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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PES General Meeting, Tampa, 24-28 June 2007
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 \(\rightarrow\) less transmission needed
• Location – remote from load
• Need access – base load plant
  – Drives increase in network cost
• Low load factor
• Dilemma:
  – Over investment \(\rightarrow\) low network utilisation
  – Under investment \(\rightarrow\) 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”
Transmission capacity and system LOLP performance

Additional risk pertinent to finite transmission capacity
Impact of wind on generation plan margin

>> 20% capacity margin
(LOLP = 0.07)

“Transmission network should not unduly restrict generation to contribute to security of supply”
Benchmark defined by the existing standard

\[ \Delta \text{LOLP} = \text{constant} \]

Transmission capacity for system with any form of generation can be determined.
Methodology to determine additional transmission capacity

System LOLP for systems with wind
System LOLP for systems without wind
Additional capacity needed
Economics driven transmission capacity

• 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

Optimal solution

Total cost

Generation cost

Transmission investment cost

Transmission capacity

Cost

Optimal solution

Total cost

Generation cost

Transmission investment cost

Transmission capacity

Cost
Case Study

Figure 6.1 - GB Generation Connection Opportunities

Source of data: Interim GB SYS Nov 2004

10 GW on shore Wind Power

3 GW off shore Wind Power
## Results and comparison

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Results are driven by both model and input data assumptions.
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

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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