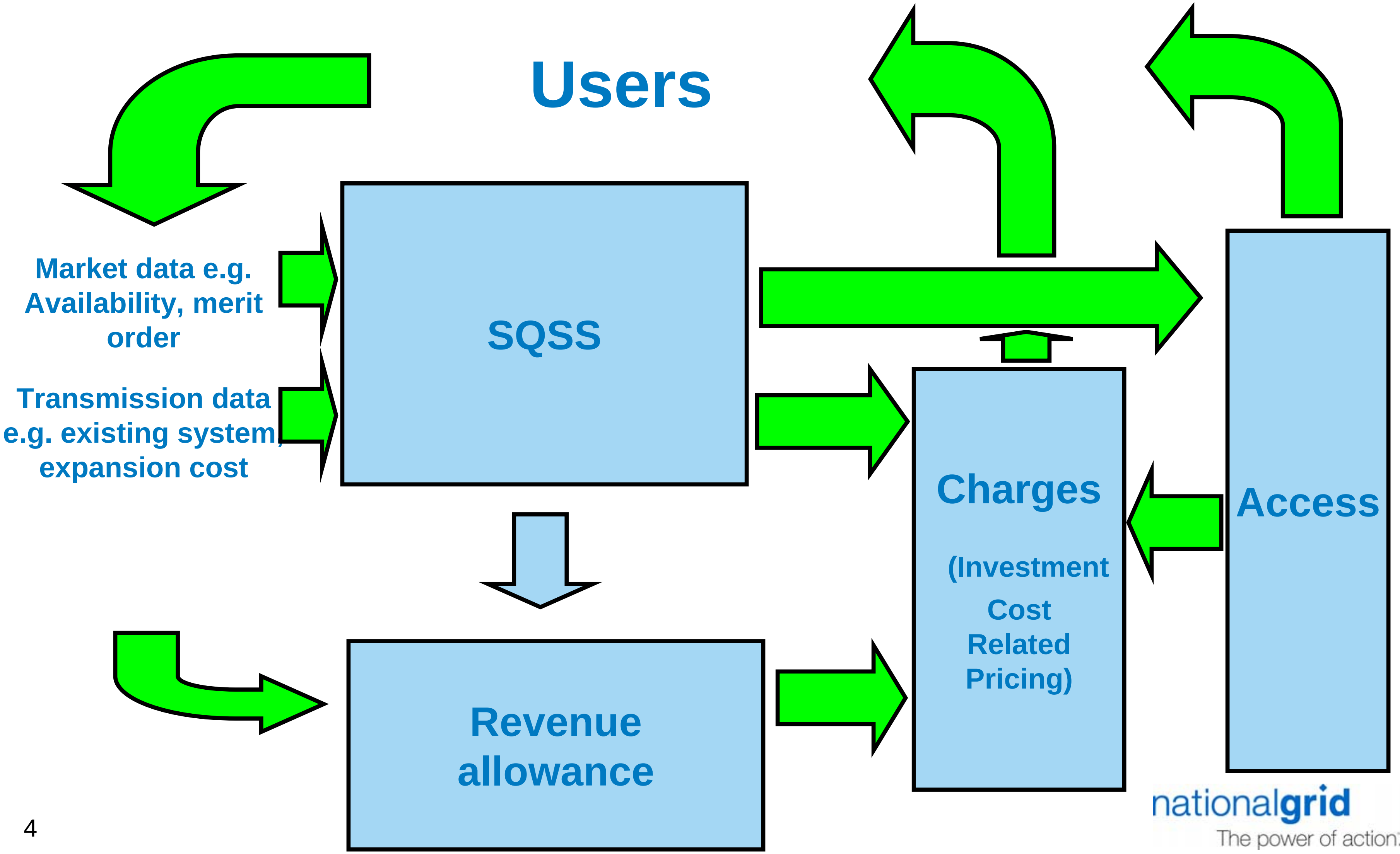
Charges – interaction with investment and access



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Main electricity transmission charges

- **Transmission Network Use of System** (TNUoS) Charges ~ £1600m
  - Recovers the costs of installing and maintaining Infrastructure assets
  - TO Price Control
- **Balancing Services Use of System** (BSUoS) Charges ~ £1.24/MWh
  - Recovers the total costs of operating the system
  - SO Price Control
- **Connection Charges** ~ £140m
  - Recovers costs of owning Connection assets
  - TO Price Control plus Excluded Services

Who do we charge?

- TNUoS
  - Generators (27%)
  - Suppliers (73%)
  - Interconnector Owners
- BSUoS
  - Generators
  - Suppliers
  - Interconnector Users
- Connection
  - Directly Connected Generators
  - Distribution Network Operators (DNOs)
  - Directly Connected Consumers
  - Interconnector Owners

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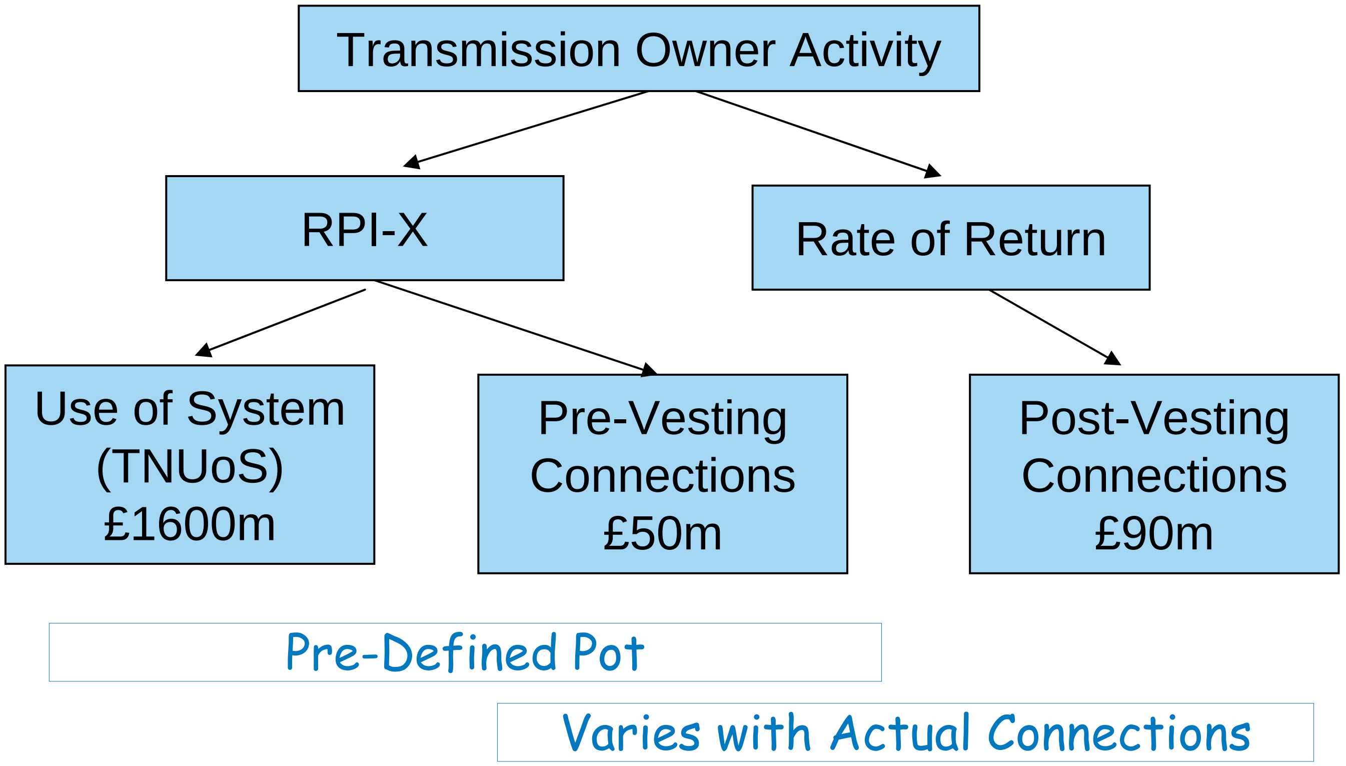
GB Revenues – TNUoS and Connection



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Regulated revenue set by price control

M_t = $PR_t + TIRG_t + PT_t + IP_t + CxIncRA_t + IE_t + DIS_t + ER_t + LC_t + TS_t + TOInc_t - k_t$

M_t = Maximum Allowable Revenue

PR = Base transmission revenue, includes RPI-X and indexation. Set at £987m for 2007/08 (in 2004/05 prices) – £1233m for 10/11 (NGET)

TIRG = Renewables allowance, LC D3

PT = Total pass though, LC D4, includes TO revenues, licence fee, rates and rental, ITC, final sums, interruption payments

IP = Transmission incentive payments – LC D5, includes reliability, innovative funding, SF6

K_t = over/under recovery from previous year

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Current charging framework

- Standard Licence Conditions:
  - C4: Charges for use of system
  - C5: Use of system charging methodology
  - C6: Connection charging methodology
  - C7: Non discrimination between Users
  - C13: Small generators discount

Condition C4: Charges for use of system

- To prepare a statement of use of system charging methodology for approval by the Authority
- To prepare a statement of use of system charges
- To give 150 days notice of proposals to change use of system charges (except where the Authority consents to a shorter period)
- To revise information contained in the statements as may be necessary to ensure accuracy in all material aspects

Condition C5: Use of system charging methodology

- Requires National Grid to develop a use of system charging methodology approved by the Authority that:
  - facilitates effective competition in the generation and supply of electricity
  - ensures that charges as far as reasonably practicable, reflect the costs incurred
  - takes account of developments in the transmission business, as far as reasonably practicable

- To keep the methodology at all times under review
- To consult CUSC users on proposed modifications, allowing a period of no less than 28 days within which to make written representations

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Condition C6: Connection charging methodology

- Requires National Grid to develop a connection charging methodology approved by the Authority, that:
  - facilitates effective competition in the generation and supply of electricity
  - ensures that charges as far as reasonably practicable, reflect the costs incurred
  - takes account of developments in the transmission business, as far as reasonably practicable
- To keep the methodology at all times under review
- To consult CUSC users on proposed modifications, allowing a period of no less than 28 days within which to make written representations

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Condition C7: Prohibition on discrimination between Users

- In the provision of use of system or in the carrying out of works for the purpose of connection to the GB transmission system, the licensee shall not discriminate as between any persons or class or classes of persons
- The licensee shall not in setting use of system charges restrict, distort or prevent competition in the generation, transmission, supply, supply or distribution of electricity
- For the avoidance of doubt the adjustment of use of system charges made in accordance with standard condition C13 shall not place the licensee in breach of this condition

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Condition C13: Adjustment to use of system charges (small generators)

- When calculating use of system charges to eligible generators the licensee shall set a charge in conformance with standard condition C4 (charges for use of system) less a designated sum
- Eligible generators
  - <100MW
  - Connected to 132kV
- Discounted by 25% of overall Residual tariff
  - 20010/11 = £5.51/kW
- Small generators remain liable for locational element of the TNUoS tariff

Framework linkages

- CUSC Section 2.14: User shall pay connection charges
- CUSC Section 3.9: User shall pay use of system charges
- Licensee shall give a User no less than two months prior written notice of any revised charges
- CUSC has the payment processes
- CUSC also contains obligation to supply information to set charges
- Bilateral contracts have the details of specific charges
- Grid Code also requires supply of information
  - Which also feeds through to SYS
  - Used to calculate charges

TNUoS Transport Model

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How tariffs are determined

- Investment cost related pricing
- Long Run Marginal Cost of investments
- Recover allowed revenue - MAR
- Transport model
    - Used to calculated the signal
- Tariff Model
    - Used to ensure correct revenue recovery
    - G/D split

Transport model

- DC load flow (DCLF ICRP)
- Objective
  - Proxy for investment
  - Nodal
  - MW
  - Marginal km
- About providing the signal
- Revenue recovery is derived from tariff model

Transport model principles

- DC Load Flow transport model
    - Transparency
    - Predictability
    - Stability
    - Reproducibility
    - Simple
- Available to Users
- No engineering experience required

Transport model basis

- Winter peak conditions
  - Drives investment
- Merged transmission system
- Forecast demand – SYS
- Straight scaling of generation

Transport model methodology

- 1) Base study
  - Total MWkm
- 2) Inject 1 MW at each node
  - Remove at slack node (centre of system)
  - Adjusted MWkm
- Marginal cost =Total MWkm - Adjusted MWkm
- Marginal MWkm can be + or –ve

Transport methodology assumptions

- Assume linearity
  - Demand and generation equal
  - Large increment has a proportional effect - ignores lumpiness
- Expansion factors (400kV OHL is base)
  - Type of circuit
    - OHL or cable
  - Voltage
    - 400 / 275 / 132 kV
    - Upgrade factor
- No spare capacity
  - Circuit ratings not considered
  - Unsecured
- All reinforcement is on existing routes based on existing technologies

TNUoS Tariff Model

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Agenda

- Zoning
- Flow-weighted marginal km
- Expansion constant
- Global locational security factor
- Re-referencing quantity
- Residual tariff
- Local tariff

Demand & Generation zones

- Demand zones represent the boundaries of the DNO networks
  - Difficult to tell where demand is sub Grid Supply Point Groups
- Generation zoning criteria
  - A zone should contain relevant nodes whose marginal km, when multiplied by the expansion constant and the security factor are all within a maximum spread of £2.00/kW
  - Geographically and electrically proximate
  - Minimum number of zones possible
  - Zones typically not reviewed more than once every price control other than in exceptional circumstances

Flow-weighted marginal km

- Calculates the flow-weighted average marginal km for each demand and generation zone
  - Total marginal km from relevant nodes
  - Total demand and generation in each zone

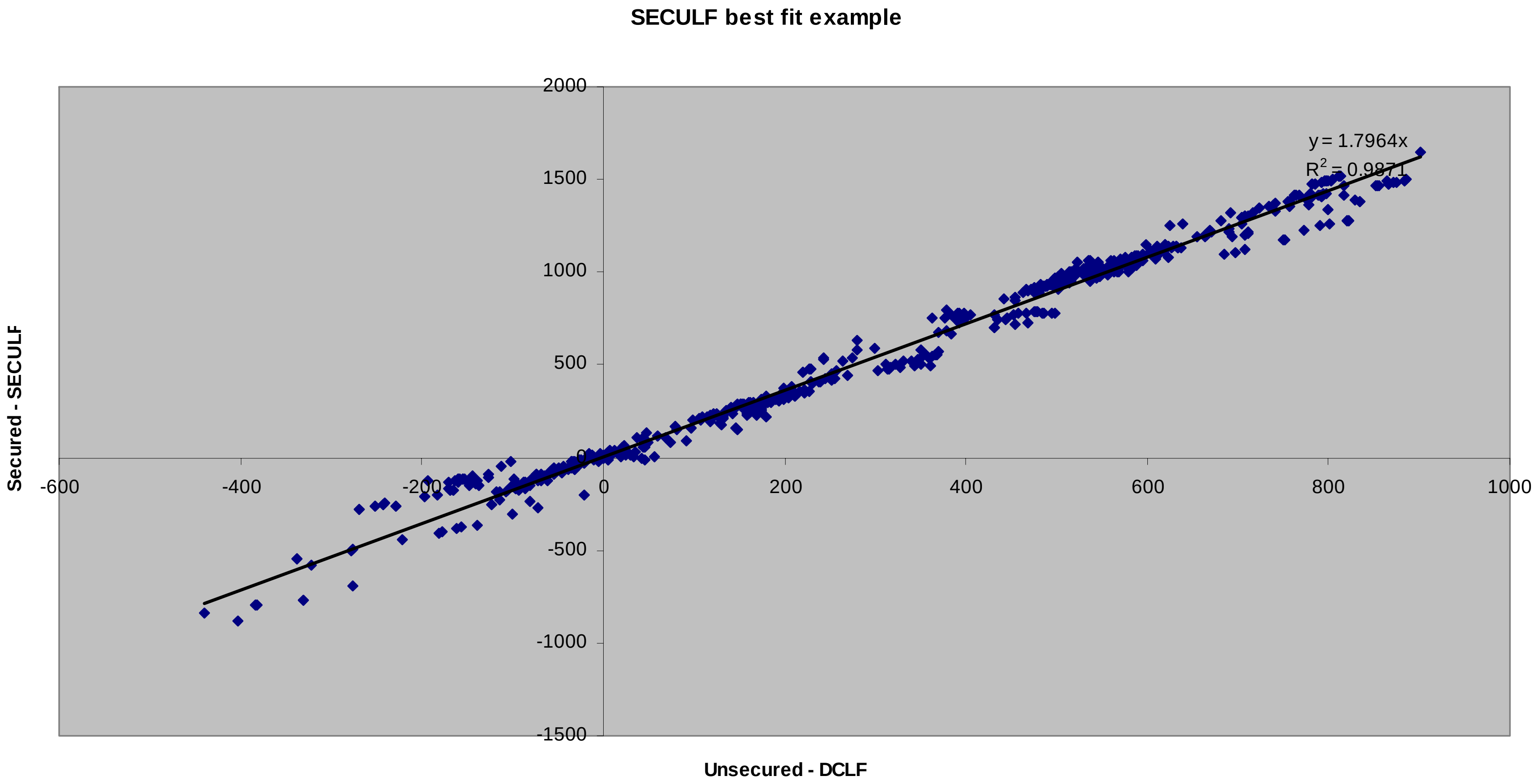
Expansion constant (£/MWkm)

- Converts marginal km into costs
- Represents the annuitised value of the transmission infrastructure capital investment required to transport 1MW over 1 km
- Derived from the projected cost of 400kV OHL at the beginning of each price control:
  - Using manufacturers budgetary prices, contracts let, lead tenders
  - Uses a range of OHL types, weighted by recent usage
  - Inflated annually by RPI

Global locational security factor

- The DCLF give unsecured MWkm, need to represent the fact that we have build more than a single line
- We run a secure DCLF transport study based on the same market background of the transport model
- Calculates the nodal marginal costs where peak demand can be met, but taking account of SQSS contingencies
  - simulating single and double circuit faults on the network
- Essentially the same process as that used for the calculations of marginal km except that the secure DCLF study additionally calculates a nodal marginal cost taking into account the requirement to be secure against a set of worst case contingencies
- The secured nodal cost is the differential between the studies and that produced by the DCLF transport model, with the resultant ratio of the two determining the locational security factor
- Reviewed at the beginning of each price control
- Approximately 1.8

Seculf best fit example



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Locational Re-referencing quantity

- Modifies the zonal weighted marginal km to ensure that the locational element of the tariff recovers 73% of revenue from demand and 27% from generation
- Locational amounts for approximately 20% of TNUoS revenue
- Re-referencing is only an intermediate step in process

Residual tariff

- Ensures appropriate overall revenue recovery and the appropriate split between demand (73%) and generation (27%)
- Accounts for approximately 80% of TNUoS revenue
  - Demand = £18.559/kW
  - Generation = £3.479/kW

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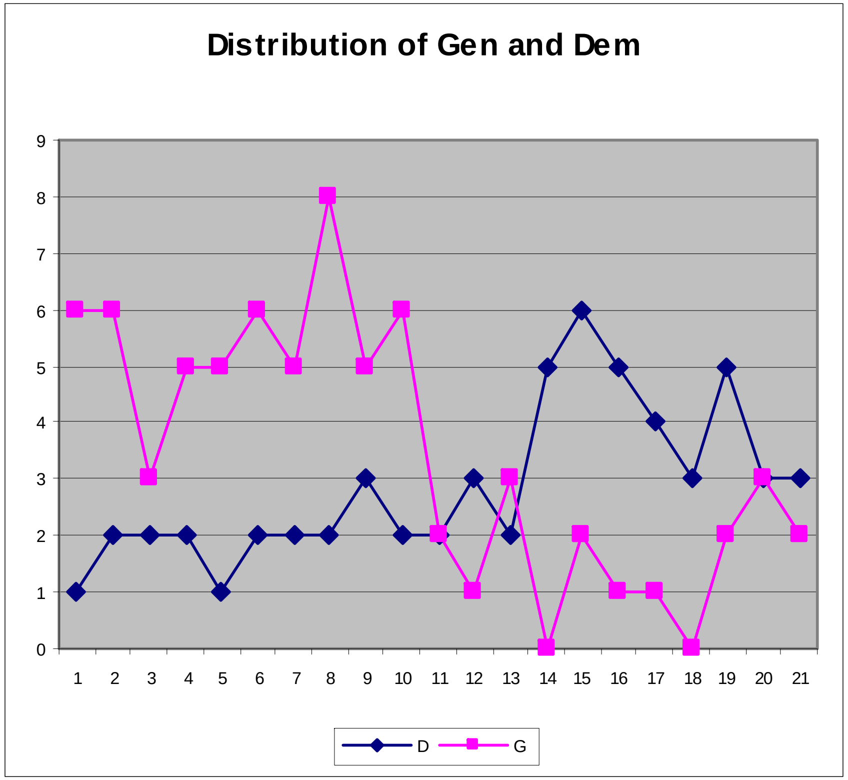
Local Charges

- TNUoS has 3 components
  - Local Substation Tariff (cost of local generator substation)
  - Local Circuit Tariff (cost of connection to MITS)
  - Wider Tariff (cost of MITS)
- Circuits: each node is given a Bus Security Factor
  - 1.0 or 1.8 – measure of redundancy
  - Transport model calculates MWkm (in 400kV base) between substations
  - Specific local charge derived and added to wider TNUoS for each generator
- Each local substation is classed with or with redundancy and by voltage
  - Local sub charge added to final tariff for each generator.

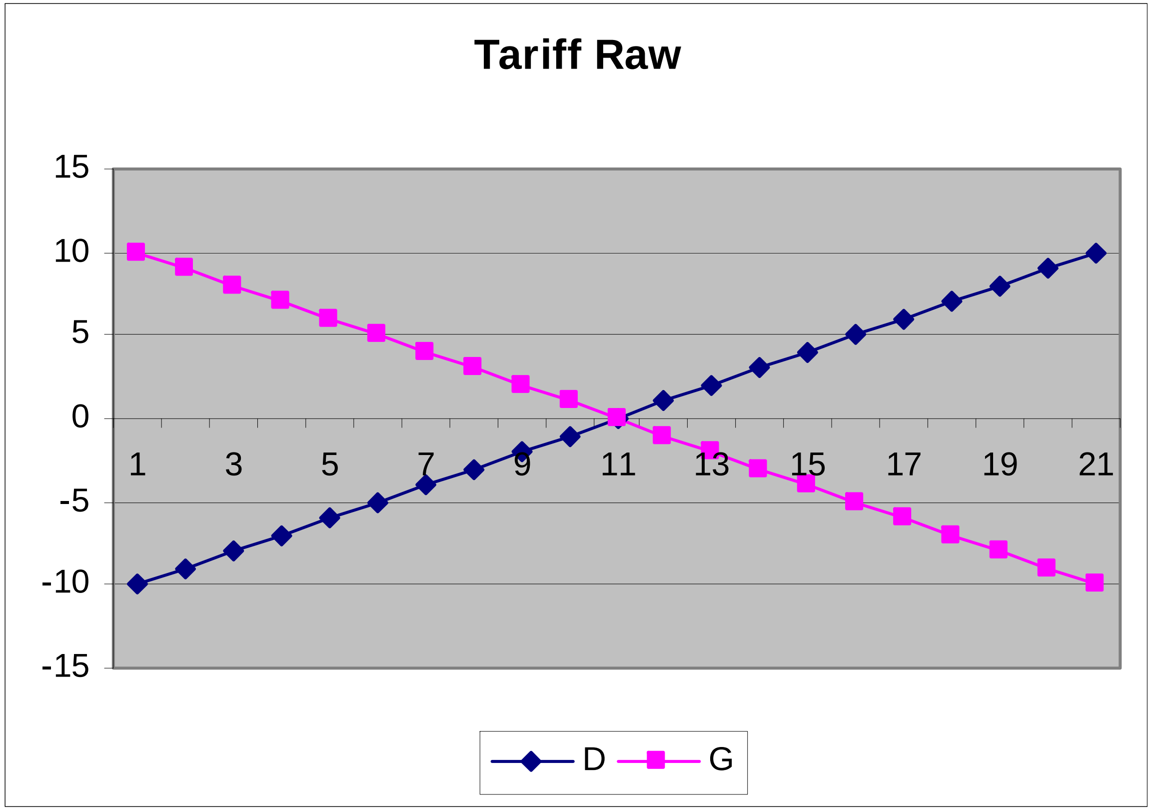
Example

- Example data to show the build up of tariff
- Distribution of G and D
- Lots of D in the south
- Lots of G in the north



Example

- Transport model give equal and opposite signals for demand and generation



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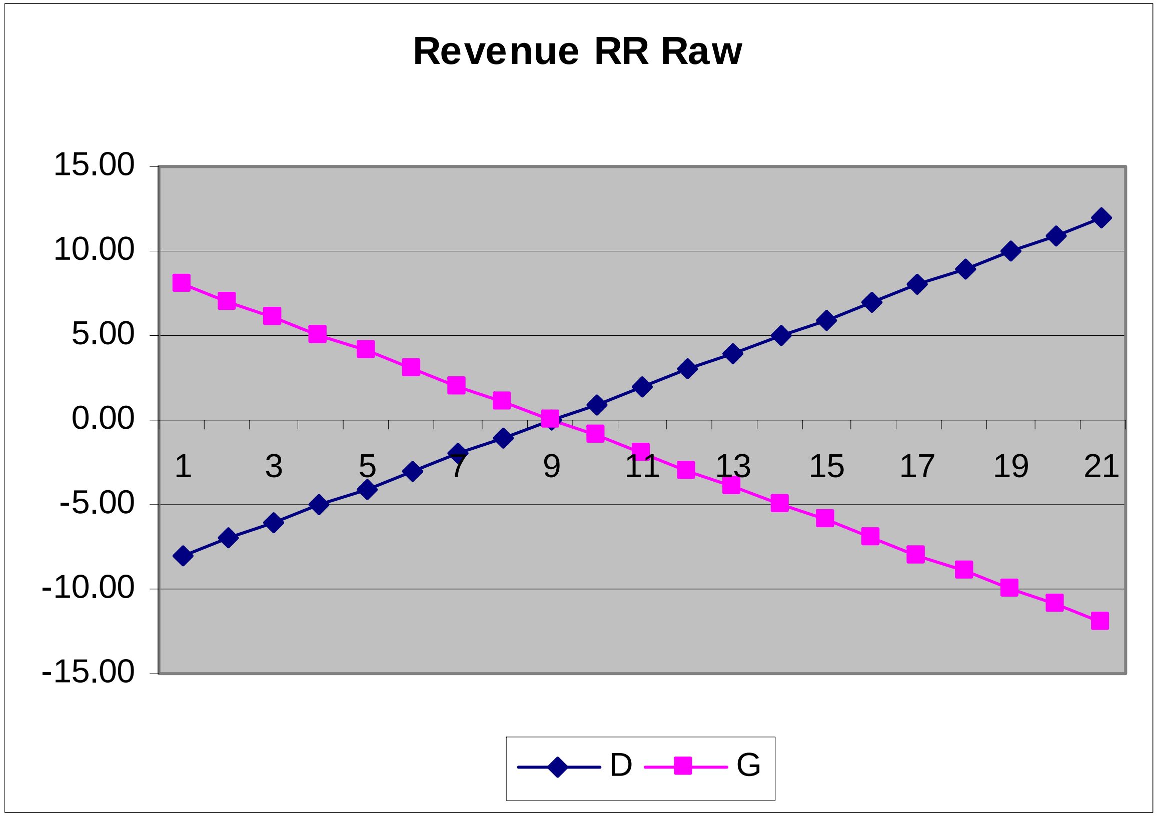
Example

- Re referencing moves the hub so that the split is 27:73
- In this example the hub moves north



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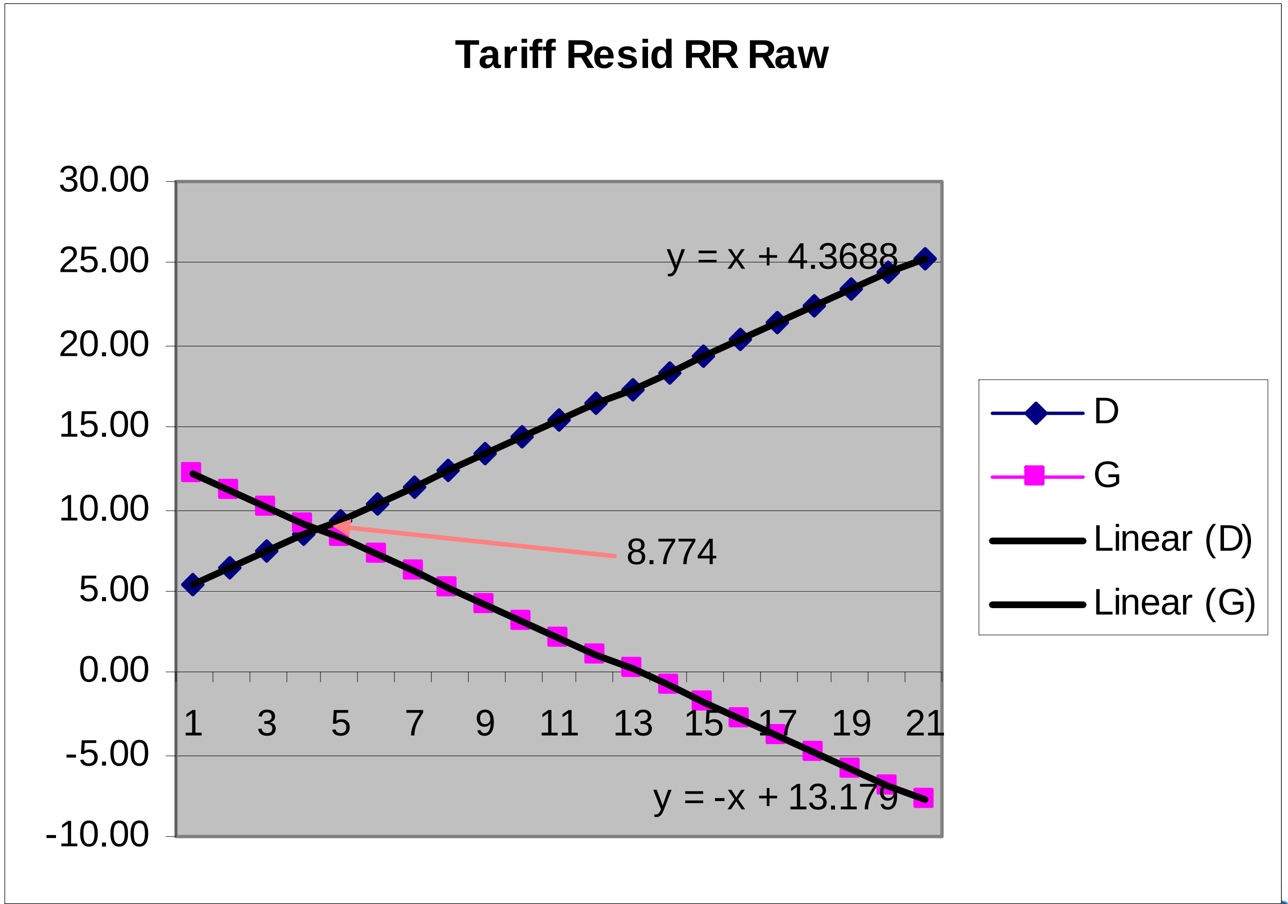
Example

- The residual is added in proportion of +27 and +73 which makes the charges asymmetric creating the embedded benefit



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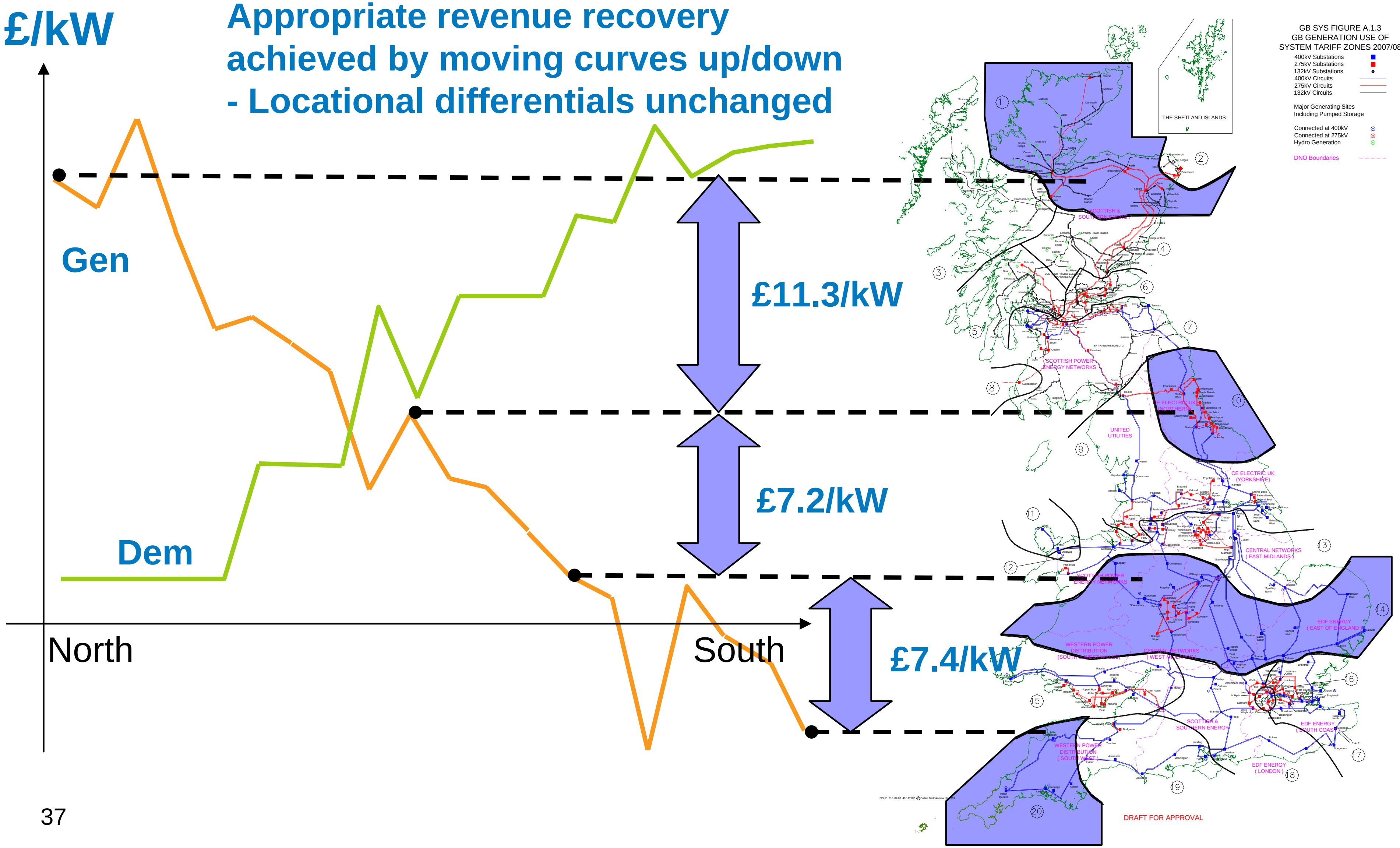
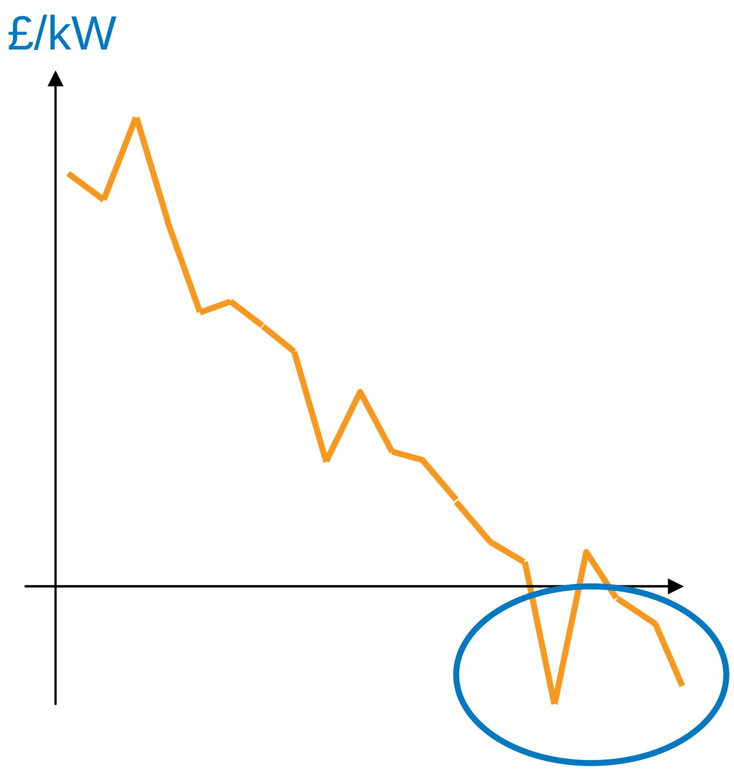
To illustrate….

Appropriate revenue recovery achieved by moving curves up/down
- Locational differentials unchanged



Negative generation charges….



- Why do we have them?
  - In order to only recover 27% of costs from generation and maintain “locational differentials”, some charging zones become negative
- How can they be justified?
  - Negative charging zones import electricity
  - Without this generation, we would need to build more transmission to secure demand, increasing transmission costs and charges!
- How significant are they?
  - In 2008/09, we paid £17m to generators in negative charging zones

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BSUoS Charging Methodology

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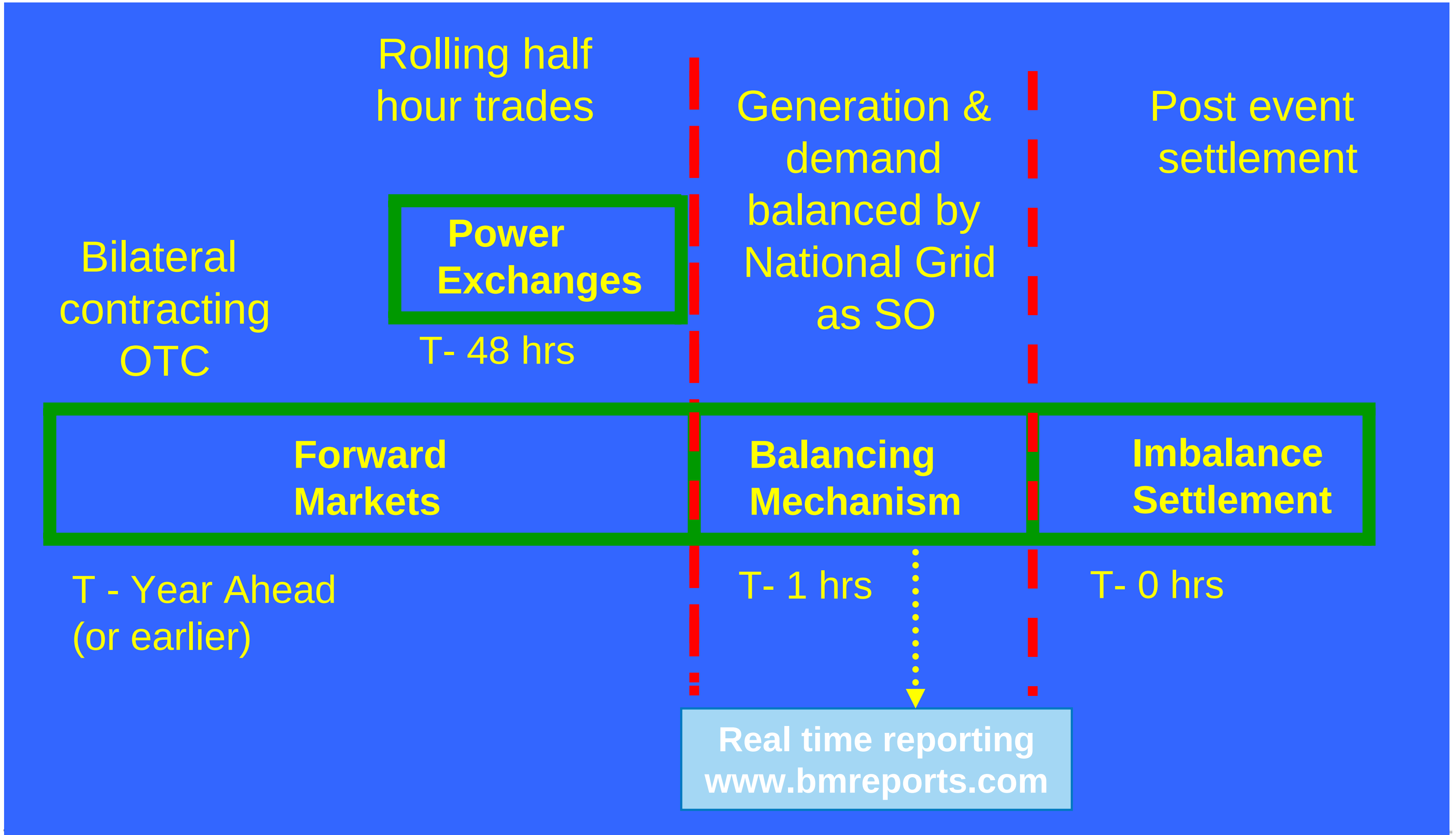
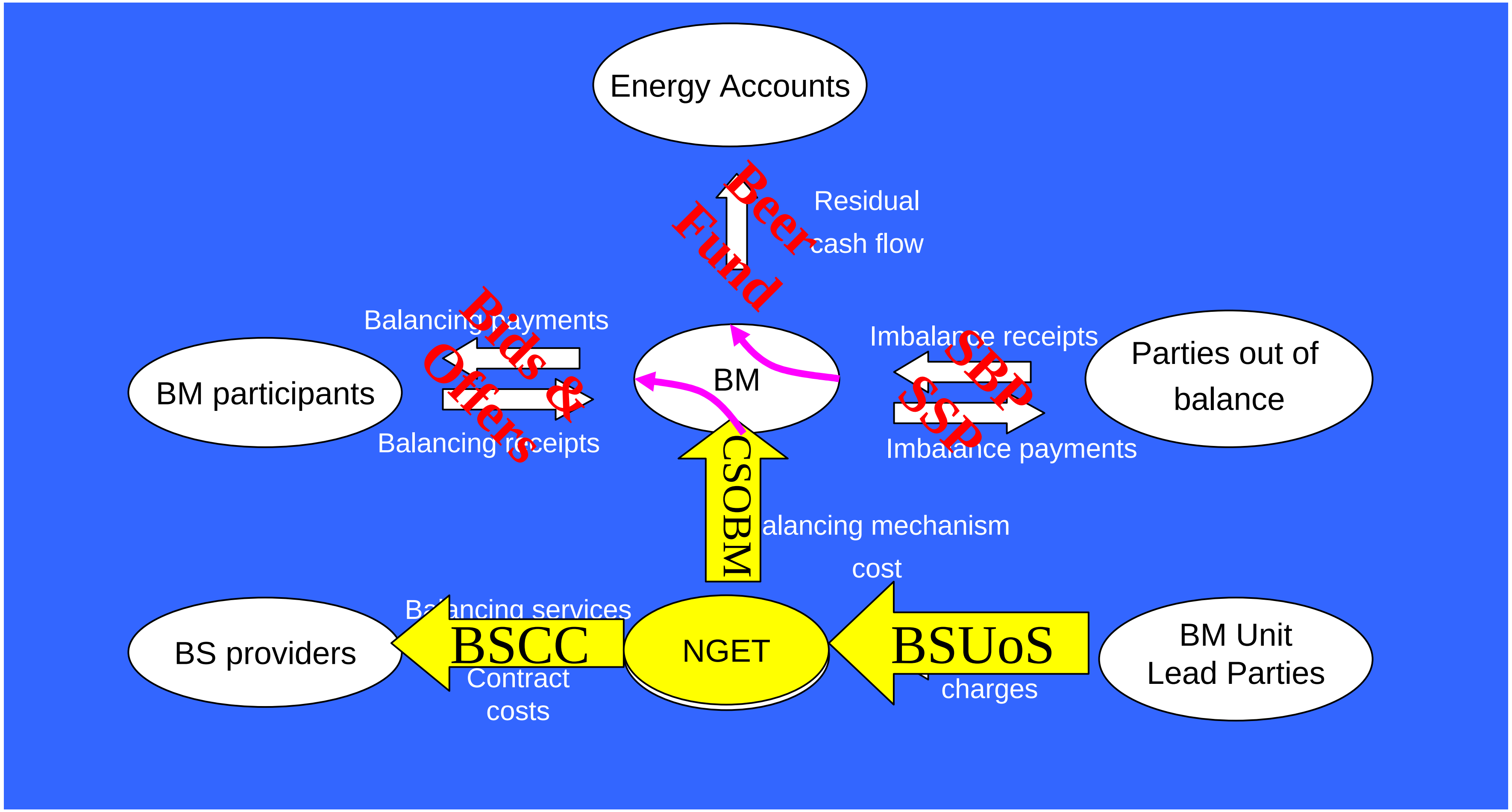
Wholesale Electricity Market



What is BSUoS?

- Balancing Services Use of System charge
- Recovers the costs of ‘balancing the system’ and the System Operator function
- Paid by Users of the transmission system
  - Lead Party of BMU
- Obligation to pay is in the CUSC
- Calculated and settled in accordance with the Charing Methodology Statement

Cashflows

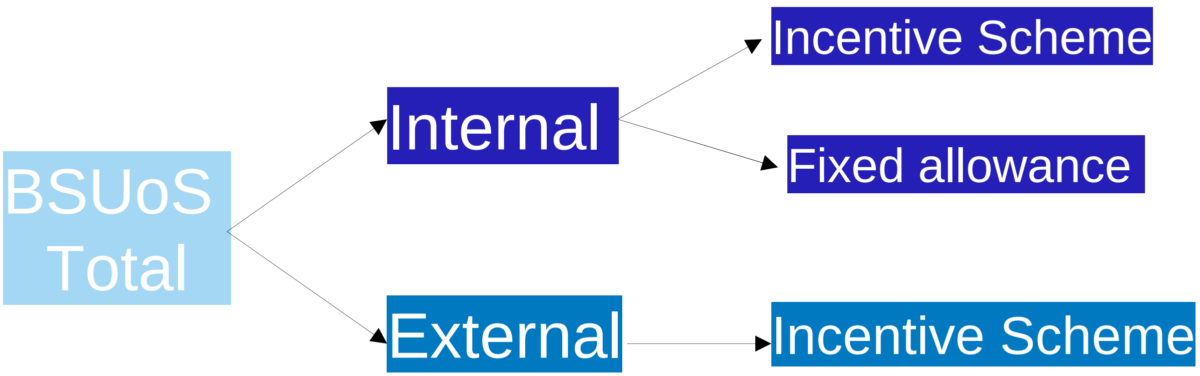

Energy Accounts
Residual cash flow
Beer Fund
Balancing payments
Bids & Offers
Balancing receipts
BM participants
BM
Imbalance receipts
SBP
SSP
Imbalance payments
Parties out of balance
CSOBM
Balancing mechanism cost
Balancing services
BSCC
Contract costs
BS providers
NGET
BSUoS
charges
BM Unit Lead Parties

BSUoS Overview

- £/MWh - one price per period, paid by all
  - BMU Lead Parties (Generators, suppliers, I/C users)
- Calculated half-hourly
- Billed Daily
- Charge is allocated on actual metered volumes
- Three stage settlement: (excluding II)
  - Initial charge based on SAA “SF” volume allocation run (d+28)
  - End of Scheme reconciliation (June)
  - Final Reconciliation “RF” (d+14 months)

What does BSUoS recover?

- Recovers costs incurred as opposed to a fixed “allowance”
- Under the umbrella of an incentive scheme
- Two main components of BSUoS
  - “Internal” - internal SO costs e.g. staff, buildings, (opex)
  - “External” - costs of the services used to balance the system i.e. Electricity related products



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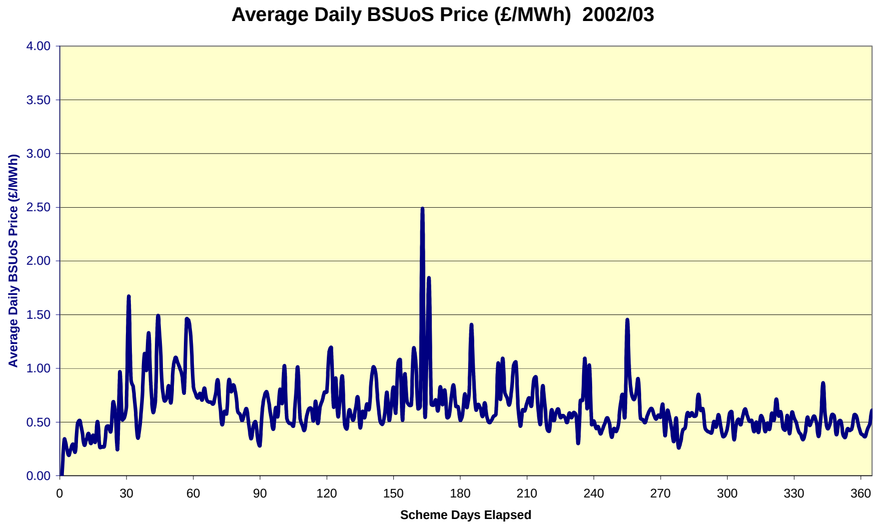
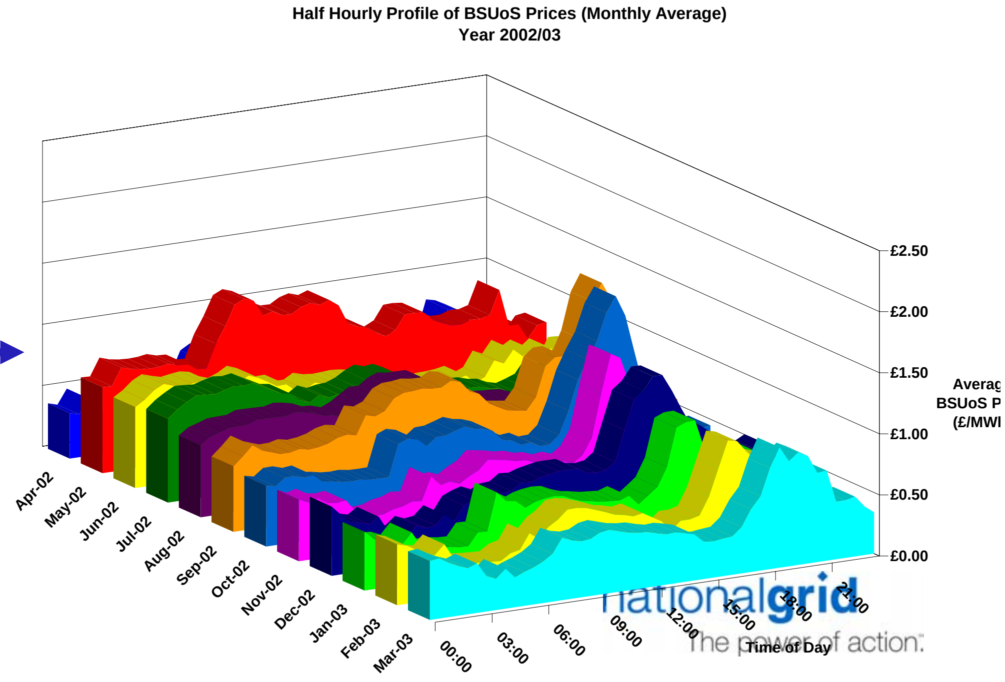
BSUoS Volatility



Average Daily

Half-Hourly



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Connection charging methodology

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Agenda

- Definition of connection assets
- Overview of ‘Plugs’
- Connection boundary principles
- Connection charging formula
- One-off charges
- Termination charges

Definition of connection assets

- Connection assets are defined as those assets solely required to connect an individual User to the GB transmission system, which are not and would not normally be used by any other connected party

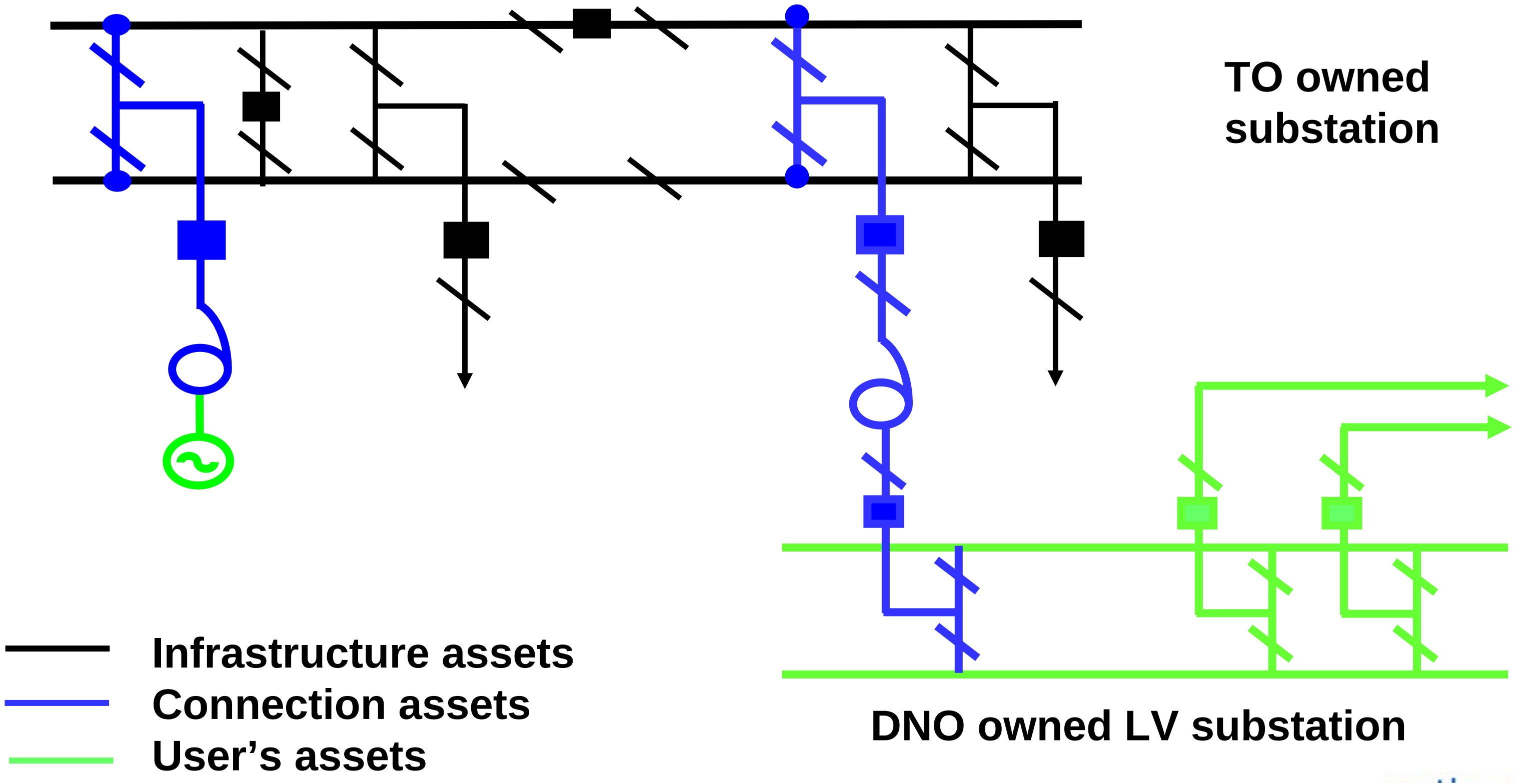
Plugs

- ‘Plugs’ implemented 1 April 2004
  - Movement of shareable or potentially shareable connection assets into Infrastructure
  - Substations and associated site infrastructure and land
  - Generation only Spurs
  - Shared National Grid owned LV substations

- Principles behind Plugs model:
  - Shallow connection charging
  - Single user connection assets
  - No sharing
  - No spurs

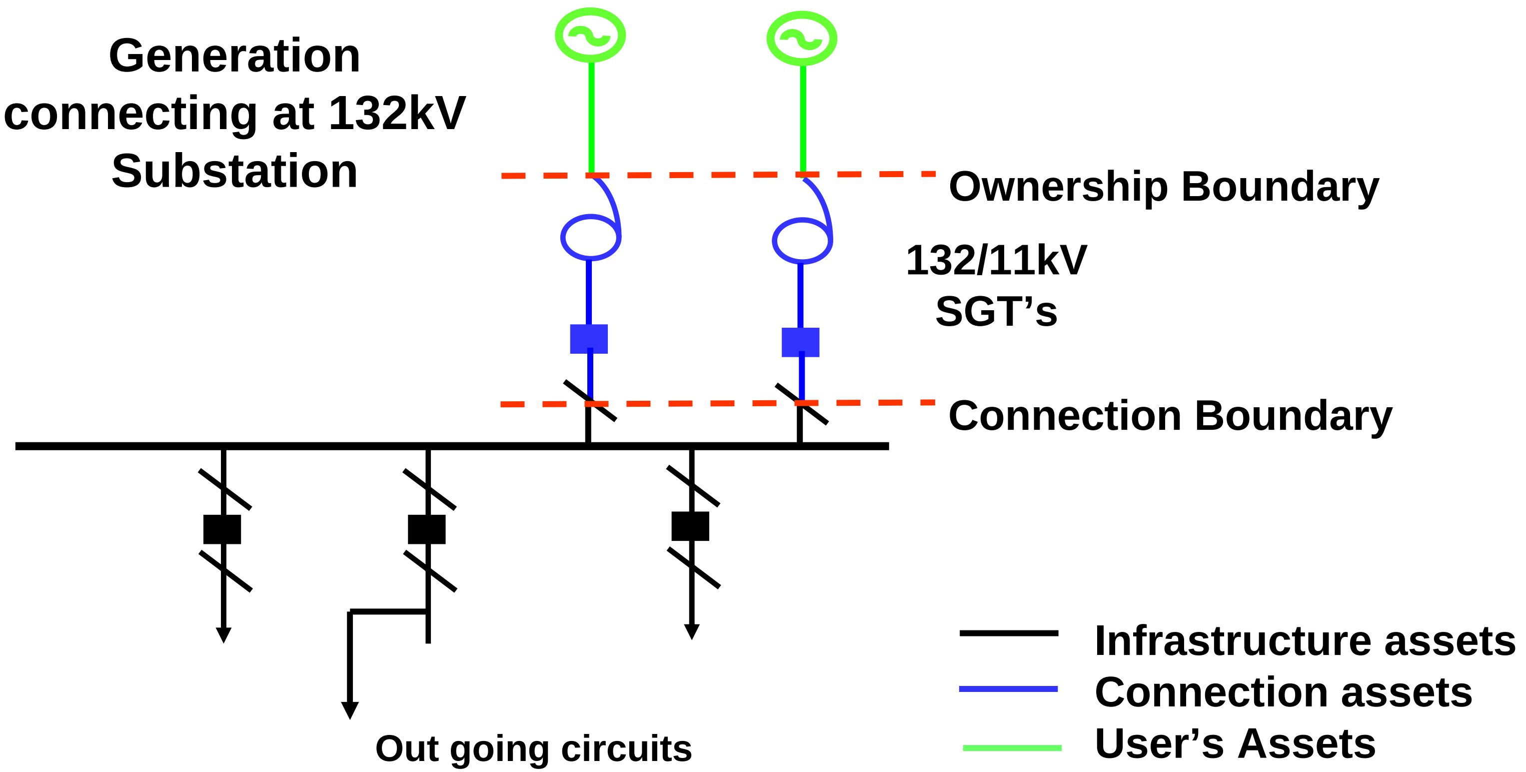
Connection assets are………….

- For double busbar type connections, are those single User assets connecting the User's assets and the first transmission licensee owned substation, up to and including the double busbar bay



Connection assets are…………..

- For teed or mesh connections, are those single User assets from the User's assets up to, but not including, the HV disconnector



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Connection assets are………….

- For cable and overhead lines at a transmission voltage, are those single User connection circuits connected at a transmission voltage equal to or less than 2km in length that are not potentially shareable

- In instances when the design of some connection sites may not be compatible with the basic boundary definitions, a connection boundary consistent with these principles will be applied

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Parties liable for connection charges

- Directly connected generators
- Distribution Network Operators (DNOs)
- Directly connected consumers
- Interconnector owners

Connection charging

- Re-calculated annually from 1 April, giving two months notice
- Asset based charge levied on Users
  - to recover costs, with a reasonable rate of return, of providing assets for connection to the GB transmission system
- Charges relate to the cost of assets installed solely for and only capable of use by an individual User
- Charged by asset, taking account of:
  - asset value
  - asset age
  - site-specific maintenance
  - costs of running the transmission system

Connection charge formula

Annual connection charge$_n$ =

$$D_n\,(GAV_n) + R_n\,(NAV_n) + SSF_n\,(RPIGAV_n) + TC_n\,(GAV_n)$$

$D_n (GAV_n) + R_n (NAV_n) + SSF_n (RPIGAV_n) + TC_n (GAV_n)$

- GAV = Gross Asset Value
- Represents the initial cost of an asset, typically made up of the following components:
  - Construction costs – cost of bought in services
  - Engineering – allocated equipment and direct engineering costs
  - Interest During Construction – financing cost
  - Liquidated damages premium
- Re-calculated annually
- Depreciation typically 40 years, although customer choice
  - 2.5% of GAV

$D_n (GAV_n)$ + $\mathbf{R_n (NAV_n)}$ + $SSF_n (RPIGAV_n)$ + $TC_n (GAV_n)$

- R_n Rate of return
- NAV = Net Asset Value
  - Average (mid-year) depreciated GAV of the asset
  - Reduction of 1.25% in Year 1
  - Reduction of 2.5% in Subsequent Years
  - Reduction of 1.25% in Year 41, to zero

- Rn = 6.0% for RPI valuation
- Rn = 7.5% for MEA valuation

$D_n (GAV_n) + R_n (NAV_n) + \mathbf{SSF_n (RPIGAV_n)} + TC_n (GAV_n)$

- SSF = Site specific maintenance
- Maintenance only component that recovers a proportion of the costs and overheads associated with the maintenance activities at a specific site
- Calculated Annually:
  - Forecast SSM for GB / Total GB connection assets
- Currently 0.52%
- Reviewed under BETTA condition 6, agreed to keep generic

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$D_n (GAV_n) + R_n (NAV_n) + SSF_n (RPIGAV_n) + \mathbf{TC_n (GAV_n)}$

- TC = Transmission Cost Factor
- Reflects transmission running costs incurred by TO's that should be attributed to connection assets:
  - Rates
  - Operation
  - Indirect overheads
- Calculated at the beginning of each price control using published operating expenditure figures
- Corresponds with the proportion of the TO's connection assets as a % of total GAV
- Currently 1.45%

Example

- Asset with GAV of £100,000 in its first year of charging
- Depreciation period of 40 years
- SSF of 0.52%
- TC of 1.45%

D_n (GAV_n)	= 2.5% * £100,000	£2,500
R_n (NAV_n)	= 6.0% * £98,750	£5,925
SSF_n ($RPIGAV_n$)	= 0.52% * £100,000	£ 520
TCn (GAVn)	= 1.45% * £100,000	£1,450
		£10,365

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One-off charges

- Any works that are not directly attributable to a connection asset and the cost of which cannot be capitalised into either connection or infrastructure.
- The following can be classed as One-off works:
  - Moving or relocating equipment
  - Temporary towers for OHL diversions
  - Operational intertrips
  - Non-standard connections
- Main driver is whether a cost can be capitalised to connection or infrastructure

Termination Charges

- Where a User wholly or partially disconnects from the transmission system, they will be required to pay a termination charge, incorporating the following elements:
  - NAV of assets at the end of financial year in which termination or modification occurs
  - Reasonable costs of moving assets and making good the condition of the connection site
  - Remaining connection charge for the year
  - Remaining TNUoS and BSUoS charge
  - Previous capital contribution will be taken into account

Current Charging Issues

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Embedded

- National Grid has obligations through its transmission licence to promote effective competition and charge cost-reflectively
- Charges therefore have both a locational element (reflecting impact on investment) and a residual element (collecting revenue)

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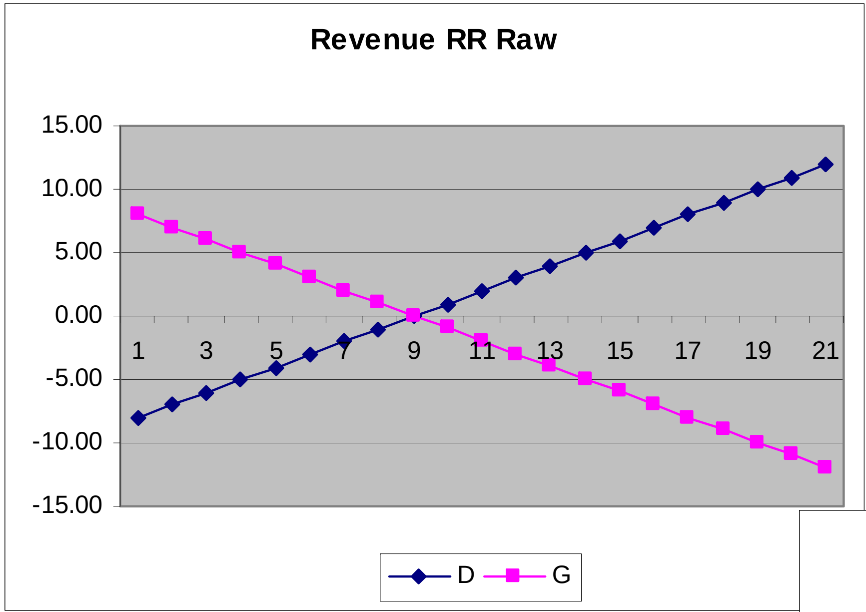
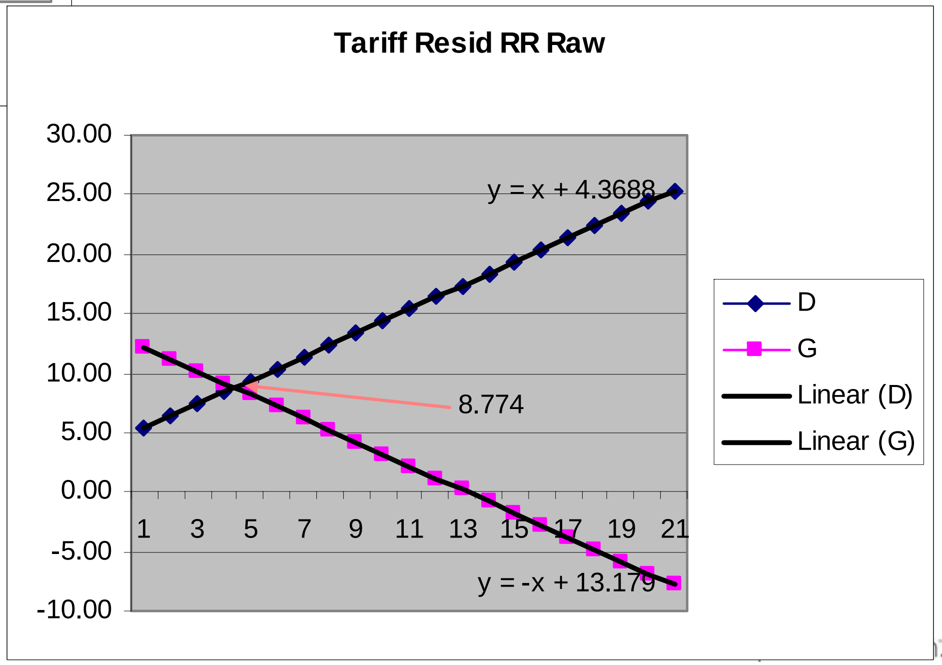
Embedded

- DG is in competition with directly connected generators for supply of demand
- DG avoids g-TNUoS and pays negative (i.e. receives) d-TNUoS (the residual)
- If charges were purely locational, this would be broadly cost-reflective and equitable between DG and directly connected
  - Locational element of d-TNUoS tariffs correctly reflects impact on the wider transmission system of a DG in a given location
- In addition to the impact on the wider transmission system, DG also has an impact on the local transmission system.

Embedded in simple example

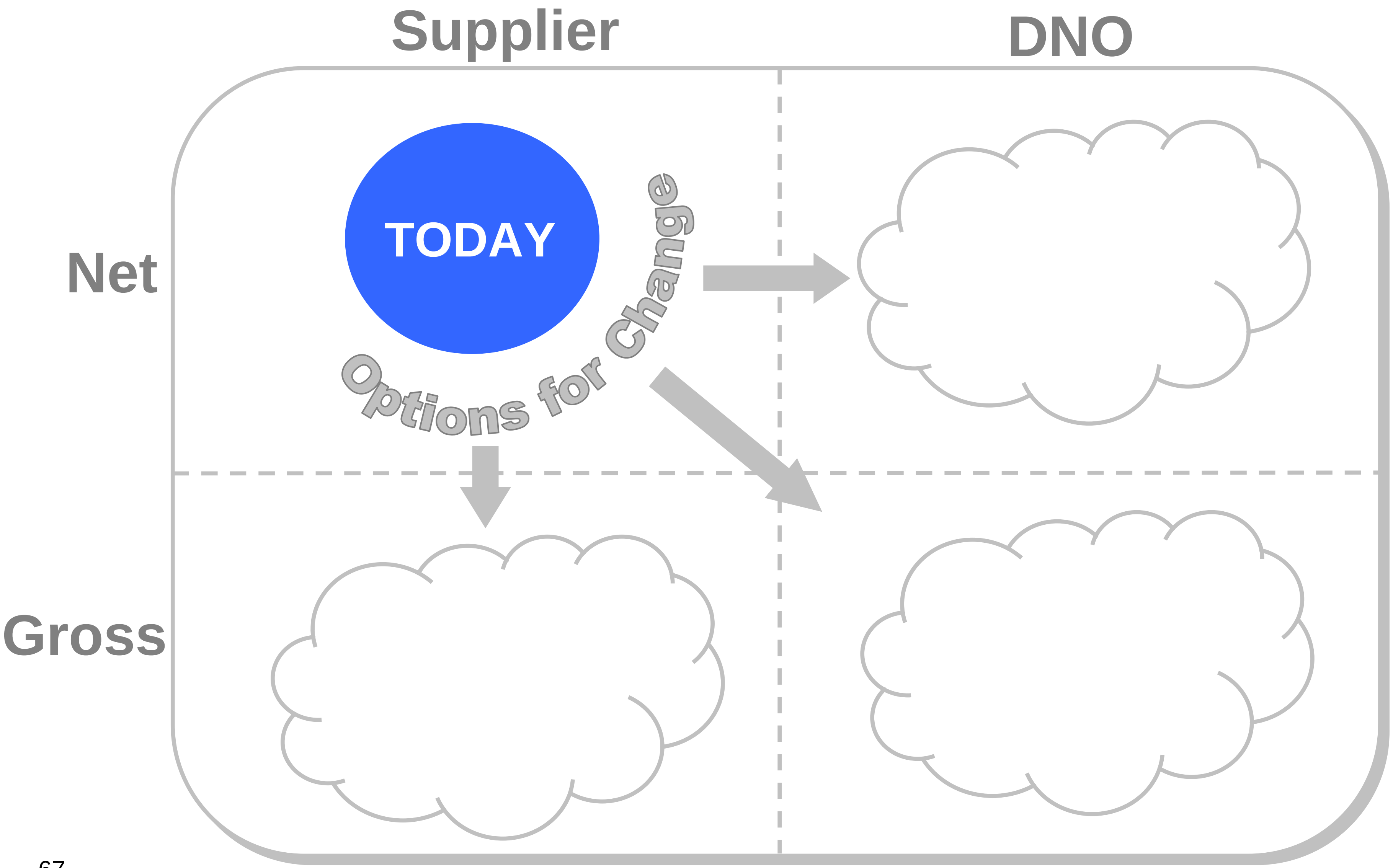


- Works OK in with locational only as DG sees –ve D = +G



- Adding residual creates the embedded benefit
- It is nothing to do with the actual benefit of embedding

Options for Change



Options for Change

	Supplier	DNO
Net	**Not cost reflective** • Existing arrangements / minimal disruption • Ofgem & government have indicated that there is an issue • Analysis indicates not cost-reflective (~200% >) • Contractual issues with exporting GSPs	~ Could indirectly address cost-reflectivity issue ✓ Directly addresses contractual arrangements ~ Introduces massive implementation complexity;
Gross	✓ Directly addresses cost-reflectivity issue ✓ Removes the need for more complicated contractual arrangements ~ Requires de-minimus threshold and robust/transparent discount level	**Same result from less complicated model** ✓ Directly address cost-reflectivity issue ✓ Removes need for more complicated contractual arrangement ✗ Introduces significant implementation complexity for same result as gross supplier

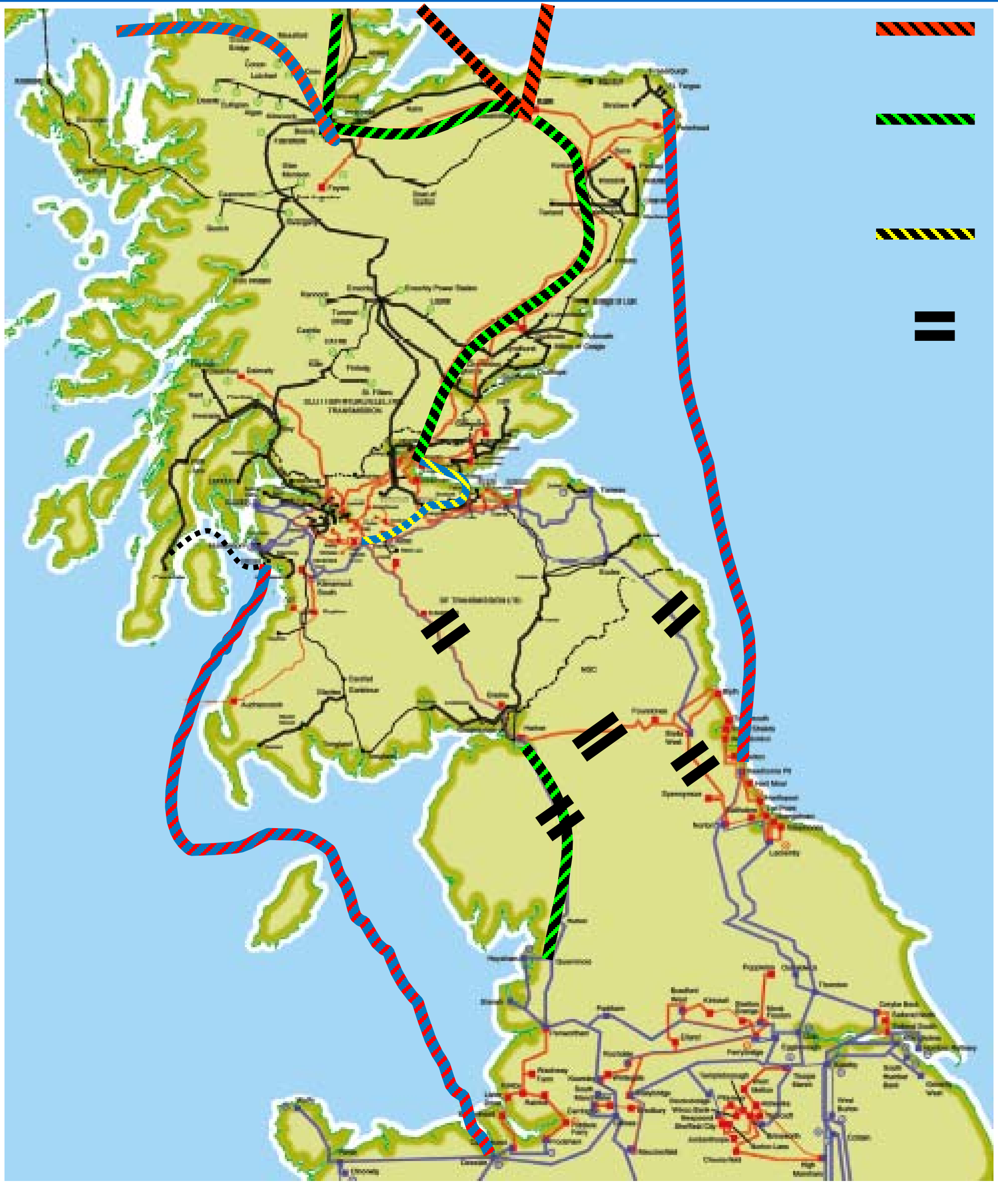
Europe

- Compliance with third package
- Are interconnectors part of the transmission system?
- Should import and export be treated as generation and demand ?
- Compliance with
  - Regulation: Cross-border exchanges 714/2009 (1228/2003)
    - Inter TSO Compensation mechanism
    - Tarification (average annual G <=€2.5/MWh)
    - Congestion management (on interconnectors)
  - Directive: Renewables 2001/77 (2009/28 -2012)
  - Directive: Competition 2009/72 (2003/54)

Largest Loss

- SQSS proposal is to increases largest loss from 1320MW to 1800MW
- Additional £160m per year in SO costs
- National Grid has obligation to keep charges under review and update
- How do we signal it to generation to ensure the net gain for GB is positive
  - Yet avoid a barrier to entry for new technologies
  - Facilitate wider Government objectives

Network Upgrades



Sub sea Interconnector:
HVDC cable from Hunterston – Deeside (circ 1.2 - 1.9GW) £0.7bn
HVDC cable from Peterhead – Northeast England (circ 1.2 - 1.9GW) £0.8 bn

Accommodates 11.4 GW of renewables in Scotland

Why sub-sea?

- Reduced consenting risk
- Brings energy into our network at the right place
- Operationally more flexible

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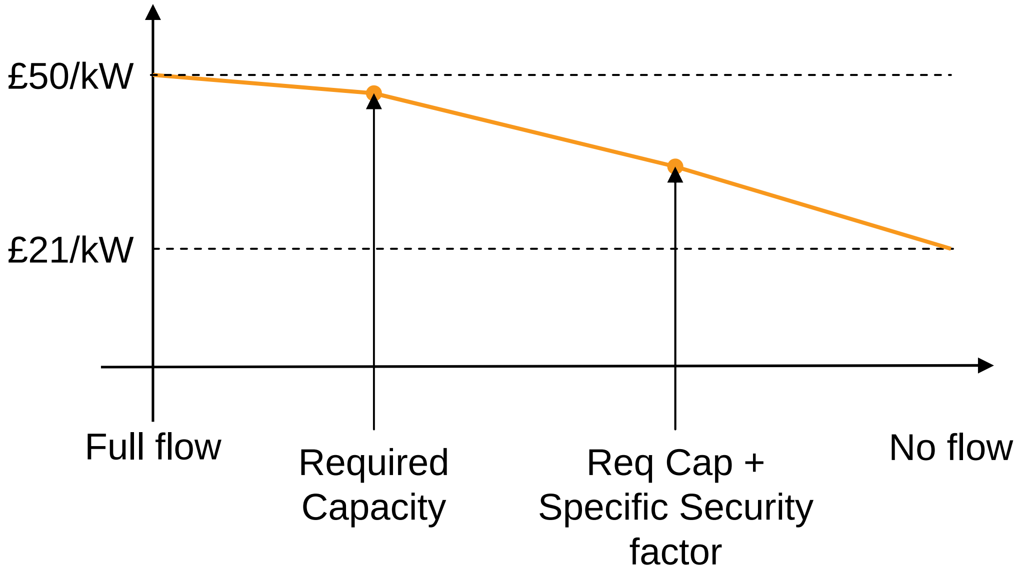
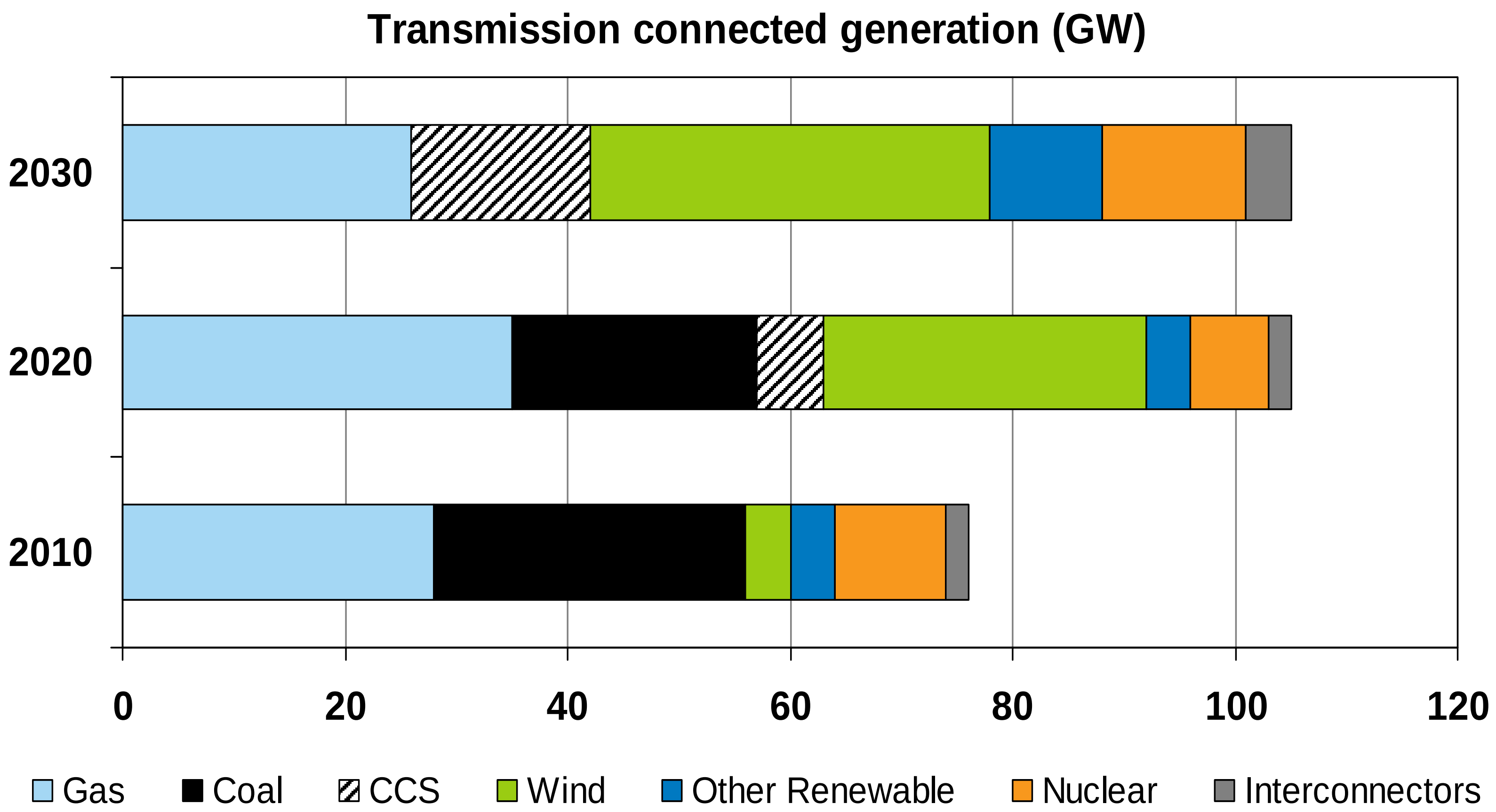
ENSG “Bootstraps”



- Existing charging model based on passive network elements
- Flow on HVDC cables depends on mode of operation
- Need to consider
  - Required capacity Charge for what is required (rather than installed)
  - Specific security factor Reflect operation following faults

The changing generation mix



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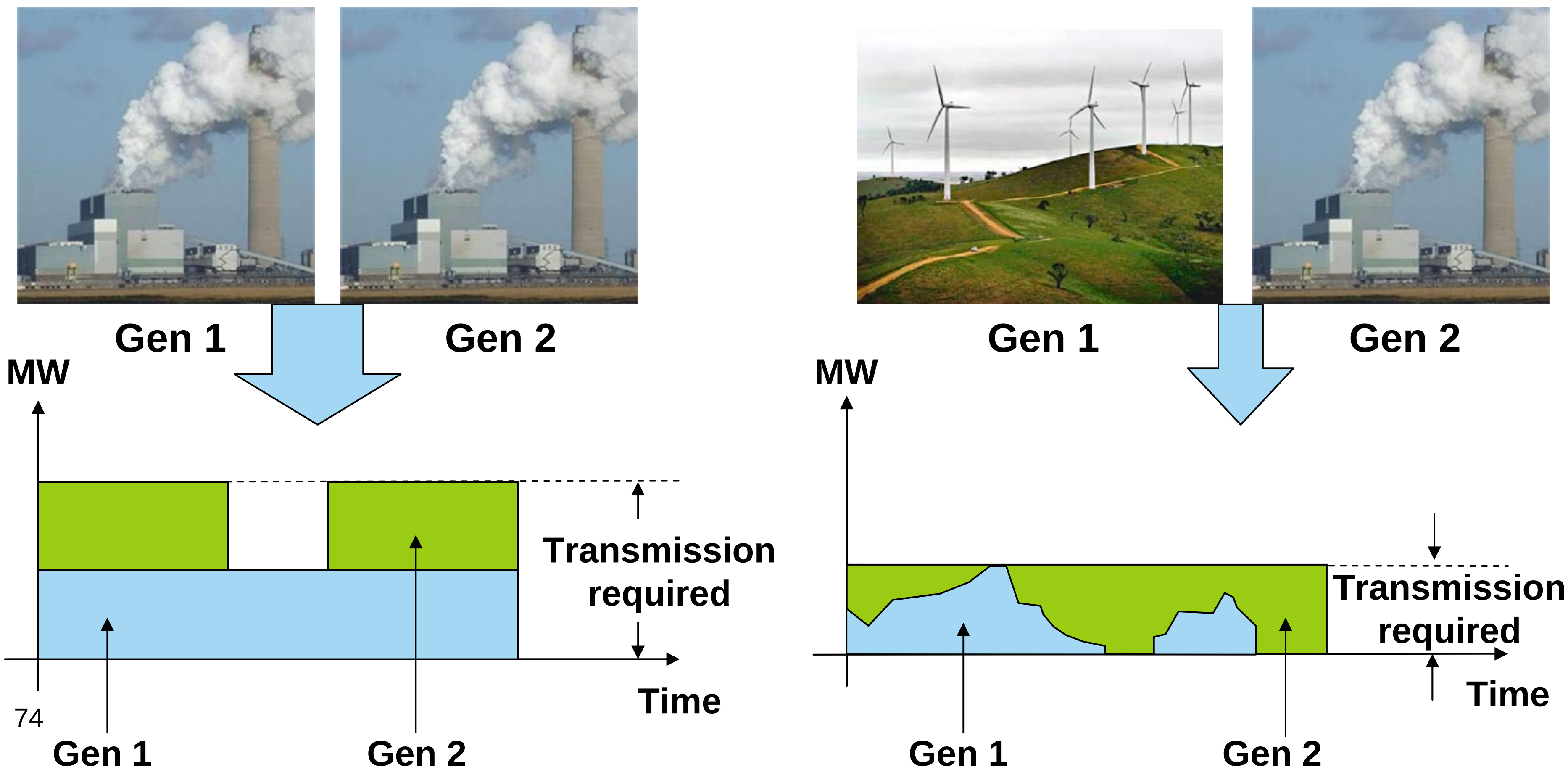
Transmission charging for wind generation

- We are investigating options to develop charges to better reflect the impact that wind generation has on transmission investment.



SQSS interaction - Wind

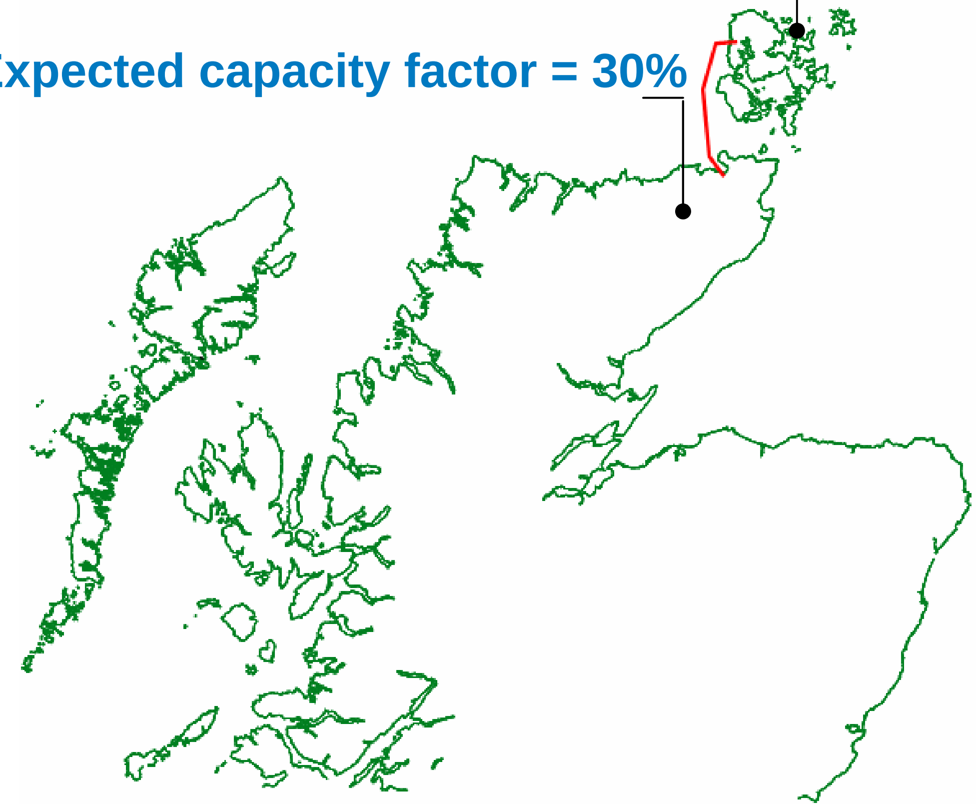
- A peak demand based methodology alone is unlikely to be appropriate in a world of high wind penetration
  - With more wind generation and higher plant margins, transmission investment is more likely to be driven by consideration of year-round operation rather than demand peak
- SQSS review has been examining how a cost benefit approach can be integrated in to overall process
  - Requires assumptions about generation
- Given the range and sensitivity to the assumptions, the current preferred approach is detailed scenario analysis to establish a simplified transparent approach
- The SQSS approach is being replicated in the charging model
  - Gives an average 30% cheaper tariff

For example….

Expected capacity factor* = 49%

Estimated cable cost = £2m / year

Expected capacity factor = 30%



- Consider a 100MW windfarm developer trying to choose between a mainland project or a project on Orkney

  Windfarms can make higher returns on Orkney - because its windier

  - Orkney generator makes £32m / year but has to pay additional £2m / year for cable
  - Mainland generator makes £20m / year

  Developer should choose Orkney - cable cost is economically justified.

Capacity factor* = Annual output expressed as % of installed capacity

Questions?

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