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Theme 4 – Reflecting New Technology: HVDC



Assessment of options for setting of HVDC in Transport model

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4 Reflecting HVDC in Transport Model

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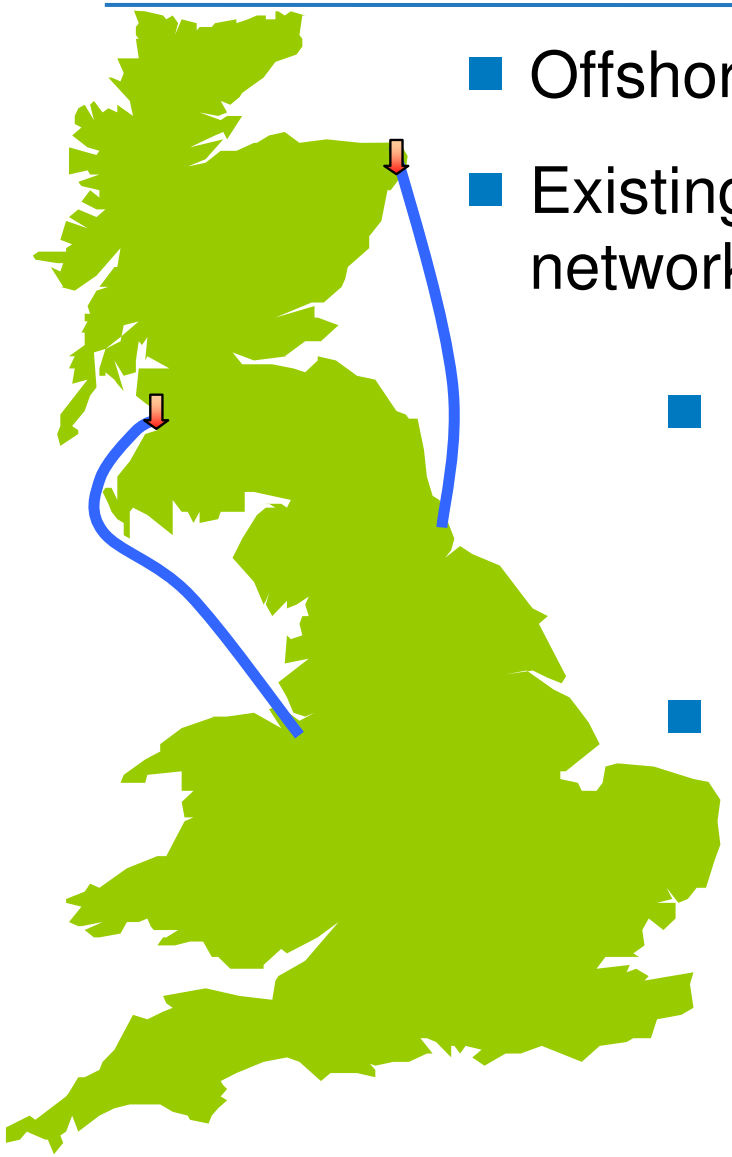

- Offshore HVDC links – 'Bootstraps'
- Existing charging model based on passive network elements
  - HVDC represents an active component of the network
- Therefore in Transport model need to;
  1. estimate level of power flow
  2. calculate desired impedance

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Options for calculating power flow

1. Optimal Power Flow

   Derive power flow from optimal operation calculation - complex

2. Transmission Routes

   Assume equal power flow on each double circuit equivalent route

3. Transmission Circuits

   Assume equal power flow on each major circuit

4. Circuit Ratings

   Pro-rata flows based on circuit ratings

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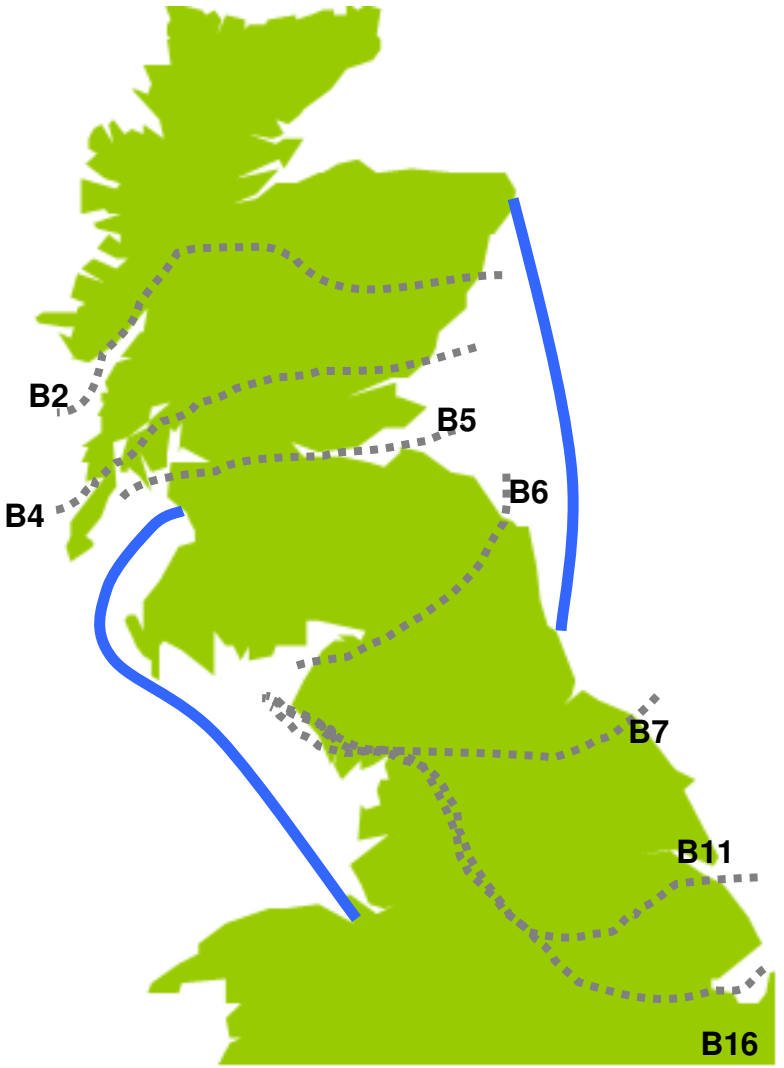
Managing Multiple Boundaries



- Options 2-4 assume flow setting based on single boundary management
- In reality each bootstrap crosses multiple boundaries
- Option 4B – managing multiple boundaries through ratings

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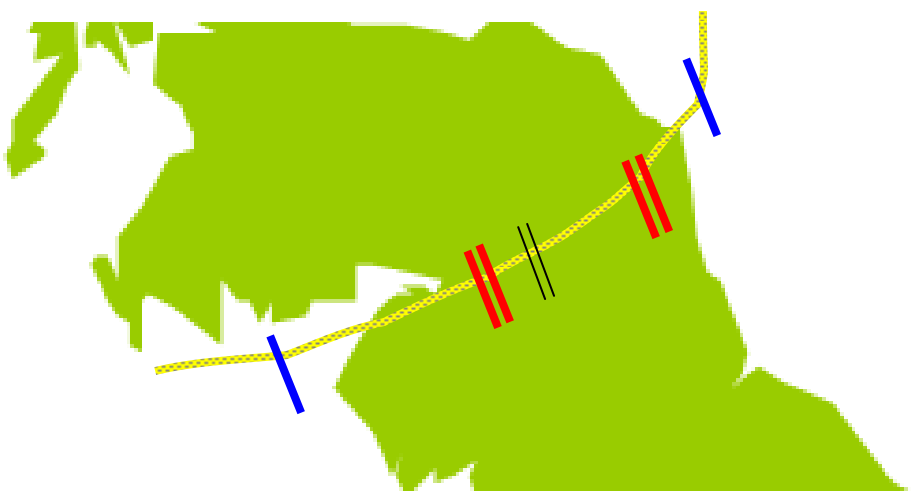
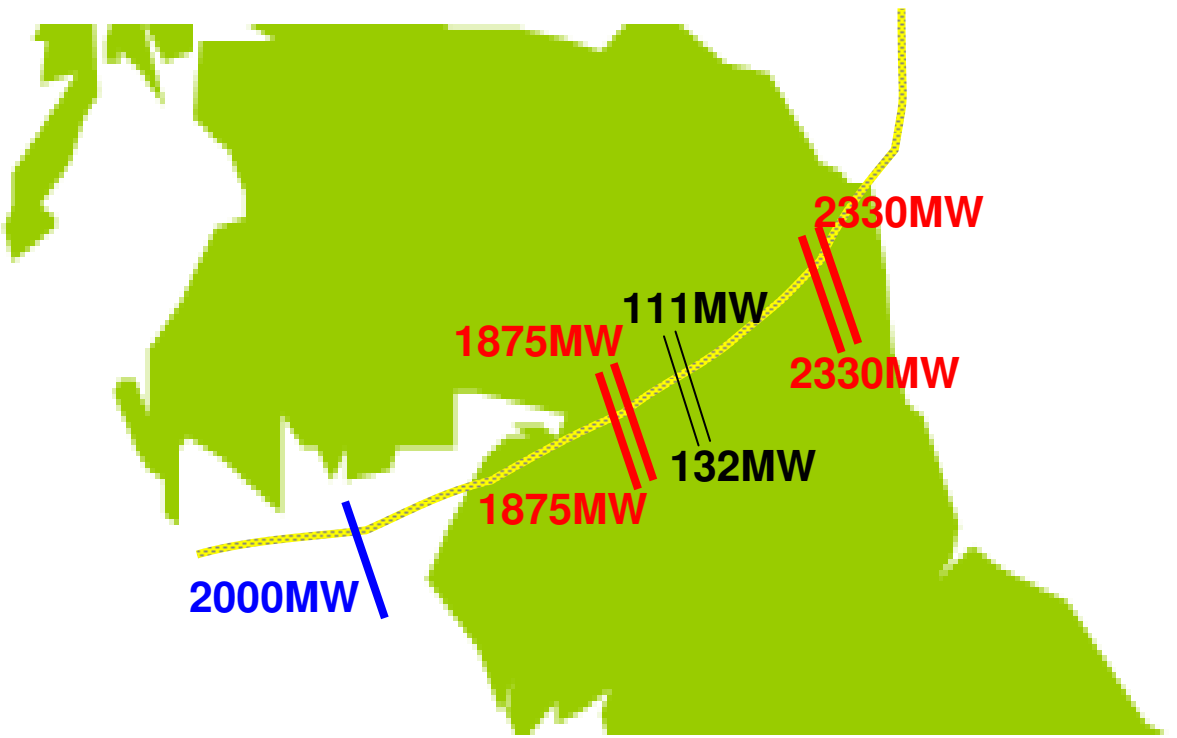
Proposed simplifying assumptions

- Flows based on Transport Model background (Year Round)
- Boundary with fewest onshore circuits used for single boundary approach – most constrained boundary; B6
  - 3 onshore double circuit routes
  - 132kV circuits ignored for options 2&3, i.e. 4 circuits on 2 routes considered, due to relatively small size (capacity approx. 6% of 400kV)



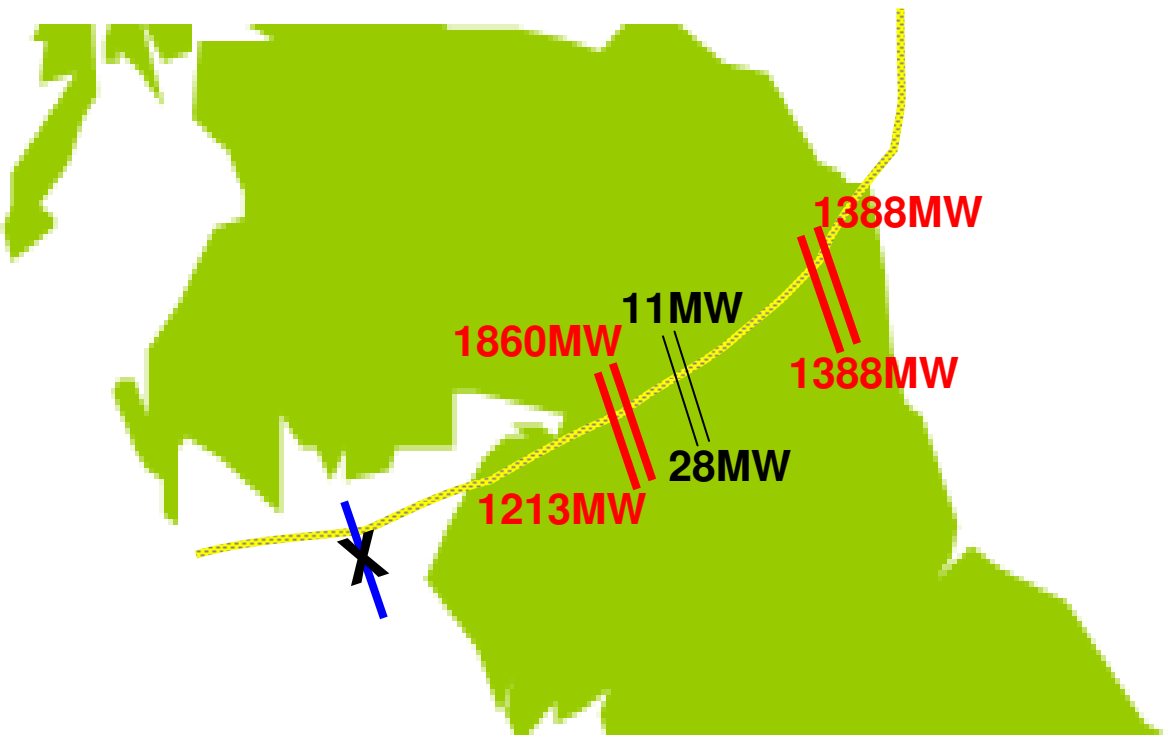
2015 Western HVDC Example

- Step 1 – Ascertain total rating of circuits across boundary in Transport model including HVDC
  - B6 total = 10844MW



2015 Western HVDC Example

- Step 2 – Ascertain flow across boundary in Transport model YR background without HVDC
  - B6 total = 5889MW



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2015 Western HVDC Example

Step 3 – Calculation of desired HVDC flow. For single boundaries*;

2. Transmission Routes $BF_{MW} * HVDC_{cap} / N_R$
3. Transmission Circuits $BF_{MW} * HVDC_{cap} / N_C$
4. Circuit Ratings;
   a. single boundary $BF_{MW} * HVDC_{cap} / BR$

Where;

BF_{MW} = MW boundary flow from Transport model with no HVDC

$HVDC_{cap}$ = MW capacity of HVDC circuit

N_R = No. of routes across boundary

N_C = No. of circuits across boundary

BR = total rating of boundary

*Note: Optimum power flow method not investigated

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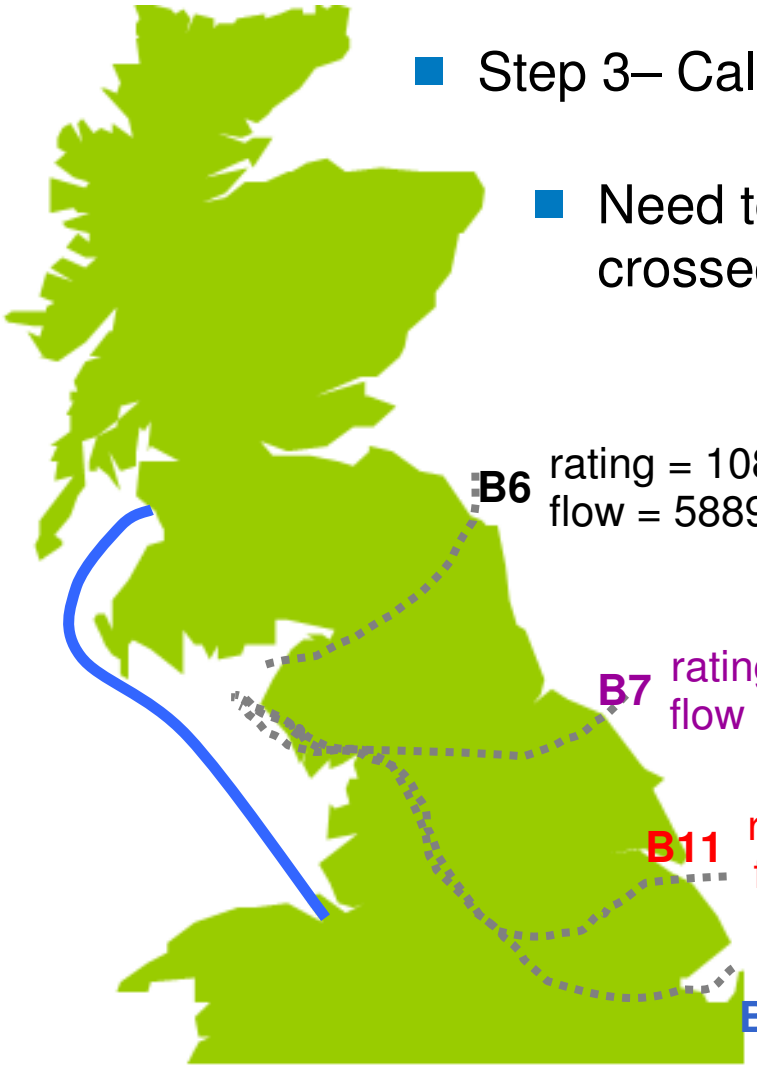
2015 Western HVDC Example



- Step 3– Calculation of HVDC flow. For option 4B;
  - Need to repeat 4A calculation for each boundary crossed
    - In this case;
      - **B6 required HVDC flow = 1086MW**
      - **B7 required HVDC flow = 740MW**
      - **B11 required HVDC flow = 651MW**
      - **B16 required HVDC flow = 753MW**
    - Multiple boundary result is average of four boundaries

4 2015 Western HVDC Example Results

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2. Transmission Routes *Desired flow: 1963MW*

3. Transmission Circuits *Desired flow: 1178MW*

4. Circuit Ratings;
   a. single boundary *Desired flow: 1086MW*
   b. multiple boundaries *Desired flow: 808MW*

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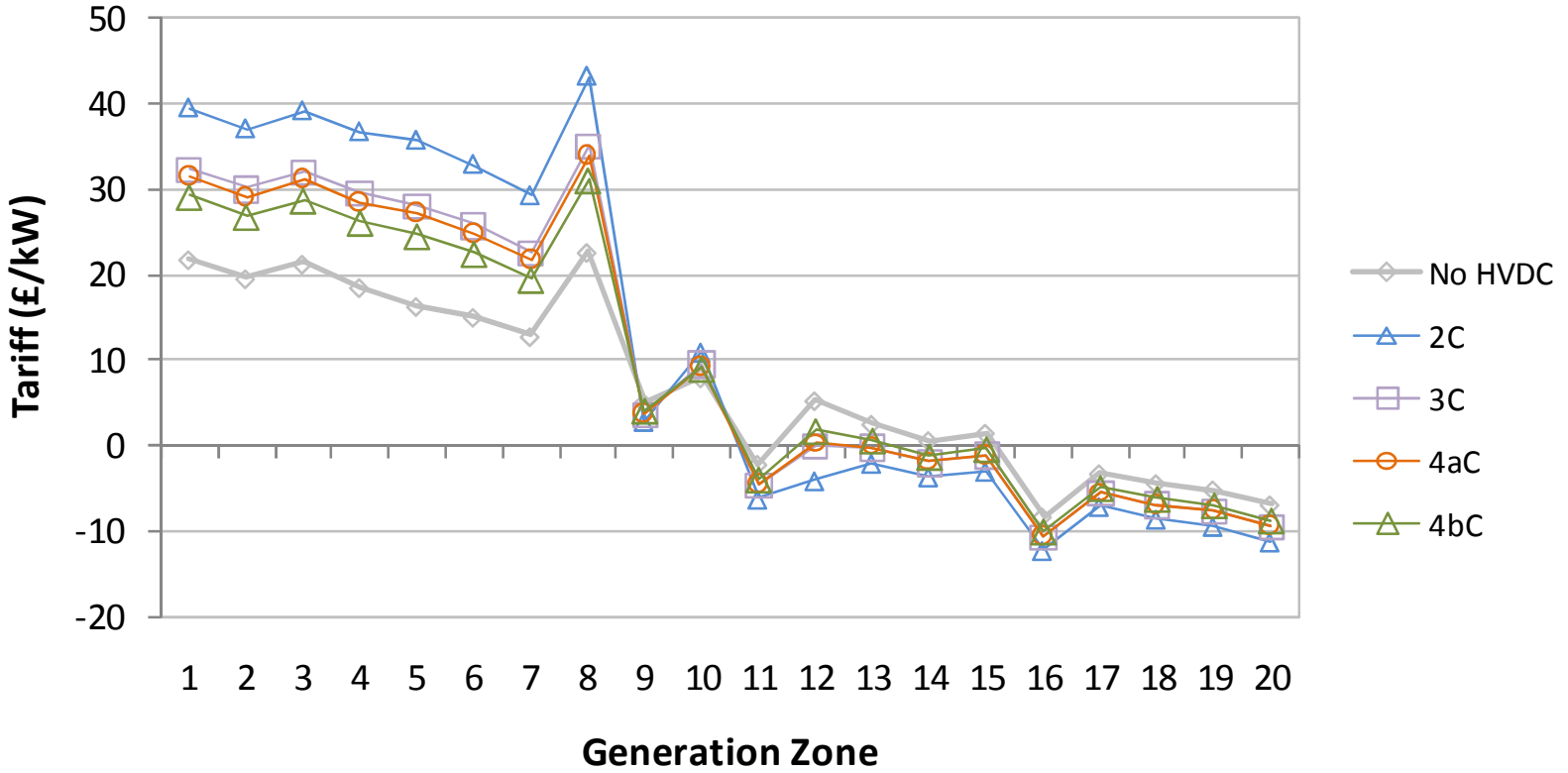
Impact on tariffs

- Desired flows need to be converted into impedances in Transport model
- Matrix developed for this calculation
- Table contains Transport model input assumptions

Calculation Method	Cost Option	EF	400kV OHL km	X	Flow	Total flow cost
2	B	5.6	2064.9	1.92	1963	4053398.7
	C	10.1	3754.4	1.92	1963	7369887.2
3	B	5.6	2064.9	4.86	1178	2432452.2
	C	10.1	3754.4	4.86	1178	4422683.2
4a	B	5.6	2064.9	5.5	1086	2242481.4
	C	10.1	3754.4	5.5	1086	4077278.4
4b	B	5.6	2064.9	8.2	808	1668439.2
	C	10.1	3754.4	8.2	808	3033555.2

Impact on tariffs – generation

- Only full cost EF results shown for clarity



- 2 – Routes; 3 – Circuits; 4a – Ratings (single); 4b – Ratings (multiple)
- 2011/12 Revenue + 2015/16 Transport Model