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HVDC



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HVDC

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Parallel HVDC – Defect

- Parallel HVDC circuits – ‘Bootstraps’
- Existing charging model based on passive network elements
  - HVDC represents an active component
  - High relative £/MWkm cost
  - Some precedent offshore

1. Which costs go into EF calculation?
2. Where does incremental MW flow?

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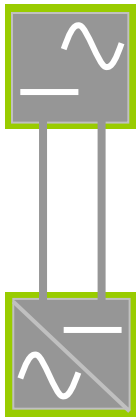
Expansion Factor - Original

- Annuitised, unit capital cost – £/MWkm/year
- Includes all cable and converter costs
- Consistent with existing treatment of radial HVDC circuits; appropriate for parallel links?



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Expansion Factor – Converter stations

Alternatives to remove:

- AC equivalent costs (generic)
  - 50% removal
  - Based on Cigre cost breakdown
- Quadrature Booster capability costs (generic)
  - Additional 10% removal
  - Based on WG analysis
- AC equivalent costs (specific)
  - Specific % removal for each link
  - Better information / more cost reflective?

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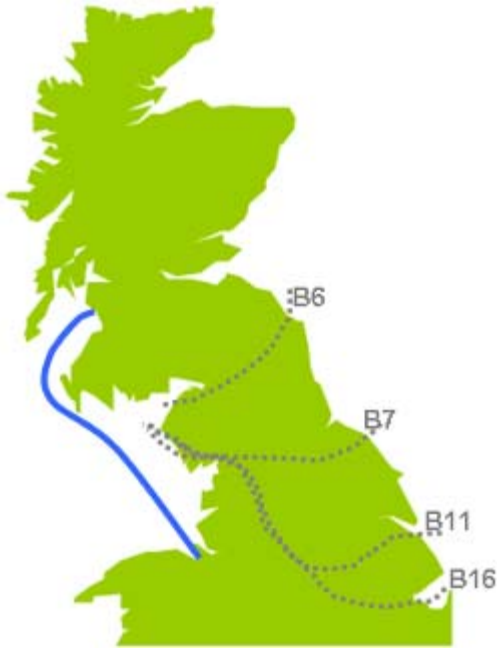
Incremental MW flow



- HVDC no fixed impedance (flows controllable)
- Model HVDC as pseudo-AC → need impedance
- Obtained by calculating power flow in base case
  - Average across relevant boundaries

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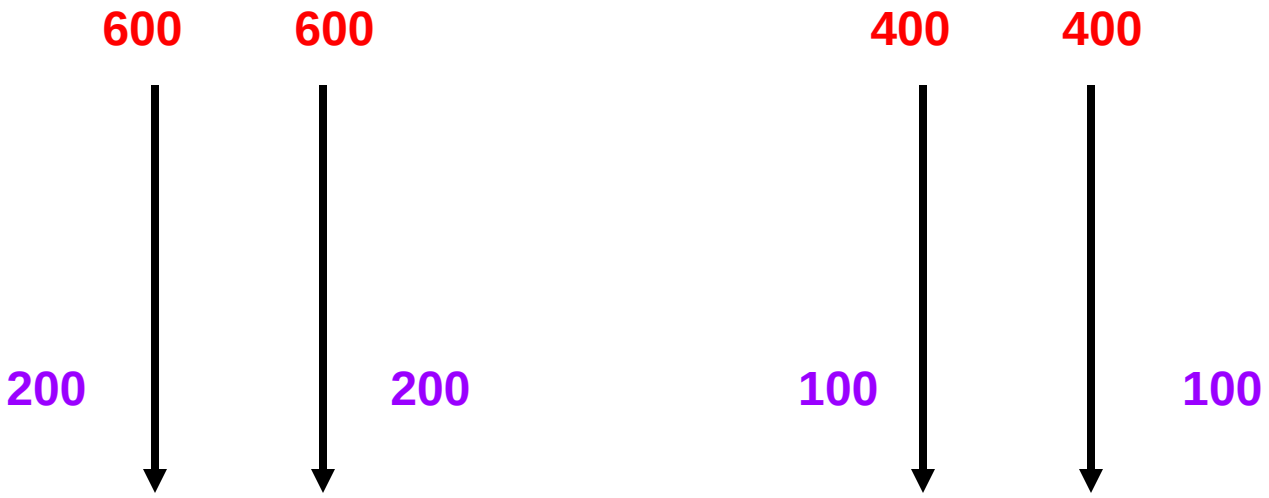
Calculating flows – example



Total capacity: 2000

Total flows: 600

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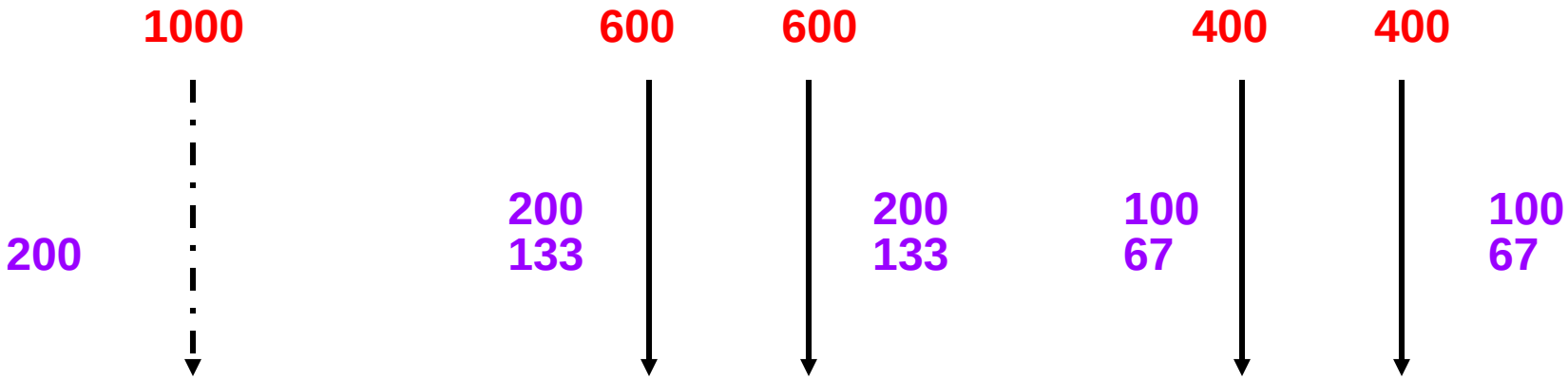
Calculating flows – example 2

HVDC bootstrap



Total capacity: 3000
Total flows: 600

To calculate flow down bootstrap: $\frac{\text{Bootstrap capacity}}{\text{Total capacity}}$ **x** Total flow

Example calculation: $\frac{1000}{3000}$ **x** 600 **= 200** (flow down bootstrap)

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HVDC - Potential alternative elements

Parallel HVDC
Single boundary impedance
Specific EF 100% Conv+100%Cable (original)
Specific EF 90% Conv+100%Cable (QB)
Specific EF 50% Conv+100%Cable (AC sub)
Specific EF; generic 40% Conv+100%Cable (AC sub + QB)
Specific EF; generic 0% Conv+100%Cable (fixed asset)
Specific EF; generic onshore Equiv.
Specific EF; generic 50% Conv+100%Cable (AC sub)
Specific EF; specific *x*% Conv. cost reduction (AC sub)
T - 4 EF calculation

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Islands



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Islands

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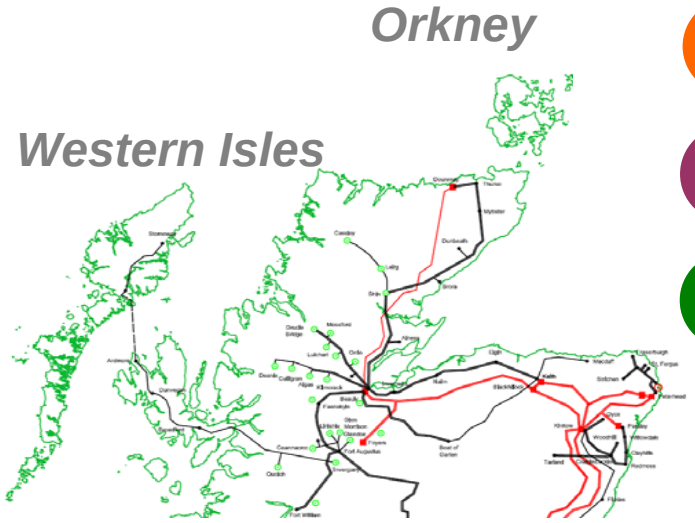
Scottish Island Connections – Defect

- Circuits proposed comprised of sub-sea cable technology
- Not accommodated in onshore charging methodology
- Configuration not envisaged when 'local circuit' charging was introduced



1. Which costs go into EF calculation?
2. Revise MITS (local/wider) definition?
3. Security factor (1.8) for MITS nodes?

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Expansion factor

- Different network technology proposed for each island
- Calculate technology specific expansion factors
- Based on annuitised, capital unit costs
- Treat consistently with HVDC bootstraps

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Expansion Factor – Island converter stations

Alternatives to remove:

- Consistent with solutions for HVDC
  - AC equivalent costs (50% generic or specific)
- No QB element for Islands
- Voltage Source Converter costs
  - Additional 20% (generic) removal
  - Based on post-WG consultation analysis

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Security Factor for MITS nodes

- MITS definition in Original changed to classify radial circuits (including island connections) as ‘local’
- Some WACMs not including definition change
- Circuit spans of lower redundancy would have adjusted Expansion Factor calculation (i.e. multiply by 1.0/1.8)
  - for all radial circuits
- Tariff commensurate with access rights

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Islands – Potential alternative elements

Islands
Specific EF 100% Conv+100%Cable (original)
Specific EF; generic 30% Conv+100%Cable (AC sub + STATCOM)
Specific EF; generic 50% Conv+100%Cable (AC sub)
Specific EF; generic 0% Conv+100%Cable (fixed asset)
Specific EF; specific *x*% specific Conv. cost reduction (AC sub)
T - 4 EF calculation (AC + DC)

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Deriving illustrative tariffs

- Capacity information
  - based on RIIO-T1 final proposals for SHE-T
- Project Cost information
  - Latest publicly available information
  - Where no data available then use generic cost data
    - Source: 2011 ODIS (inflated to 2012 prices) and discussions with SHE-T
- Converter / AC Substation Cost information
  - Use generic cost data
    - Source: 2011 ODIS (inflated to 2012 prices) and discussions with SHE-T

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Illustrative local island link circuit tariffs

Original	Western Isles	Shetland	Orkney AC	Orkney HVDC
Local Circuit Tariff	102.51	71.04	42.96	54.34
Expansion factor	53.95	19.64	48.32	37.18

50% converters	Western Isles	Shetland	Orkney AC	Orkney HVDC
Local Circuit Tariff	82.48	63.53	42.96	39.32
Expansion factor	43.41	17.56	48.32	26.90

30% converters	Western Isles	Shetland	Orkney AC	Orkney HVDC
Local Circuit Tariff	74.46	60.52	42.96	33.31
Expansion factor	39.19	16.73	48.32	22.79

- Do not include wider, local substation or residual tariff elements
- Island connections may also have on-island local circuits which are not included