DTI Centre for Distributed Generation and Sustainable Electrical Energy

Transmission Investment and Pricing in Systems with Significant Penetration of Wind Generation

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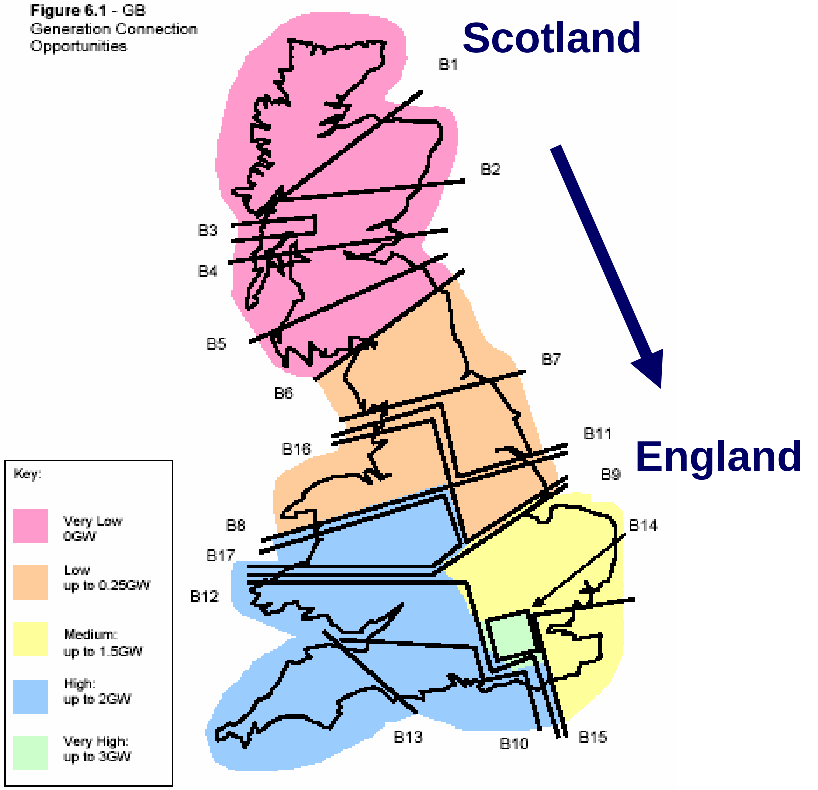
UK experience

- Implications of significant wind penetration on transmission capacity
- **Example:** UK cases
- 15 GW wind connection applications in Scotland
- **Key question**: how much transmission capacity driven by wind ?
- **Barrier**: incomplete transmission planning standards



Source: Interim GB SYS Nov 2004

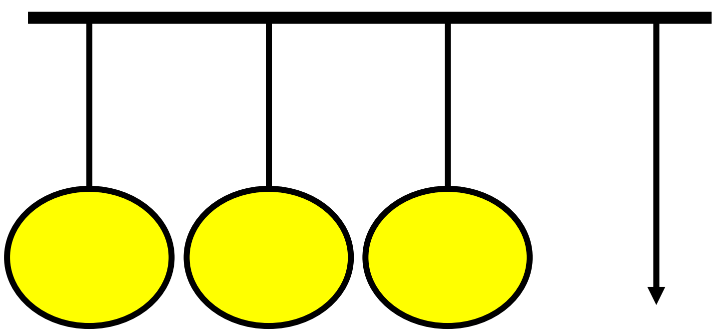
Transmission planning frameworks

- Reliability driven network investment
  - Links between generation and transmission investment for maintaining supply reliability
  - Sharing reserves between areas
  - Measuring the additional risk pertinent to finite transmission capacity
- Economics driven network investment
  - Use of most economic energy resources in balance with network investment decisions
  - Cost benefit analysis

Challenges introduced by wind power

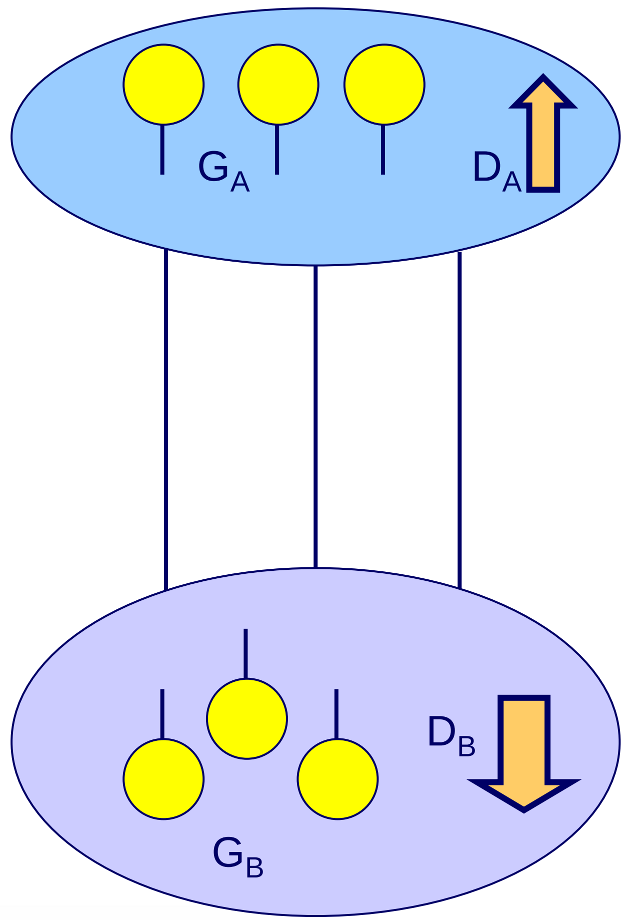
- Low capacity credit
  - Intermittent , less predictable, less controllable
  - Contribution to supply reliability is limited → less transmission needed
- Location – remote from load
- Need access – base load plant
  - Drives increase in network cost
- Low load factor
- Dilemma:
  - Over investment → low network utilisation
  - Under investment → limit the use of renewables, increase congestion

Link between generation and transmission security standards



20% capacity margin

(LOLP = 0.07)



"Transmission network should not unduly restrict generation to contribute to security of supply"

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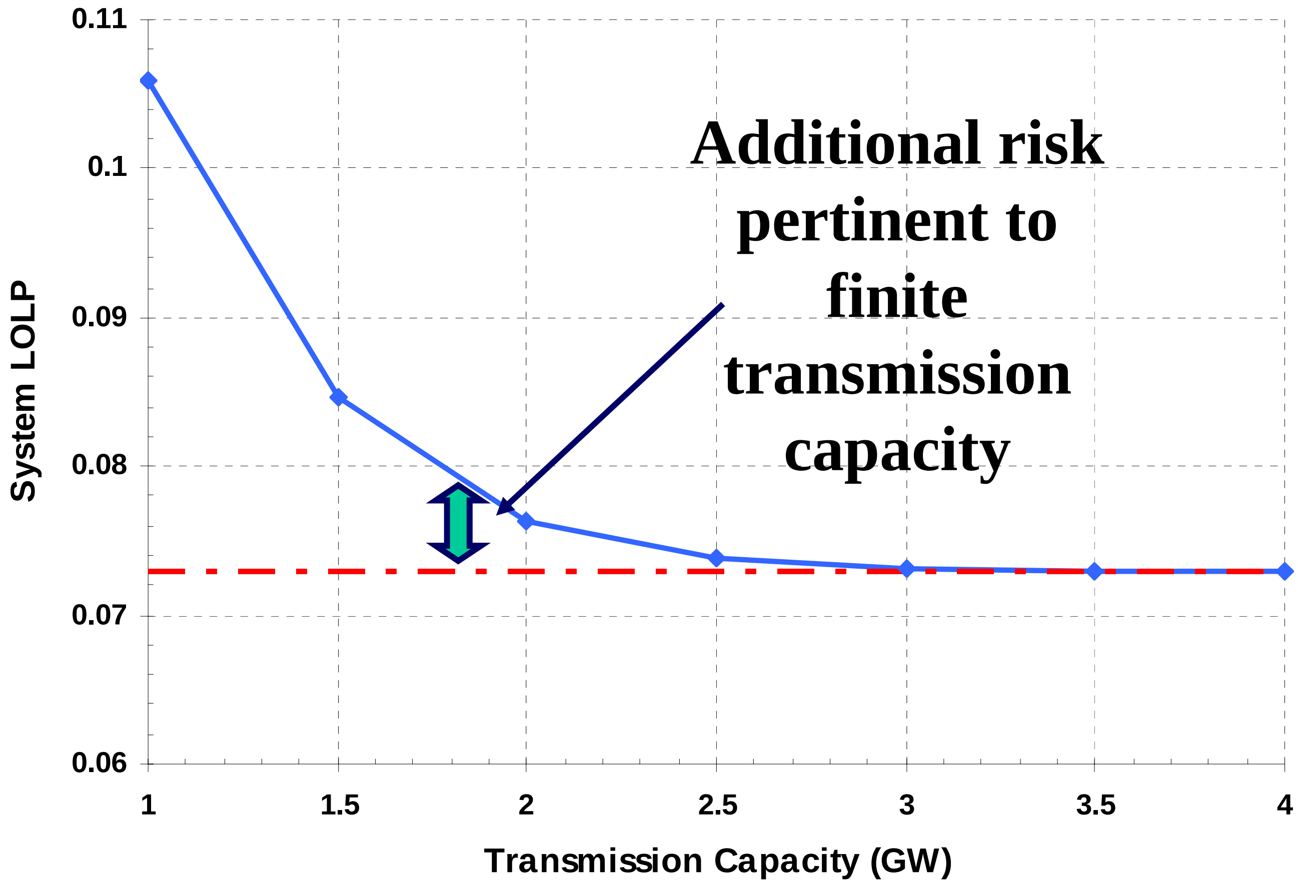
Transmission capacity and system LOLP performance



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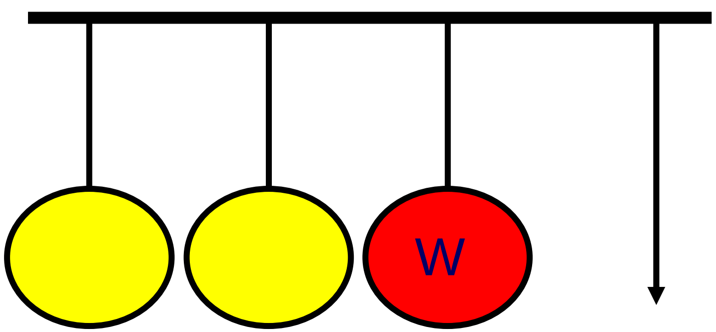
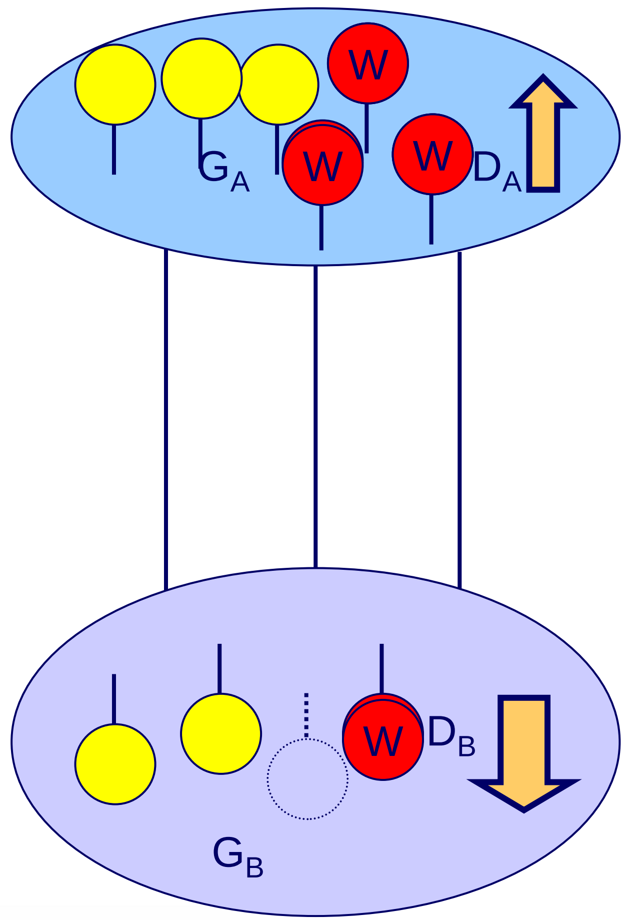
Impact of wind on generation plan margin



>> 20% capacity margin

(LOLP = 0.07)



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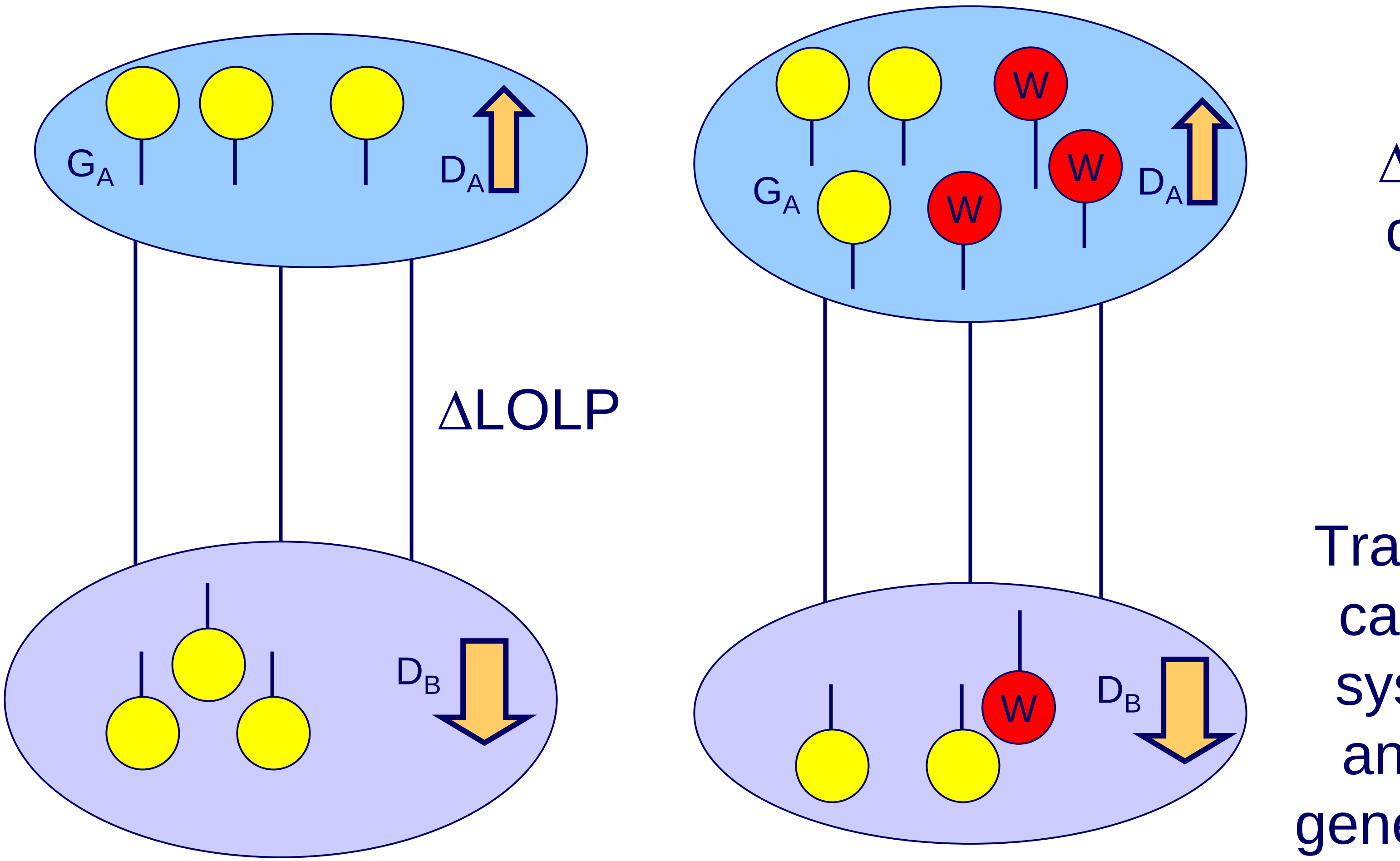
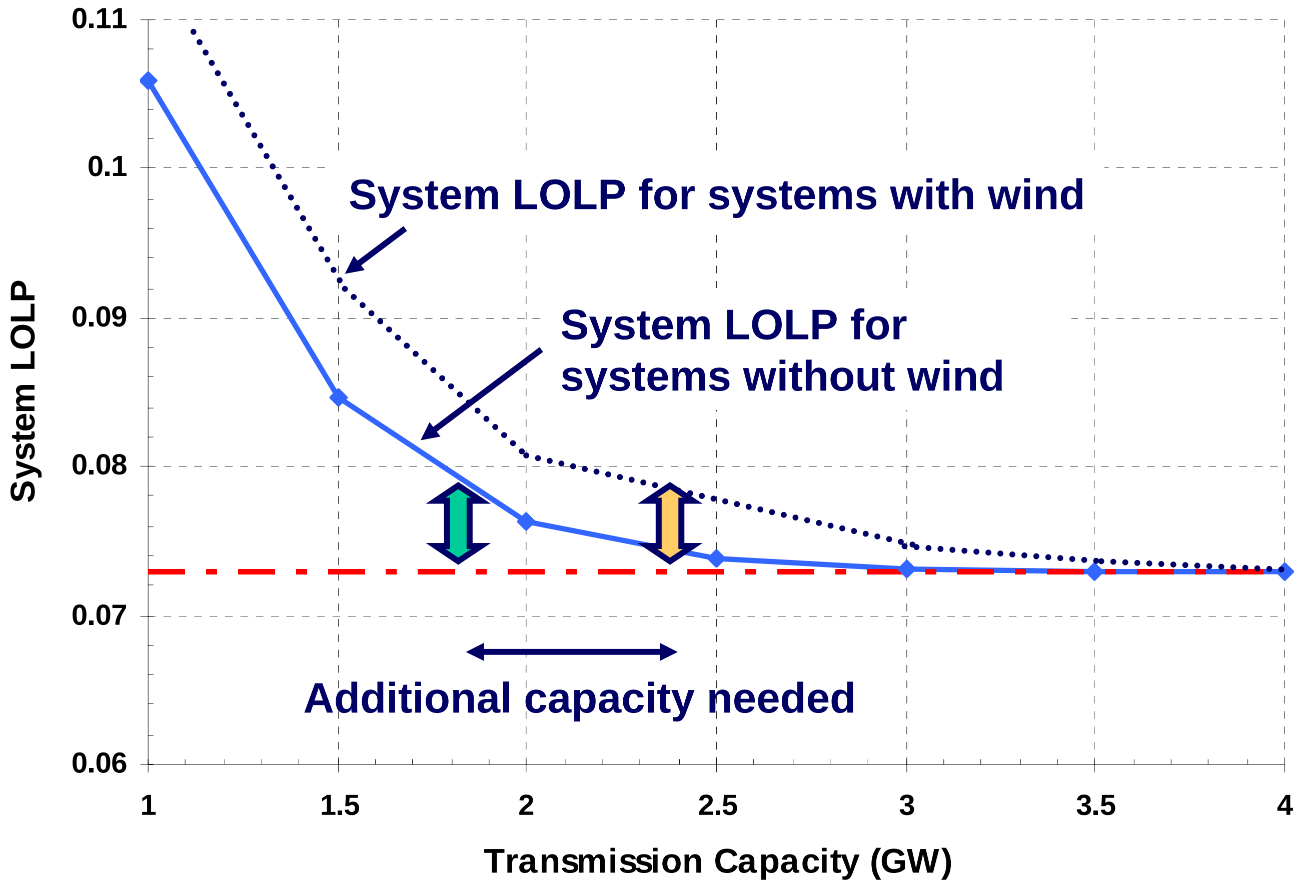
Benchmark defined by the existing standard



ΔLOLP = constant

Transmission capacity for system with any form of generation can be determined

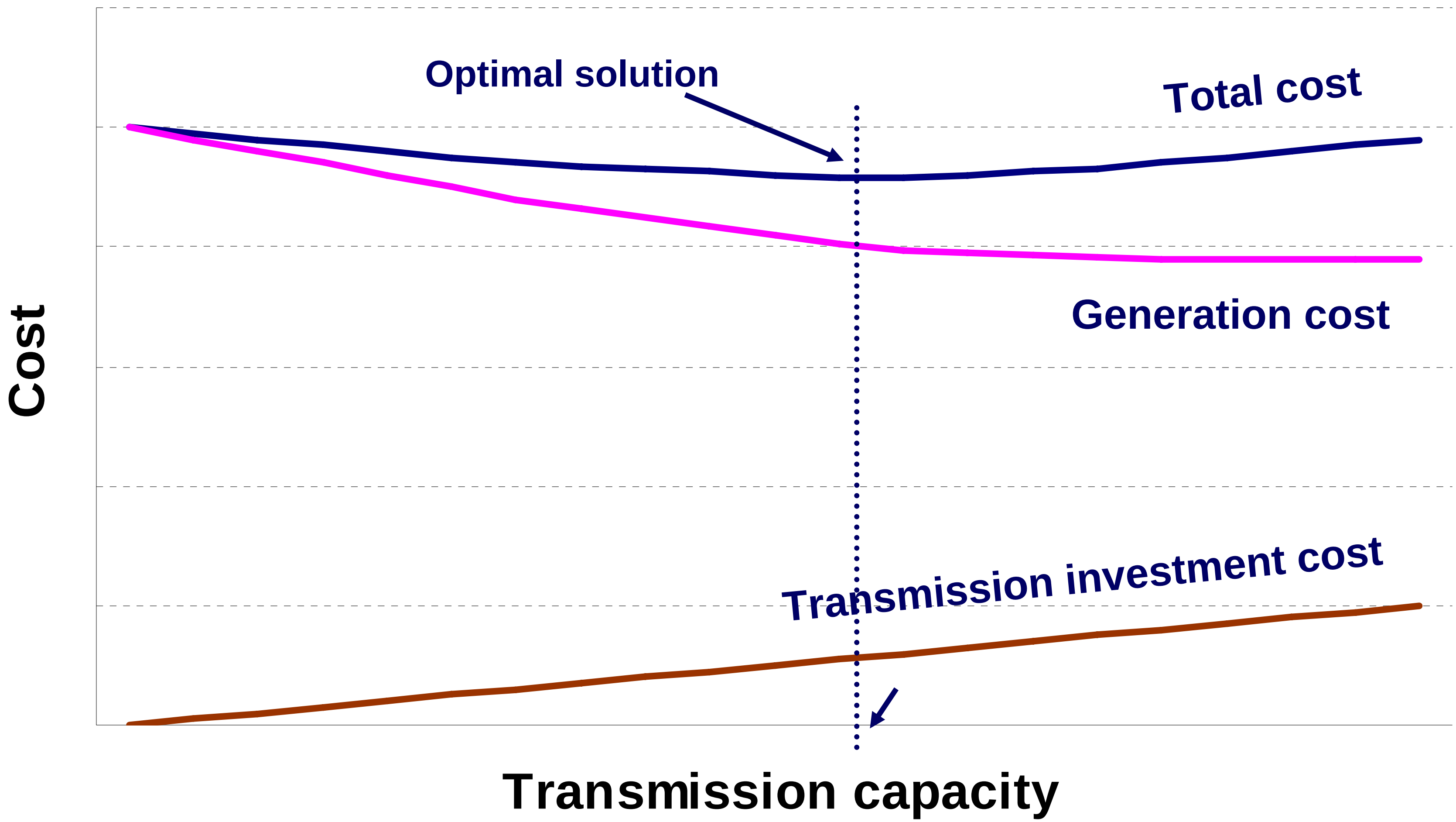
Methodology to determine additional transmission capacity



Economics driven transmission capacity/1

- Cost-benefit analysis: balancing cost of transmission investment against the benefits of reinforcement, i.e. reduction of constraint costs (over the life span of the investment).
- Year-round assessments of the system operation is carried out by considering daily and seasonal variations in generation and demand (for a spectrum of credible backgrounds)
- Whole system needs to be considered (boundary approach may not be appropriate as it may underestimate the transmission cost and hence overestimate the need for transmission).

Economics driven transmission capacity/2



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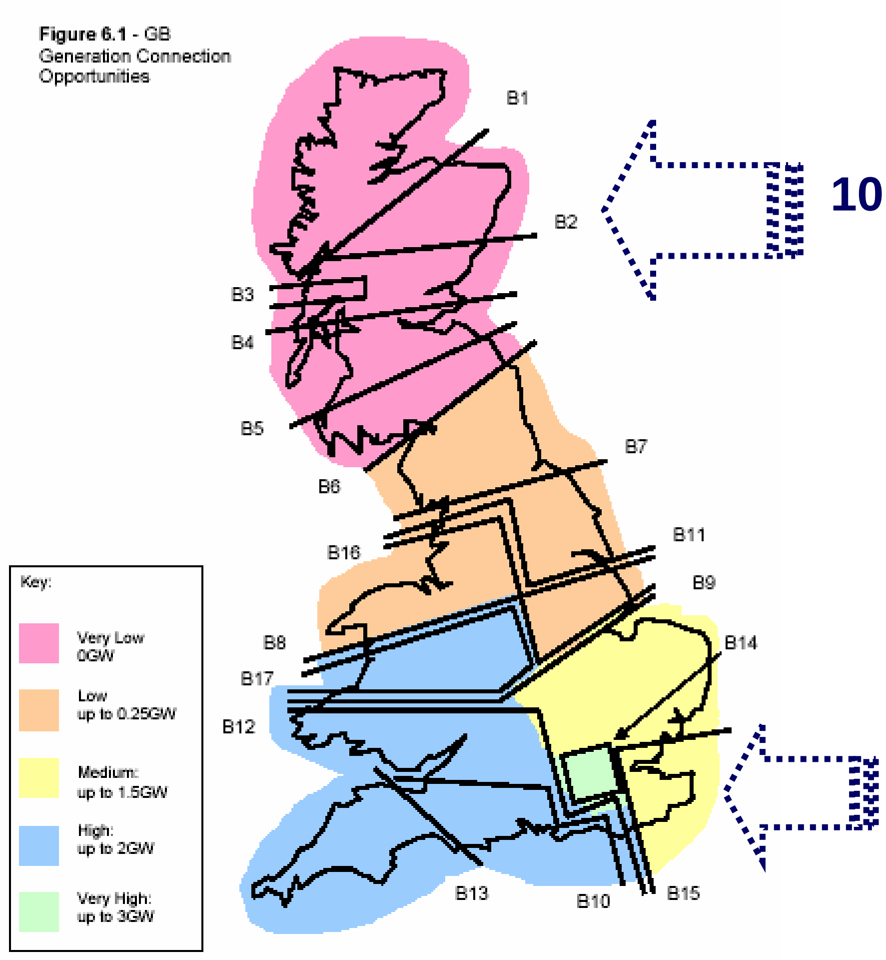
Case Study



10 GW on shore Wind Power

3 GW off shore Wind Power

Source of data: Interim GB SYS Nov 2004

Results and comparison

From	To	Security	Economics	Conv Std
NW-SHETL	N-SHETL	2100	2437	2561
N-SHETL	S-SHETL	3500	3571	4439
S-SHETL	N-SPTL	3300	4110	4904
N-SPTL	S-SPTL	4100	3564	5438
S-SPTL	UN-E&W	4300	5357	7667
UN-E&W	N-E&W	4700	4935	7514
NW-E&W	N-E&W	2400	1942	2424
NE-E&W	N-E&W	5600	2218	4895
N-E&W	M-E&W	8700	7870	10674
MW-E&W	M-E&W	6800	4798	6848
ME-E&W	M-E&W	5400	4459	4869
M-E&W	S-E&W	8100	8434	9206
SW-E&W	S-E&W	3400	2781	4360
SE-E&W	S-E&W	5100	1438	4766

Results are driven by both model and input data assumptions

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Conclusions on the impact of wind power on transmission capacity

- Wind contributes less to network capacity than conventional generators
  - Should be reflected into transmission charges for wind
  - Wind should pay less for transmission charges (and get paid less too)
- Network capacity for wind is more likely driven by economics rather than reliability
  - Both are important, reliability provides the basis then economics
- Wind and conventional should share transmission capacity
  - Optimise utilisation of lines and reduce network investment

Cost reflective network pricing methodologies

	Charges based on Reliability(£/kW/year)		Charges based on Economics (£/kW/year)	
Nodes	Wind Generation	Conventional Generation	Wind Generation	Conventional Generation
NW-SHETL	9.07	41.53	17.90	26.66
N-SHETL	7.10	37.31	15.46	14.77
S-SHETL	5.81	33.99	13.22	27.89
S-SPTL	2.09	21.78	5.87	13.40
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Future works

- Supporting the GB SQSS Review Group
  - Reliability analysis of interconnected systems and need for transmission investment
    - Benchmark risk re-assessment, frequency and duration analysis, comprehensive sensitivity assessments
    - Development of deterministic rules (reliability driven scaling factors)
  - Support the development of CBA methodology and examine its robustness (economics driven scaling factors)
- Further development of Long Run and Short Run Marginal Cost pricing for transmission access in the UK

Summary

- Need for updating transmission planning standards to include future generation technologies
  - Different characteristics and should not be treated the same
  - Late reactions may cause wind cannot be connected
- Economics and reliability are the fundamental frameworks for planning transmission systems
  - Characteristics of generation technologies on these two aspects are critical to be understood
- Wind drives less network capacity and should pay less
  - Links between investment drivers and transmission charges

THANK YOU FOR YOUR ATTENTION

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