NETS SQSS Review

Industry Review Group

Wind Criteria Workshop

Scottish and Southern Energy

SP TRANSMISSION

nationalgrid

Agenda

- [Existing SQSS Criteria]
- [GSR001 & SQSS Fundamental Review]
- Dual Criteria
- UK Wind Characteristics
- Demand Security Criterion
- Deterministic vs. Cost Benefit Analysis Criteria
- Development of a Wind Integration Criterion
- Consultation Questions

Development of Wind Integration Criteria

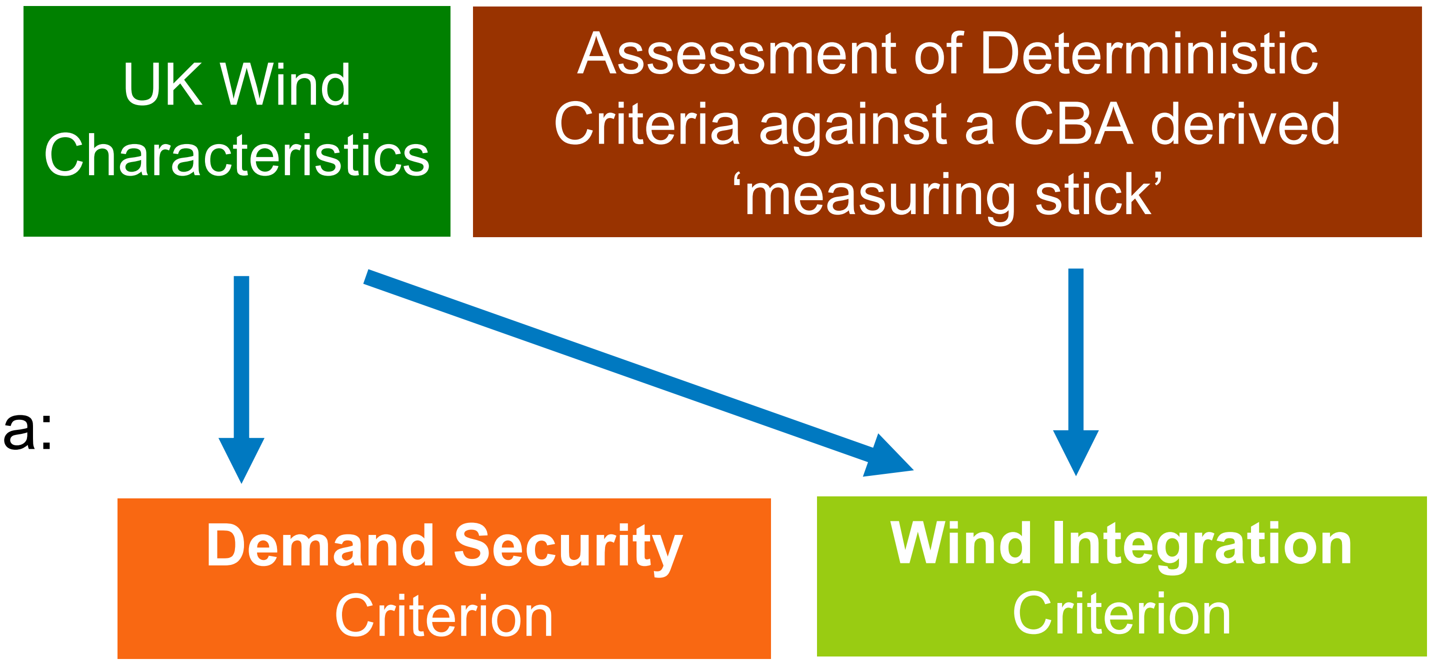
- GSR001 in 2007-2008
- SQSS Fundamental Review 2008-ongoing
- Establishment of dedicated SQSS wind integration working group in March 2010
- Aim to consult on proposals June 2010
- Report to Ofgem mid-July 2010

SQSS Fundamental Review

- Issue fell within the remit of Working Group 3
- Breadth of WG3's scope hindered progress on this specific aspect
- Recognition of increasing volume of wind applying for connection to the system resulted in establishment of this dedicated working group
- Remaining issues within Working Group 3's wider remit will continue to be analysed later in 2010

Recent & Ongoing Assessment

- Two streams of analysis:
- Dual criteria:



Dual Criteria

- SQSS has dual goal of ensuring the transmission system
  - does not unduly restrict generation in securing demand
  - does facilitate market operation

- Previous proposals (i.e. 72%/5%) have sought to simultaneously ensure both in a single criterion – simplified solution to get to CBA answer

  → Confusion

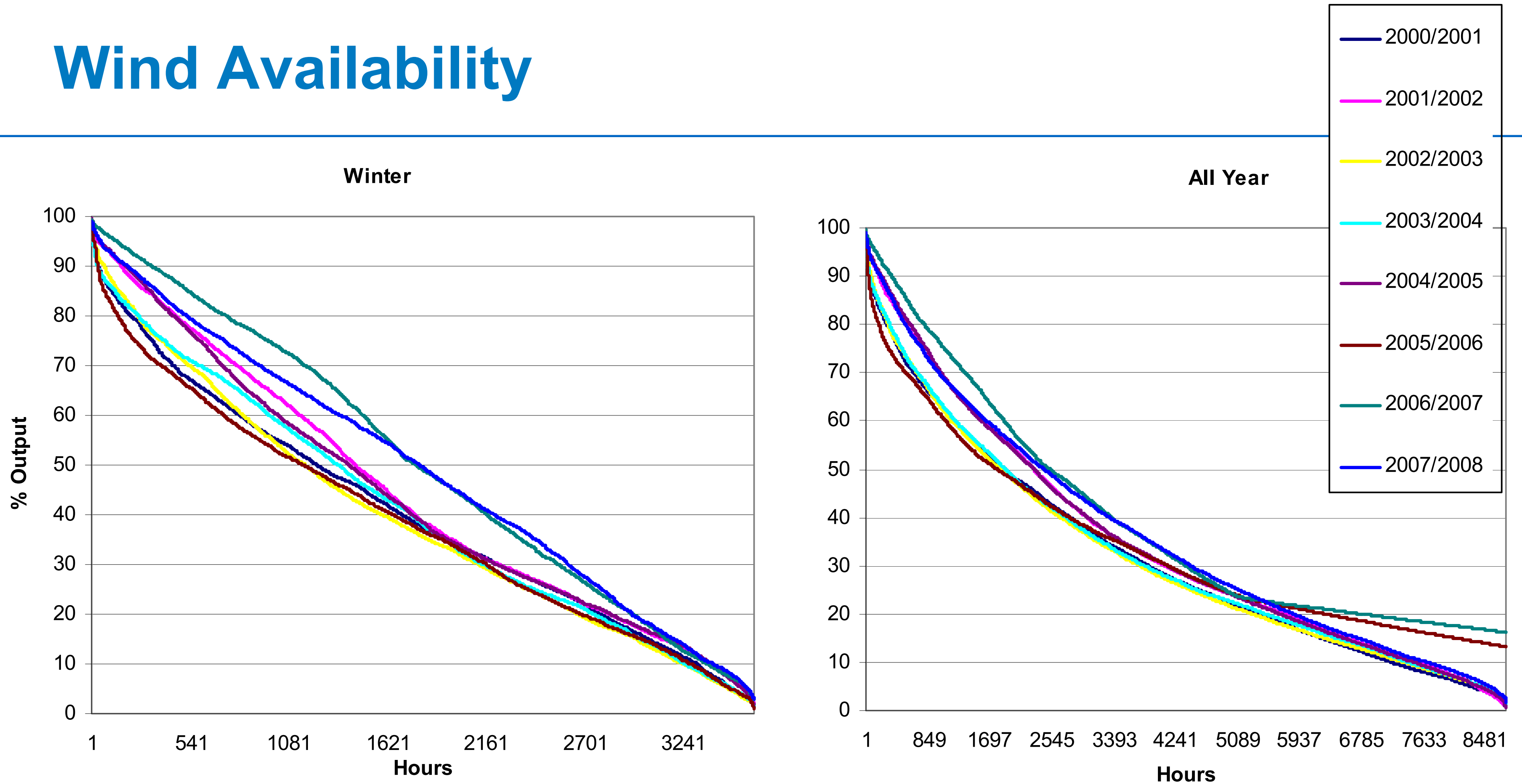
- Now proposing separate 'demand security' criterion

Analysis of UK Wind Characteristics

Analysis of wind data compiled by Poyry:

- Hourly capacity factor data from 36 wind measurement sites throughout Britain and Ireland from 2000 through to 2007.
- Includes on & off-shore locations
- Data adjusted to account for turbine hub height
- Wind farm locations/capacities as per Gone Green 2030 scenario.

Wind Availability



On average, generation is above..	40% of Rated Output	60% of Rated Output
Throughout Winter	50.3% of the time	28.8% of the time
Throughout Entire Year	33.0% of the time	16.4% of the time

Regional Wind Correlation

- Regional differences in wind generation significantly affect the requirement for transmission reinforcement.

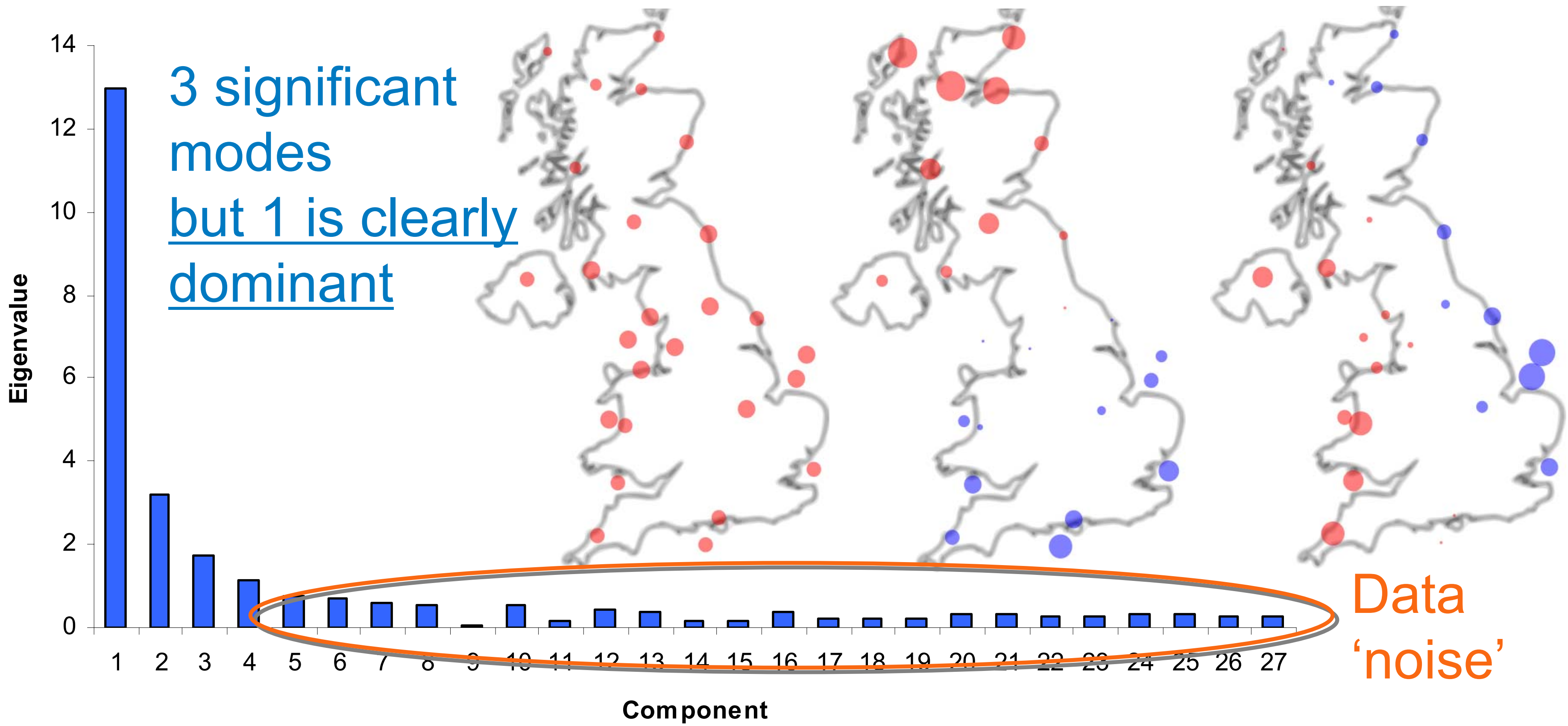
		England										
		0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	**Totals**
Scotland	0-10%	9.20%	6.12%	4.73%	2.78%	1.45%	0.86%	0.56%	0.32%	0.14%	0.09%	26.25%
	10-20%	4.70%	5.12%	3.54%	2.66%	1.80%	1.28%	0.89%	0.67%	0.33%	0.27%	21.25%
	20-30%	1.90%	2.96%	2.62%	2.01%	1.51%	1.22%	0.89%	0.71%	0.45%	0.34%	14.61%
	30-40%	0.93%	1.76%	1.58%	1.46%	1.09%	1.01%	0.87%	0.86%	0.59%	0.48%	10.62%
	40-50%	0.55%	1.05%	0.95%	0.95%	0.97%	0.95%	0.90%	0.72%	0.67%	0.59%	8.30%
	50-60%	0.28%	0.55%	0.65%	0.76%	0.70%	0.77%	0.71%	0.66%	0.64%	0.72%	6.43%
	60-70%	0.10%	0.35%	0.39%	0.54%	0.46%	0.60%	0.59%	0.55%	0.67%	0.82%	5.06%
	70-80%	0.06%	0.17%	0.21%	0.28%	0.28%	0.34%	0.49%	0.48%	0.51%	0.88%	3.71%
	80-90%	0.02%	0.06%	0.09%	0.11%	0.14%	0.21%	0.26%	0.35%	0.46%	1.00%	2.70%
	90-100%	0.00%	0.01%	0.02%	0.06%	0.05%	0.07%	0.09%	0.10%	0.19%	0.50%	1.08%
	Totals	17.73%	18.13%	14.77%	11.61%	8.46%	7.31%	6.25%	5.41%	4.64%	5.69%	

- Significant alignment of wind generation in Scotland with wind generation in England and Wales → little diversity

Regional Wind Correlation

- Another view…

1.Same Everywhere **12.3** | 2. North/South Difference **3.16** | 3. East/West Difference **1.76**



Demand Security Criterion

- Wind generation cannot contribute significantly to demand security:
  - Low & intermittent capacity factor
  - Significant wind correlation throughout Great Britain
- Propose use of separate demand security criterion that assumes a low/zero contribution from intermittent generation (where intermittent generation = wind, wave, tidal)
- Not expected to drive transmission reinforcement on most boundaries

Proposed Demand Security Criterion

- **Set all intermittent generation in GB to 0 / 5% output,** then:
  - If remaining plant margin exceeds 120%, apply the ranking process to set some non-contributory
  - Otherwise, all non-intermittent generation is considered contributory
  - Scale contributory generation to ACS demand*
  - Add ½ Interconnection Allowance (IA) / full IA

Existing Process

* Allow the scaling factor to exceed 100% if generation is insufficient to meet demand. This implicitly assumes new generation build, distributed pro-rata around the country.

Proposed Demand Security Criterion

- In all published NG scenarios from 2005-2030, the proposed criterion requires a much lower boundary capability than a ‘high wind’ criterion for most SYS boundaries
- The criterion is most relevant to the importing boundaries within south-west England (SYS boundaries B10, B12, B13)
- It is recognised that zero wind is a slightly extreme case, but there is little point agonising whether to use ~3% or ~5% etc. Since only ~2GW of wind is expected in SW England, and so the boundary requirement will only be affected by 50-100MW; insignificant given the scale of transmission reinforcements

Wind Integration Criterion

- To provide the appropriate level of transmission to minimise the net cost of transmission reinforcement and market operation, year-round, in a system with significant volumes of intermittent (especially wind) generation.

Cost-Benefit Approach – Features

- We are talking about an Economic Appraisal, which is Probabilistic on the within-year operating conditions only
    - We are not talking Probabilistic on Gen / Dem = Planning Backgrounds
- Traditional Exposition of the Probabilistic Approach is merely a cost-benefit test, viz: ‘One assesses a particular reinforcement proposal against the base-case of current system = Do-Nothing’
    - We do not see a detailed method, that comes up with some sort of ‘required capability’
    - So a cost-benefit may not support any concept of ‘a compliant network’; all one can say is ‘we cannot identify any economic reinforcement’

Cost-Benefit Approach – Merits

- Cost-Benefit PROs:
  - Directly reflects the underlying economics of transmission
  - Is always debated, in detailed assessments of major new transmission
- Cost-Benefit CONs:
  - Depends on a host of input data values
  - Eg: Conventional gen availability; Wind availability; Merit order, year-round; Seasonal transmission capabilities; Transmission Outage rate; Bid and Offer prices; Availability and Price of inter-trips and other post-fault measures
  - As a result, typically non-transparent
  - Likely to be inconsistent over time
  - Analysis takes longer and is more labour intensive
  - Difficult for Scottish TOs to apply, who do not access GBSO data
  - Extremely difficult for us to determine how users will value transmission in the future, we can only note how they valued it in the past

Sensitivity of Cost-Benefit Approach

- GG5c 2020 Required Capabilities:

Boundary	Existing (MW)	Base Case	BDGKM	CN
B6	2200	6910	4860	8020
B7a	3600	9630	6720	10680

B. Transmission price from 100 → 50 £/MW.km

D. Seasonal Capabilities 93% 85% 76% → 90% 80% 70% of Winter Capability

G. 1000MW of Peterhead from Baseload_Gas → Marginal_Gas

K. Reduce availability of Nuclear and CCGT by 5% (ie 90% / 85% → 85% / 80%)

M. South-North → North-South despatch within fuel-type

C. Bid-Offer differential +40%

N. Hydro undercuts France; and 1000MW of Longannet from Marginal_Coal to Baseload_Coal

Deterministic Approach – Merits

- Deterministic PROs:
  - Simply explained & can be applied transparently
  - Depends on a smaller number and variety of input data values
  - Will be consistent across years
  - Can be pragmatically applied by TOs
- Deterministic CONs:
  - Calibrated against a particular set of backgrounds
  - May not reflect the underlying economics
  - Some parameters are apparently arbitrary

Cost-Benefit vs Deterministic Conclusions

- Both approaches have significant strengths and weaknesses
- Therefore, the working group is minded to propose a hybrid solution that seeks to obtain the benefits whilst managing the weaknesses of each approach:
  - A deterministic wind integration criterion that transparently and defendably establishes a minimum boundary transfer capability.
  - Increased utilisation of detailed cost-benefit analysis to justify additional reinforcement of boundaries where specific circumstances support this

Proposed Wind Integration Deterministic Criterion

- A deterministic criterion to specify a conservative minimum boundary transfer capability, calibrated against a cost-benefit derived 'measuring stick'
- Establishes a baseline which the industry can plan against and which will support the need-case for most transmission reinforcement as it progresses through the public consenting process.
- Calibration factors may need to be re-calibrated periodically to take account of changing circumstances and evolving future forecasts

Consultation Approaches

1. Specific Reinforcement cost-benefit analysis
   - Assess specific reinforcement cost vs constraint savings, across many years
2. Indicative Transmission-Price cost-benefit analysis
   - Chart indicative boundary transmission price vs annual constraint price
   - As per 'measuring stick' described below
3. Pseudo cost-benefit analysis
   - Deterministic rule, similar to current practice
   - Rules are periodically benchmarked vs Indicative CBA

The Quest for a Deterministic Wind Integration Criterion

- The following slides describe the process used to identify the most appropriate deterministic rule. In general:
    1. Identify various deterministic rules and quantify the boundary capability they require for different boundaries
    2. Measure the operational and infrastructure costs associated with different transfer capabilities using CBA
    3. For each boundary, plot the required capabilities identified in step 1 with the costs determined in step 2
    4. Assess the various deterministic rules by their alignment of their results with the minimum-cost transfer capability
- Perform this exercise for 6 boundaries × 2 scenarios × 2 years

1. Deterministic Rules

Fixed A_T	Variable A_T		
Single A_T	Exp. $A_T \neq$ Imp. A_T	Exp. $A_T =$ Imp. A_T	
40% Contrib.	40% Contrib.		'Radical'
1a	1b	1d	1c & 1e

- Method 1a: traditional SQSS '60% / 60%'
  - Determine contributory / non-contributory as usual (Wind treated at 40%)
  - A_T for Wind = 0.72 on both export and import side
  - Scale generation to meet ACS demand
  - Add ½IA as usual
- Method 1b: lower Wind in import '60% / 5%'
  - As 1a, but set A_T = 0.05 / 0.15 / 0.25 / 0.35 (1b1 / 1b2 / 1b3 / 1b4) for Wind on import side

1. Deterministic Rules

- Method 1c1-1c4: non-ranking order:
  - For all, first set AGTs and OCGTs to non-contributory
  - 1c1. Apply At = 0.72 for Intermittent; Scale all remaining capacity to peak demand.
  - 1c2. Apply At = 0.72 to Intermittent; Fix Nuclear to 83% output; Scale all remaining capacity to peak demand.
  - 1c3. Fix Nuclear to 83% and Intermittent to 60%; Scale remaining non-intermittent capacity to peak demand.
  - 1c4. Fix Nuclear & CCS to 85%, Intermittent to 70%. Scale remaining generation to meet demand.
- Method 1e: as 1c4; ramped / fixed Boundary Allowance

	1a	1b1	1b2	1b3	1b4	1c1	1c2	1c3	1c4	1d	1e
Determine 'Non-Contributory' (Excluded) Plant by excluding generation that exceeds 120% of peak demand, when dispatched in order of their rank at the capacity shown below:											
Intermittent Generation	40%	40%	40%	40%	40%	N/A	N/A	N/A	N/A	40%	N/A
Other Generation	100%	100%	100%	100%	100%					100%	
Dispatch Remaining (Non-Excluded) Generation by setting its output to the values shown below (as % of their registered capacity), and then uniformly scaling all of the generation marked with a * so that the total level of generation matches peak demand. Underlined generation should not be scaled during this step.											
Intermittent on importing side of boundary	72%*	5%*	15%*	25%*	35%*	72%*	72%*	**60%**	**70%**	*B1&15:* 90%* *B4&6:* 80%* *B7a:* 70%* *B8&9:* 60%*	**70%**
Intermittent on exporting side of boundary		72%*	72%*	72%*	72%*						
Nuclear & CCS	100%*	100%*	100%*	100%*	100%*	100%*	**83%**	**83%**	**85%**	100%*	**85%**
Interconnectors	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Hydro & Pumped	100%*	100%*	100%*	100%*	100%*	100%*	**50%**	**50%**	100%*	100%*	100%*
Peaking (MGT & Oil)	100%*	100%*	100%*	100%*	100%*	**0%**	**0%**	**0%**	**0%**	100%*	**0%**
Other Types	100%*	100%*	100%*	100%*	100%*	100%*	100%*	100%*	100%*	100%*	100%*
Add a boundary allowance to the observed flow across each boundary											
Boundary Allowance Calculation	Existing SQSS process, which uses 'the circle diagram' to determine an interconnection allowance for each boundary which is a function of the volume of generation and demand behind the boundary.										Allowance that ramps up to 1GW

1. Deterministic Rules: Results

- For GG5a GG5c in 2015, only 11.3GW of Wind;
  - 4.8GW of plant is non-contributory
  - Hence scaling factor under 1a ends at 79%
  - Scaling factor under 1b1 ends at 82% for B6 and 81% for B9
  - Scaling factor under 1c3 is 75%
- For GG5a and GG5c in 2020, 29.4GW of Wind:
  - 7.8GW of plant is non-contributory
  - Hence scaling factor under 1a ends at 73%
  - Scaling factor under 1b1 ends at 86-90% for B6 and 79% for B9
  - Scaling factor under 1c3 is 61%

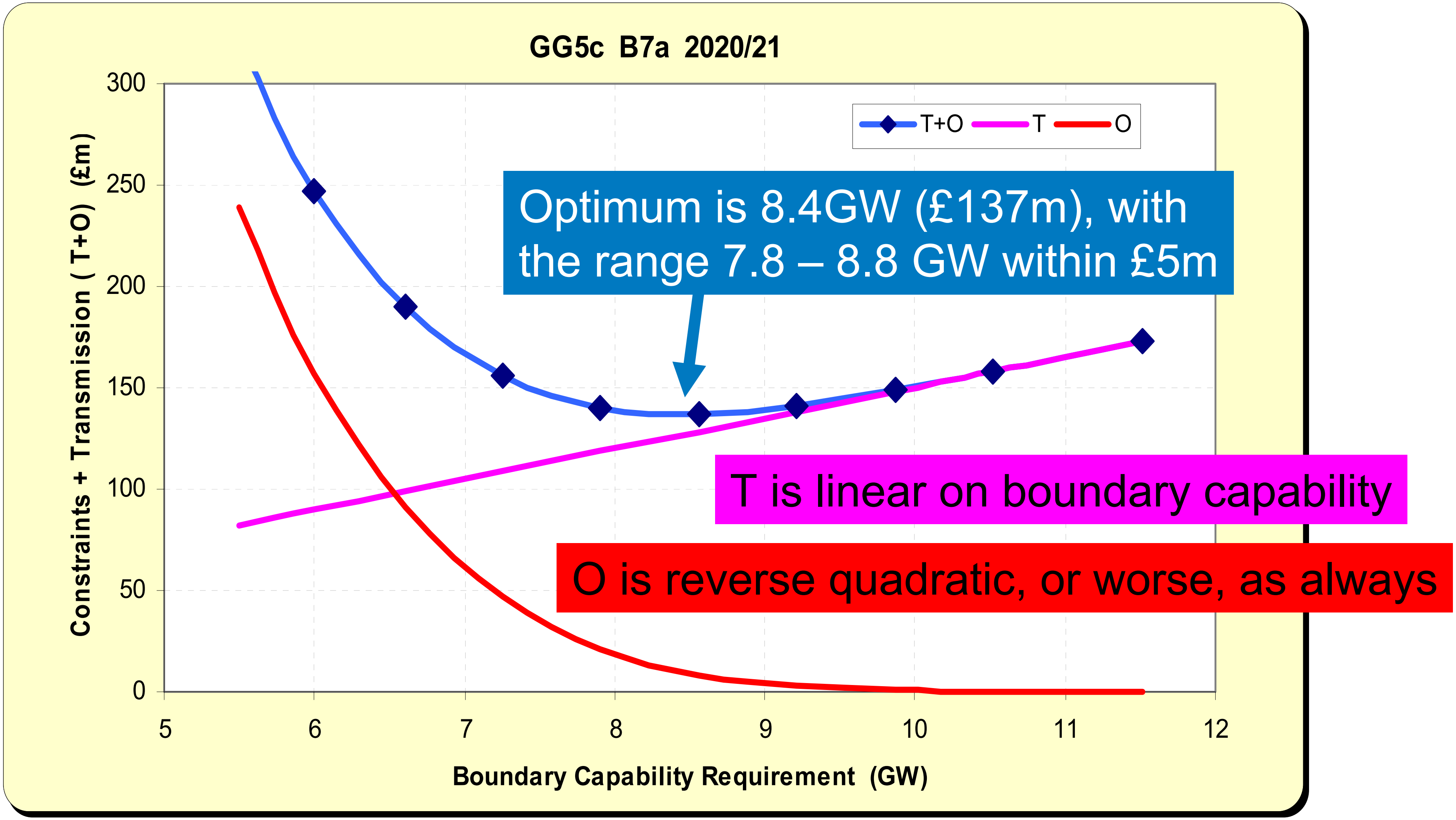
2. Economic Measuring Stick

- Backgrounds:
  - GG5a & GG5c (differ by 5GW Wind from Scotland to England)
  - Years 2015, 2020, 2030
- Transmission Price (T):
  - A ‘moderate’ 100 £/MW.km, × boundary thickness (often 100km)
- Boundary Capabilities (O):
  - Seven arbitrary winter capabilities studied, spanning from -0.25 to +1.25 of range of capabilities requires under 1a 1b1 1b2 1b3 1b4 1c1 1c2 1c3 1d

2. Economic Measuring Stick

- Cost-Benefit parameters, as of the Dec08 ENSG study:
  - 3 seasons: winter (20 week) summer_intact (20 week) summer_outage (8 week)
  - Summer_intact capab = 0.85 × winter (4-6 cct boundary) = 0.9 × winter (>7 cct)
  - Summer_outage capab = 0.7 × winter (4-6 cct boundary) = 0.8 × winter (>7 cct)
  - Generator and Wind availabilities as Dec08
  - Merit Order as Dec08 viz, Base_Gas; Base_Coal; Hydro; Marg_Gas; Marg-Coal
  - Bid Price = 0.5 × Fuel Price; Offer Price = 2.0 × Fuel Price

3. Assessment of Results — Illustration



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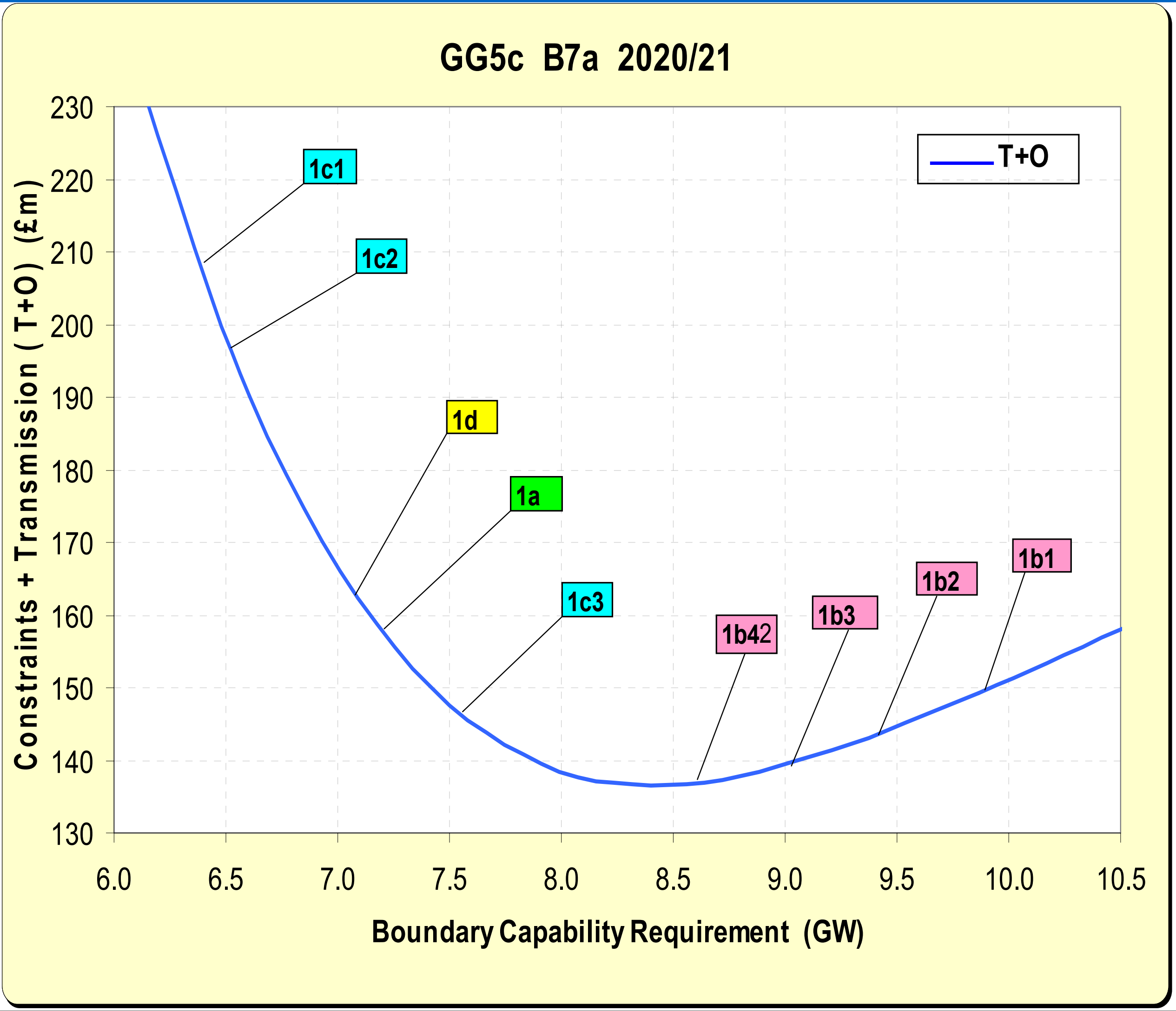


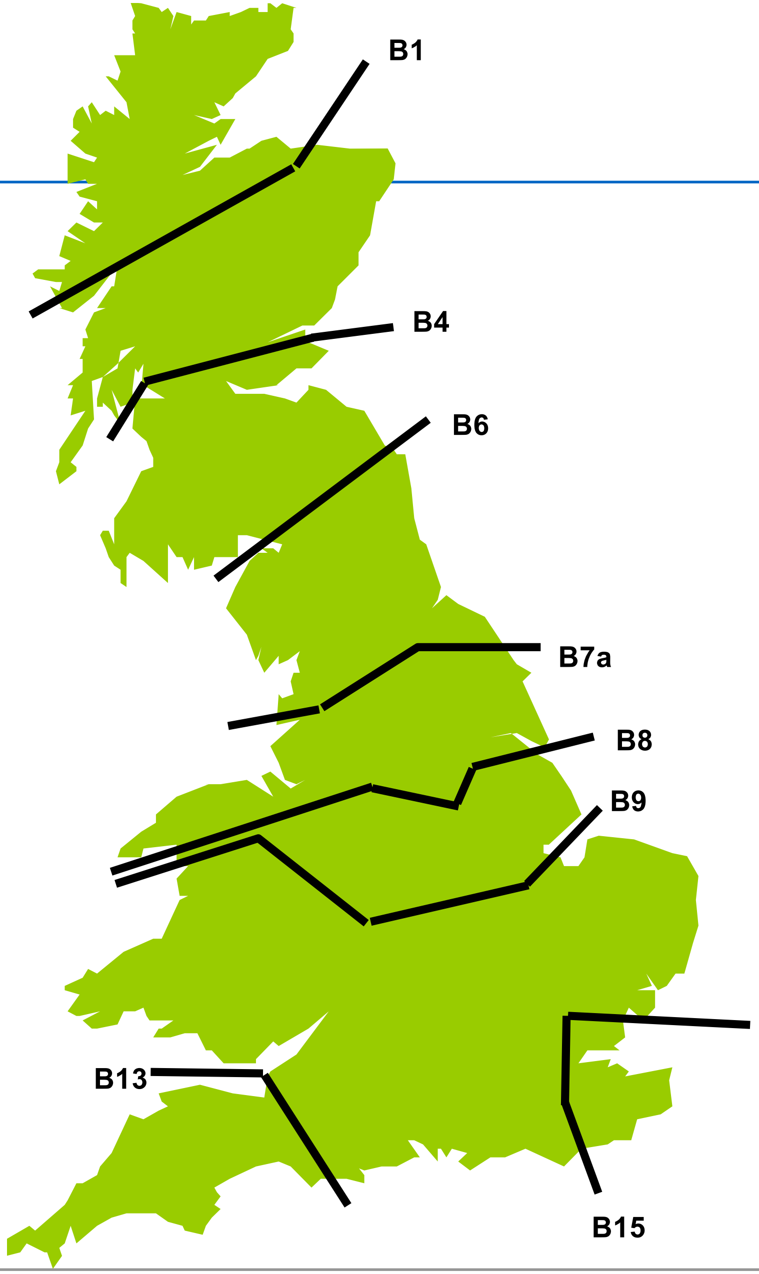
- In general, we always have:

1a < 1b4 < 1b3 < 1b2 < 1b1

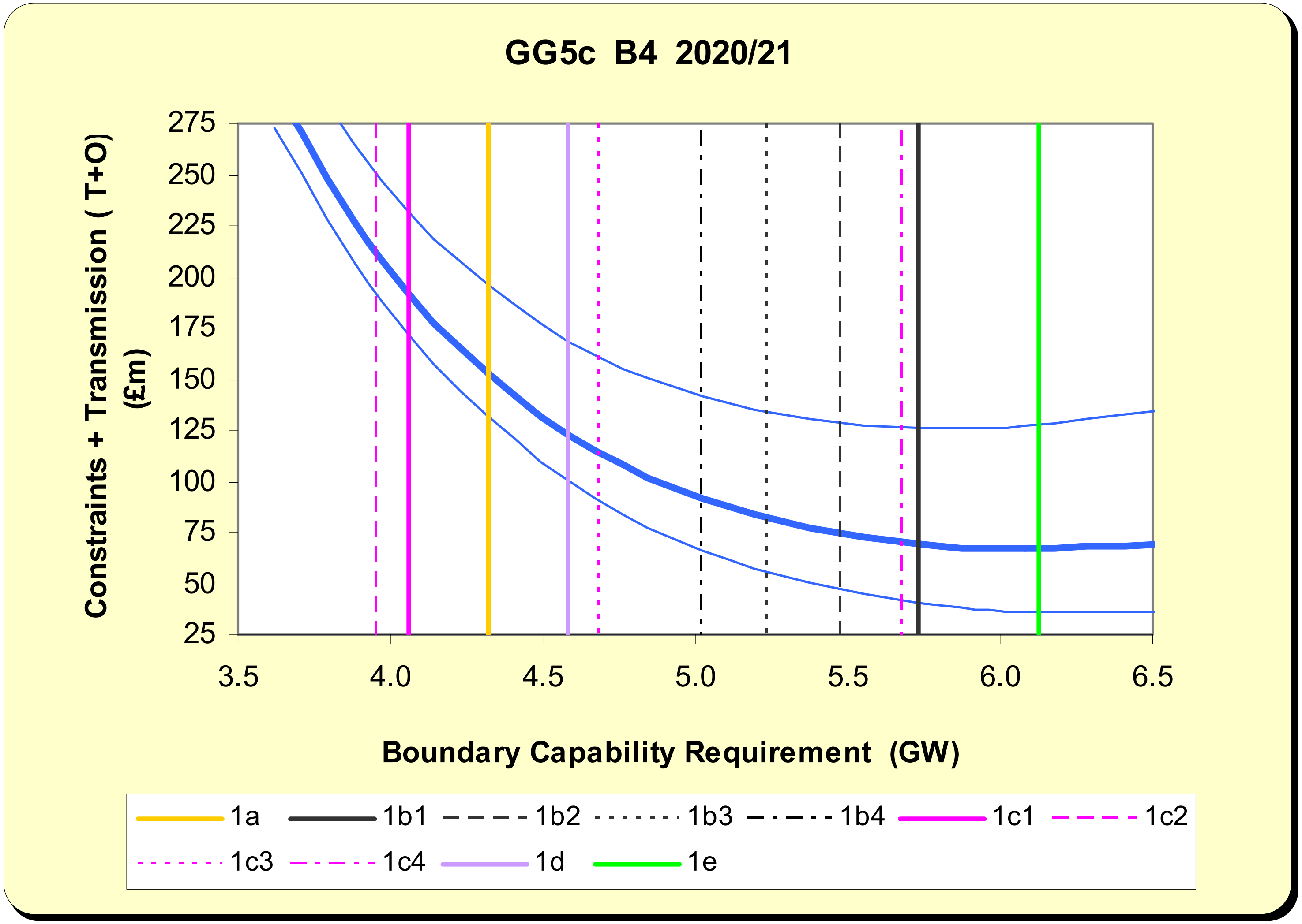
- 1c1-1c3 and 1d are usually close to 1a
- Here, 1a is 1.1GW and £16m *below* the optimum: 1b4 - 1b1 are 0.2 - 1.5GW and £0.5m - £14m *above* the optimum: 1c1 – 1c3 are 0.8 - 2.0GW and £10m - £76m *above* the optimum

Boundary	Thicknesss (km)	Background		Ranking Order Approach 1a	1b1	1b2	1b3	1b4	1d	Non-Ranking Order Approach 1c1	1c2	1c3	1c4	1e	*Optimum* GW T+O	*Range*
B4	100	GG5a	GW	2.8	4.0	3.8	3.6	3.4	2.9	2.6	2.5	2.9	3.6	4.1	*4.1*	*3.6 - 4.8*
			T+O	£96m	£44m	£46m	£49.5m	£55m	£84m	£120m	£132m	£84m	£50m	£44m	*£44m*	*< £49m*
			Δ GW from Optimum	-1.3	-0.1	-0.3	-0.5	-0.7	-1.2	-1.5	-1.6	-1.2	-0.5	0.0		
			Δ T+O from Optimum	£52m	£0m	£2m	£6m	£11m	£40m	£76m	£88m	£40m	£6m	£0m		
		GG5c	GW	4.3	5.7	5.5	5.2	5.0	4.6	4.1	4.0	4.7	5.7	6.1	*6.0*	*5.6 - 7.2*
			T+O	£152.5m	£69m	£74m	£82m	£91m	£125m	£194m	£212m	£114m	£74m	£73m	*£67m*	*< £72m*
			Δ GW from Optimum	-1.7	-0.3	-0.5	-0.8	-1.0	-1.4	-1.9	-2.0	-1.3	-1.3	0.1		
			Δ T+O from Optimum	£86m	£2m	£7m	£15m	£24m	£58m	£127m	£145m	£47m	£7m	£6m		
B6	150	GG5a	GW	3.2	5.4	5.0	4.6	4.3	3.4	2.9	2.9	3.4	4.3	4.5	*4.6*	*3.9 - 5.2*
			T+O	£117m	£81m	£76.5m	£75m	£76m	£111m	£170m	£163m	£108m	£75m	£75m	*£74.5m*	*< £79.5m*
			Δ GW from Optimum	-1.4	0.8	0.4	0.0	-0.3	-1.2	-1.7	-1.7	-1.2	-0.3	-0.1		
			Δ T+O from Optimum	£43m	£7m	£2m	£1m	£2m	£36m	£96m	£89m	£34m	£0m	£0m		
		GG5c	GW	5.8	7.9	7.6	7.2	6.9	6.2	5.3	5.3	6.4	7.8	7.9	*8.0*	*7.3 - 8.8*
			T+O	£218m	£129m	£130.5m	£135.5m	£144.5m	£187.0m	£293m	£294m	£172m	£136m	£136m	*£129m*	*< £134m*
			Δ GW from Optimum	-2.2	-0.1	-0.4	-0.8	-1.1	-1.8	-2.7	-2.7	-1.6	-0.2	-0.1		
			Δ T+O from Optimum	£89m	£0m	£2m	£7m	£16m	£58m	£164m	£165m	£43m	£7m	£7m		
B7a	150	GG5a	GW	4.7	7.7	7.1	6.7	6.2	4.6	4.0	4.1	4.7	8.3	4.9	*5.1*	*4.6 - 5.8*
			T+O	£87.5m	£115m	£107m	£100m	£94m	£91m	£117m	£109m	£91m	£89m	£89m	*£85m*	*< £90m*
			Δ GW from Optimum	-0.4	2.6	2.0	1.6	1.1	-0.5	-1.1	-1.0	-0.4	3.2	-0.2		
			Δ T+O from Optimum	£3m	£30m	£22m	£15m	£9m	£6m	£32m	£24m	£6m	£4m	£4m		
		GG5c	GW	7.3	9.9	9.4	9.0	8.6	7.2	6.4	6.5	7.6	4.9	8.3	*8.4*	*7.8 - 9.2*
			T+O	£156m	£148.5m	£143.5m	£139m	£137m	£160m	£212m	£201m	£147m	£138m	£138m	*£136.5m*	*< £141.5m*
			Δ GW from Optimum	-1.1	1.5	1.0	0.6	0.2	-1.2	-2.0	-1.9	-0.8	-3.5	-0.1		
			Δ T+O from Optimum	£20m	£12m	£7m	£3m	£1m	£24m	£76m	£65m	£10m	£2m	£1m		
B8	93	GG5a	GW	8.7	12.1	11.5	11.0	10.5	8.4	8.3	8.2	8.7	8.6	8.4	*7.3*	*6.8 - 8.5*
			T+O	£82m	£112.5m	£107.5m	£102.5m	£97.5m	£80.9m	£80m	£79m	£83m	£83m	£81m	*£76m*	*< £81m*
			Δ GW from Optimum	1.4	4.8	4.2	3.7	3.2	1.1	1.0	0.9	1.4	1.3	1.1		
			Δ T+O from Optimum	£6m	£37m	£32m	£27m	£22m	£5m	£4m	£3m	£7m	£7m	£5m		
		GG5c	GW	9.4	12.5	12.0	11.5	11.1	9.1	9.0	8.9	9.5	9.5	9.4	*7.7*	*7.4 - 9.7*
			T+O	£89m	£117m	£112m	£107m	£103m	£88m	£88m	£87m	£91m	£90m	£90m	*£86m*	*< £91m*
			Δ GW from Optimum	0.7	4.8	4.3	3.8	3.4	1.4	1.3	1.2	1.8	1.8	1.7		
			Δ T+O from Optimum	£3m	£31m	£26m	£21m	£17m	£2m	£2m	£1m	£5m	£4m	£4m		
B9	155	GG5a / GG5	GW	9.3	12.6	12.1	11.6	11.1	9.2	8.4	8.1	8.3	7.4	7.4	*7.3*	*6.7 - 8.3*
			T+O	£146m	£195m	£187m	£179m	£172m	£144m	£135m	£131m	£133m	£128m	£128m	*£127m*	*< £132m*
			Δ GW from Optimum	2.0	5.3	4.8	4.3	3.8	1.9	1.1	0.8	1.0	0.1	0.1		
			Δ T+O from Optimum	£19m	£68m	£60m	£52m	£45m	£17m	£8m	£4m	£6m	£1m	£1m		
B15	60	GG5a / GG5	GW	6.7	9.0	8.6	8.2	7.8	6.5	6.2	6.4	6.2	7.1	7.4	*8.4*	*7.7 - 9.5*
			T+O	£113m	£55m	£53m	£53m	£56m	£150m	£188m	£165m	£198m	£80m	£60m	*£53m*	*< £58m*
			Δ GW from Optimum	-1.7	0.6	0.2	-0.2	-0.6	-1.9	-2.2	-2.0	-2.2	-1.3	-1.0		
			Δ T+O from Optimum	£60m	£2m	£0m	£0m	£3m	£97m	£135m	£112m	£145m	£27m	£7m		
Total ΔT+O from Optimum		GG5a		£183m	£144m	£118m	£101m	£100m	£201m	£351m	£320m	£238m	£45m	£17m		
		GG5c		£277m	£115m	£102m	£98m	£106m	£256m	£512m	£492m	£256m	£48m	£26m		
Total T+O		GG5a		£642m	£603m	£577m	£559m	£551m	£661m	£810m	£779m	£697m	£505m	£477m	£460m	
		GG5c		£875m	£714m	£700m	£696m	£704m	£854m	£1110m	£1096m	£855m	£646m	£625m	£599m	

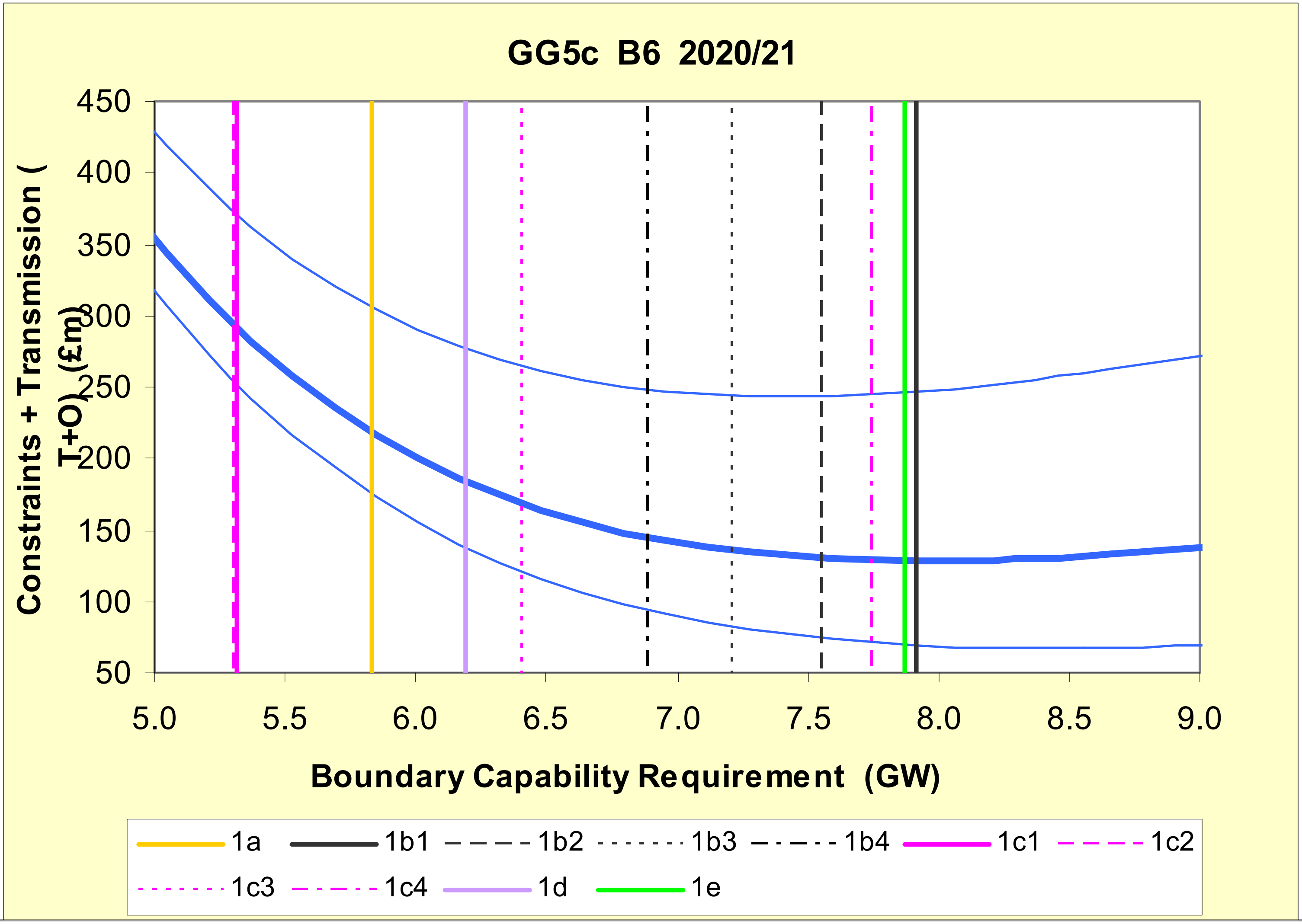
System Boundaries



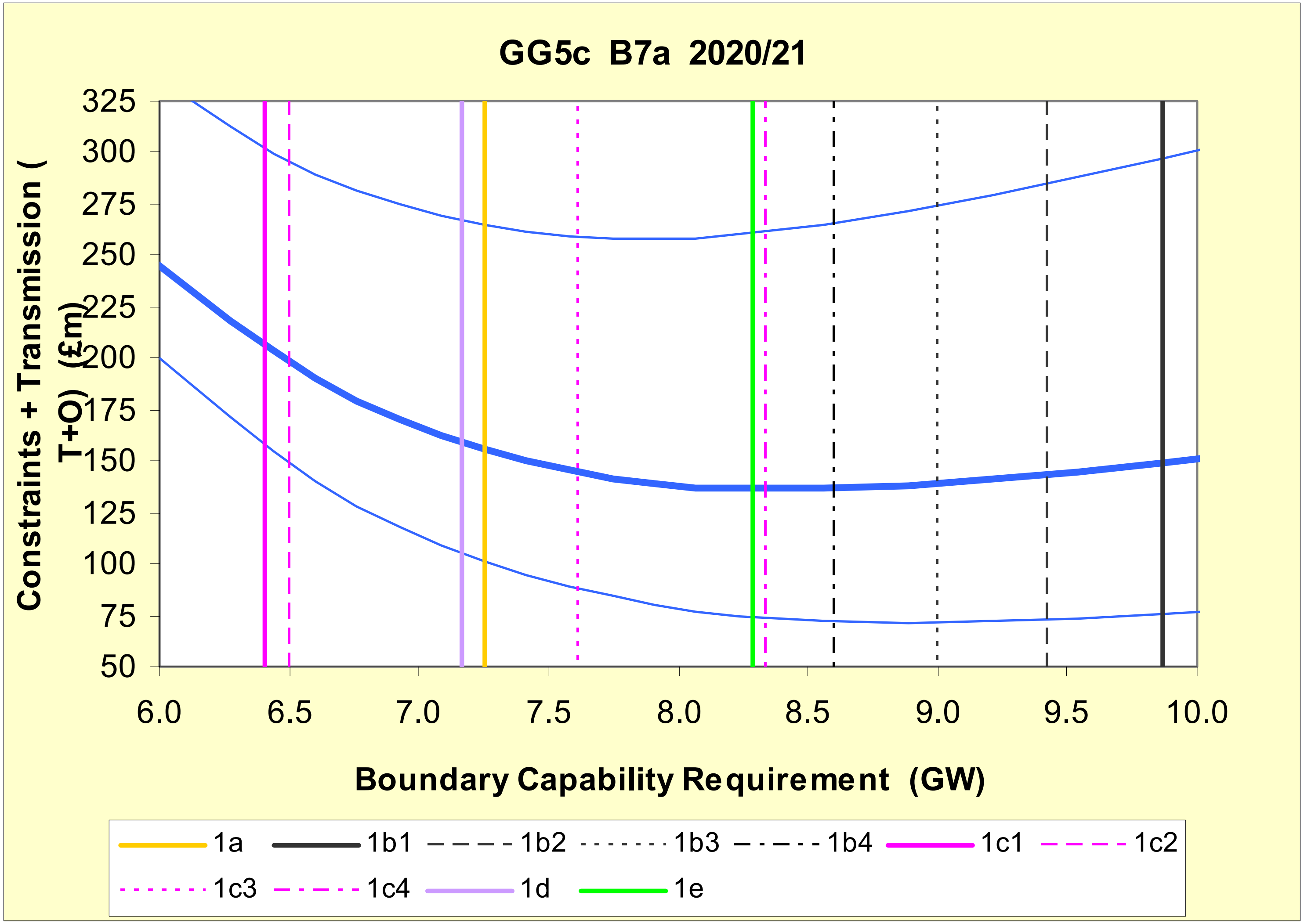
3. Assessment of Results — B4



3. Assessment of Results — B6



3. Assessment of Results — B7a



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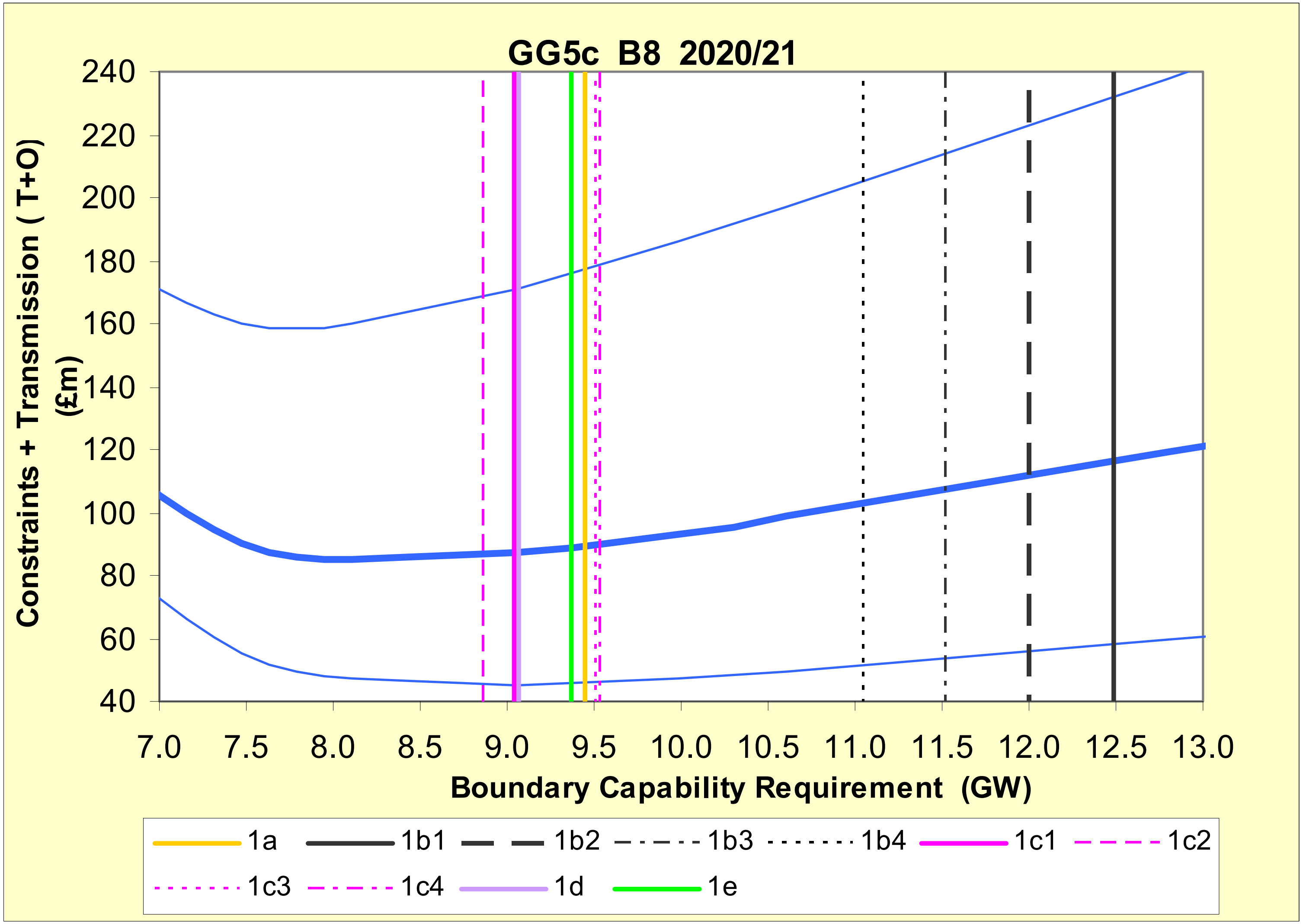
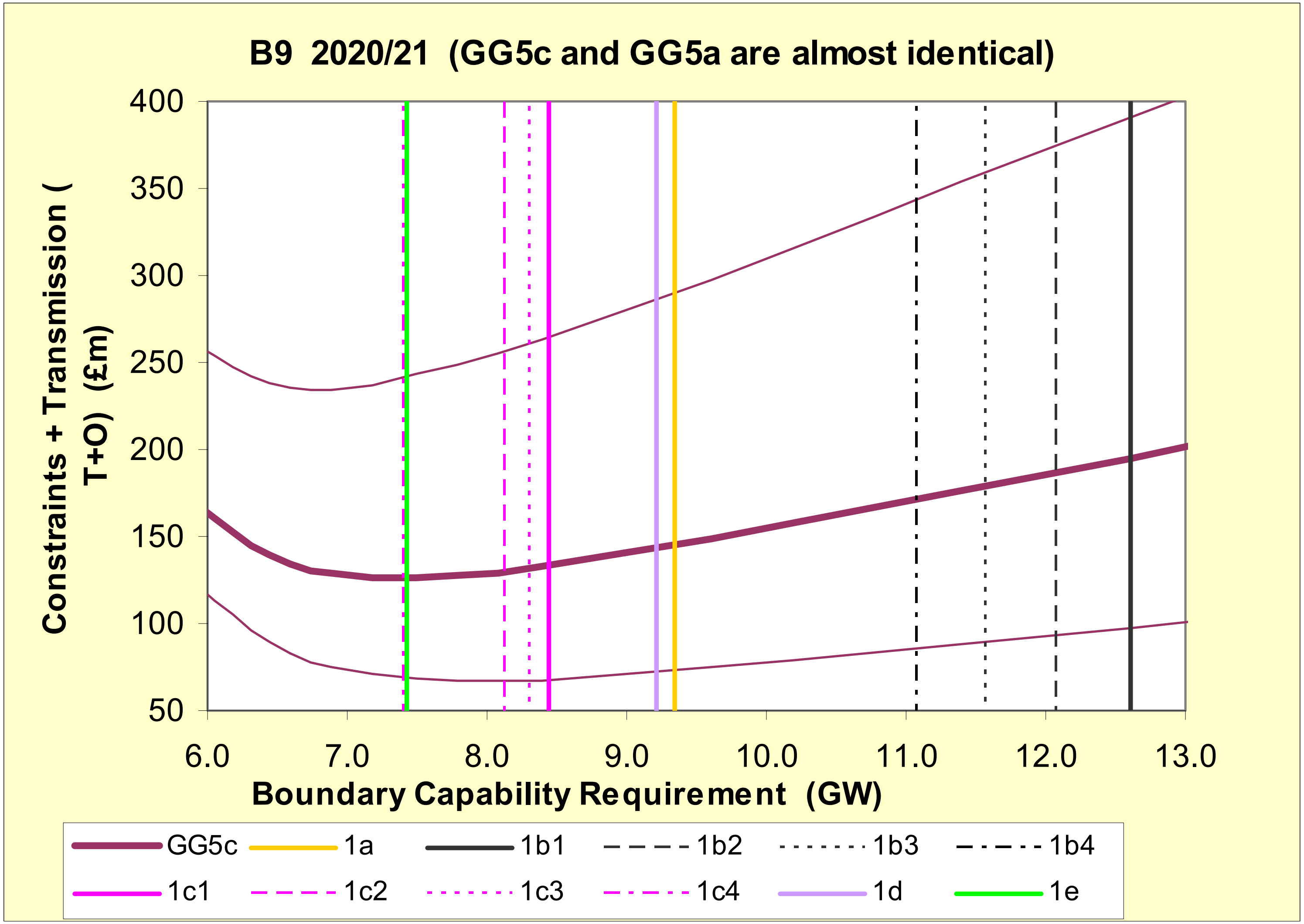
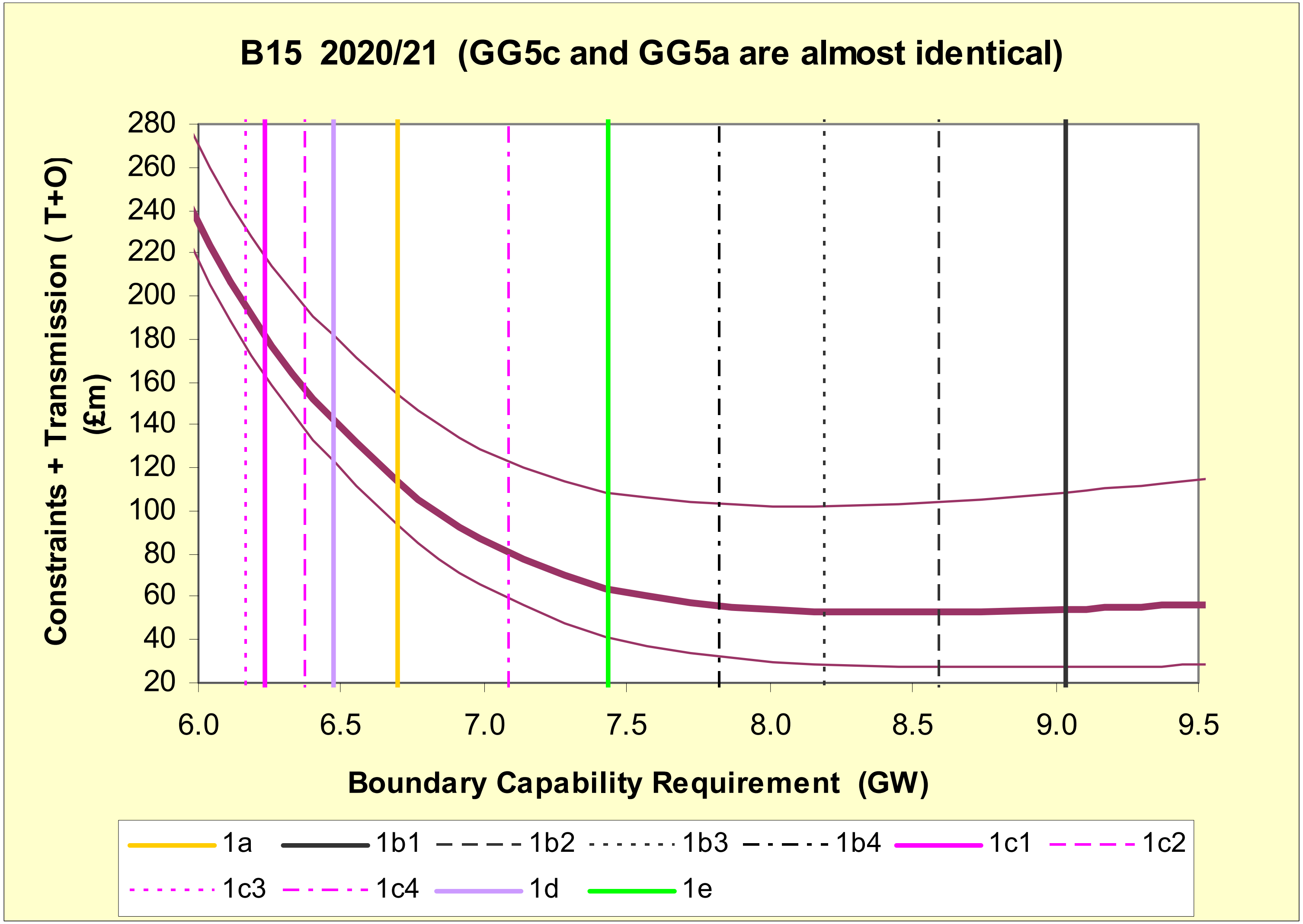
3. Assessment of Results — B8



3. Assessment of Results — B9



3. Assessment of Results — B15



4. Assessment of Results

Broadly:

- For ‘small’ export boundaries B4 B6 B15, any of 1b1-1b4 look best
- For the large boundaries B7a B8 B9, 1a, 1c1-1c4 look best
- 1e ‘fits’ significantly best of all approaches
  - Never >£10m above central optimum
  - Always within uncertainty range

Uncertainty Range – B6 Example

A high case is set by entering:

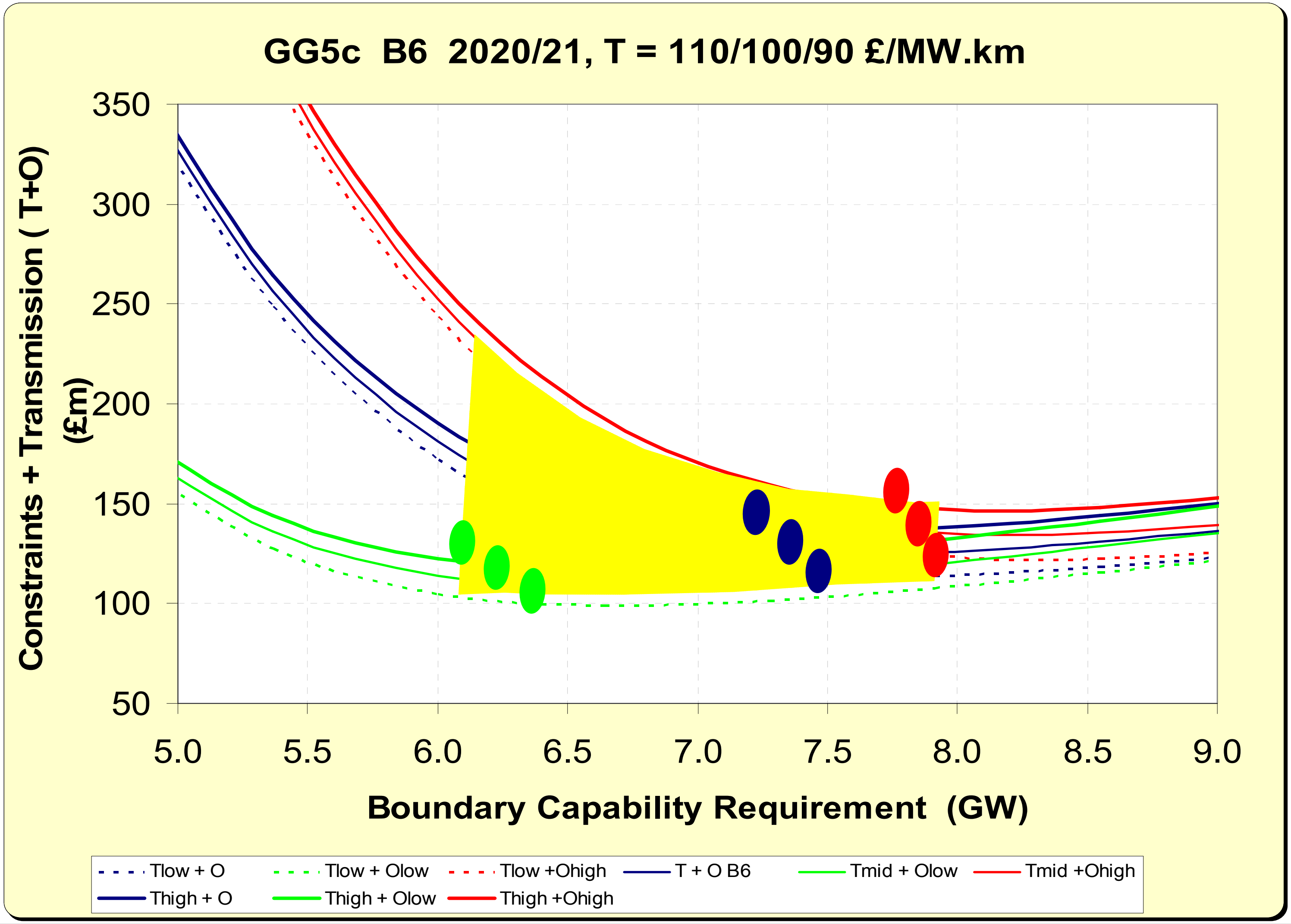
- Peterhead entered at a merit position to achieve 70% rather than 60% load factor;
- Scottish Wind modelled at 37% rather than 35% load factor;
- Offer prices average 120 not 100 £/MWh.

Likewise, a low case is set by entering:

- Peterhead entered at a merit position to achieve 40% rather than 60% load factor;
- Scottish Wind modelled at 32% rather than 35% load factor;
- Offer prices average 80 not 100 £/MWh.

These values represent the maximum and minimum values observed over the last eight years (annual averages). –ie historical range only.

Uncertainty Range



Features of the 'Measuring Stick' Optimum

In a typical case, for a marginal MW, optimum is when:

- Price of Transmission = 100km (typical thickness) × 100 £/MW.km (typical transmission price) = £10,000 /MW pa
- Price of Constraints = 170hours (incidence) × 60 £/MWh (historic Constraint price) = £10,000 /MW pa

- So optimum is at 170hours of Constraints <2% of year
- In seeking the cost-benefit optimum, one is seeking the tail of the distribution (2% is at 2.1σ, if distribution is Normal)

Sensitivities to Measuring Stick

- Backgrounds: we have covered quite a wide range of backgrounds:
  - 10% Wind in 2015; 30% Wind in 2020 and 40% Wind in 2030
  - Strong Scottish bias for Wind in GG5c and strong English bias in GG5a
- Boundaries: we have covered the major types on GB system 2015-2030
  - This study never intended to look at the import boundaries
- Deterministic Rules: there are no sensitivities, once one fixes the rules
- Economic Measuring Stick: endless sensitivities are possible
  - Halving and Doubling the transmission price is powerful. It also covers the case of doubling and halving the constraint price
  - Expect that #outage-weeks; Wind load factor; Wind correlation; etc would be minor
  - Flipping Gas and Coal in merit order might be interesting

Conclusions

- The method appears reasonably robust against possible sensitivities
- The ‘regrets’ of greater Constraints O if one under-builds, are greater than the regrets of greater Transmission T if one over-builds
- We propose approach 1e

Consultation Questions

- Q1. Do you agree with Dual Criteria in principle? Do you agree with the particular treatments and parameters within our proposed Demand Security Criterion?

(within our Cost-Benefits:)

- Q2-Q4. Are we assessing correct cost ‘terms’ within our CBA? Should we assess savings over 10 / 20 / 40 years?
- Q5-Q6. Do you identify any processes, which allay the concern of sensitivity of cost-benefit to input data? How feasible is it, for Scottish TOs to access all required cost-benefit data?

Consultation Questions

(within the pseudo cost-benefit)

- Q7. Do you agree, that our 70% direct scaling factor for Wind and Intermittent calibrates best?
- Q8. Do you agree, that we can abandon the previous ranking process?
- Q9. Are Interconnectors, which are sending power into GB, best treated at fixed size, or scaled with most generation?
- Q10. Do you agree with our ramped treatment of the fixed Boundary Allowance for small boundaries, eg SYS B1 B4?
- Q11. How often do you think we should benchmark the pseudo cost-benefit rules and parameters?

Conclusions

1. We propose dual criteria
2. For the Wind Integration criterion, there are three cost-benefit variants
    1. Specific reinforcement cost-benefit
    2. Indicative transmission-price
    3. Pseudo cost-benefit
3. We propose the pseudo cost-benefit, with deterministic rules 1e