System costs of wind generation

Ofgem discussion day 24 May 2004

Lewis Dale

Wind projections

- Wind widely expected to be the dominant renewable technology
- To meet Government 10% renewables target by 2010 (using wind only) requires ~8GW of wind turbines
- To meet Government aspiration of 20% renewables by 2020 (using wind only) requires ~25GW of wind turbines

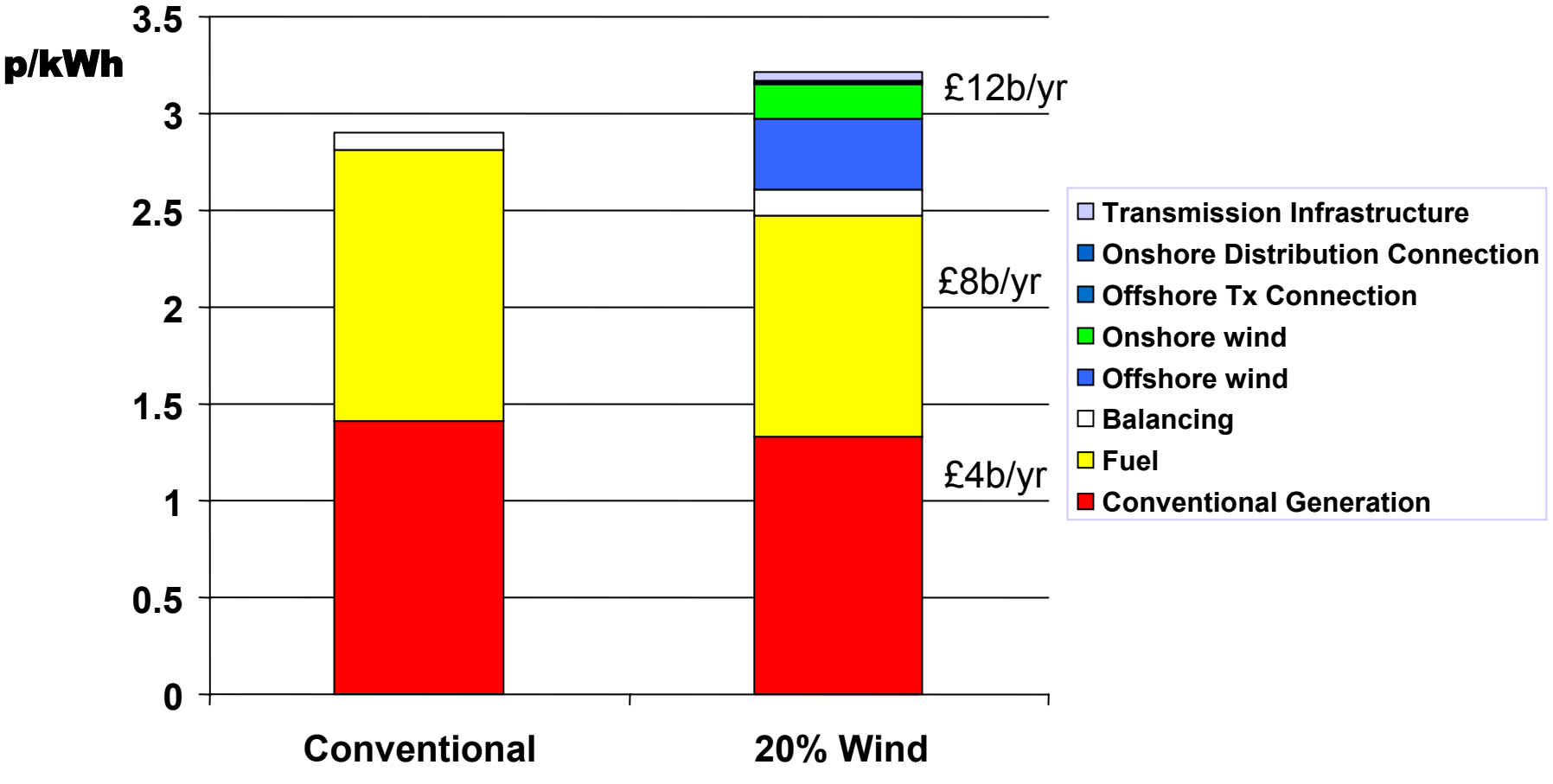
Is wind really the most economic renewable?

- Concern that wind may have significant additional 'hidden' costs which may make it susceptible to future policy shifts:-
  - System Cost of Additional Renewables report by ILEX/UMIST for DTI identified potentially large network, balancing and "capacity" costs
  - David Milborrow working papers for PIU agreed appreciable balancing costs but no capacity costs
  - Transmission Issues Working Group commissioned GB transmission studies
  - Reports of system difficulties in Denmark & Germany
- Analysis published in PowerUK Issue 109 :
  - Prof Goran Strbac, UMIST
  - Richard Slark, ILEX
  - David Milborrow, Consultant
  - Lewis Dale, TSG WS 1

“Additional” system costs of Wind

- Network reinforcement
- Intermittent production increases:
  1) Market need for flexible generation
  2) NGC’s short-term balancing task

Cost comparison - 2020 scenarios



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Results

- Total additional cost of wind ~ 0.3p/kWh (£1.2b/yr)
  - less than 5% increase on domestic electricity bills
  - circa 10% of industrial/commercial bill
  - half of ROC buyout price (cf 20% obligation @ £30/MWh = 0.6p/kWh)
- Balancing costs increased by 66% (£2.85/MWh of wind produced)
- Significant capital investment
  - £14b of wind turbines
  - £3.7b of network reinforcement

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Renewable Energy and Transmission Studies

- Studies undertaken for DTI
- Analysis for 2010
- Scottish onshore study
  - 6 GW in Scotland
  - 2 GW in England
- England and Wales offshore
  - 6 GW in England
  - 2 GW in Scotland
- Analysis currently being refined

Scottish Study

- Three cases
  - 2000 MW
  - 4000 MW
  - 6000 MW
- Undertaken with Scottish companies
  - Scottish Power
  - Scottish and Southern
- Expenditure
  - £500m - £1500m
  - Split between three companies
  - I.e. network investment circa £250/kW

England and Wales

- Based on 6 GW of wind generation in England and Wales
  - 1 GW onshore
  - 5 GW offshore
  - 2 GW Scotland
- Cost based on location
- Range of £275 m to £615 m for England and Wales transmission
  - I.e. onshore network investment between £50/kW and £100/kW
- Plus £500 m for Scottish 2 GW
  - Network developments for Scotland circa £250/kW

ILEX/UMIST System Costs of Additional Renwables (SCAR)

- Range of 2020 scenarios
  - 20% to 30% renewables
  - Different renewable fuel mixes
  - Network infrastructure costs between £65/kW and £125/kW
  - Costs lower than RETS due to plant closure & new entry assumptions for longer-term

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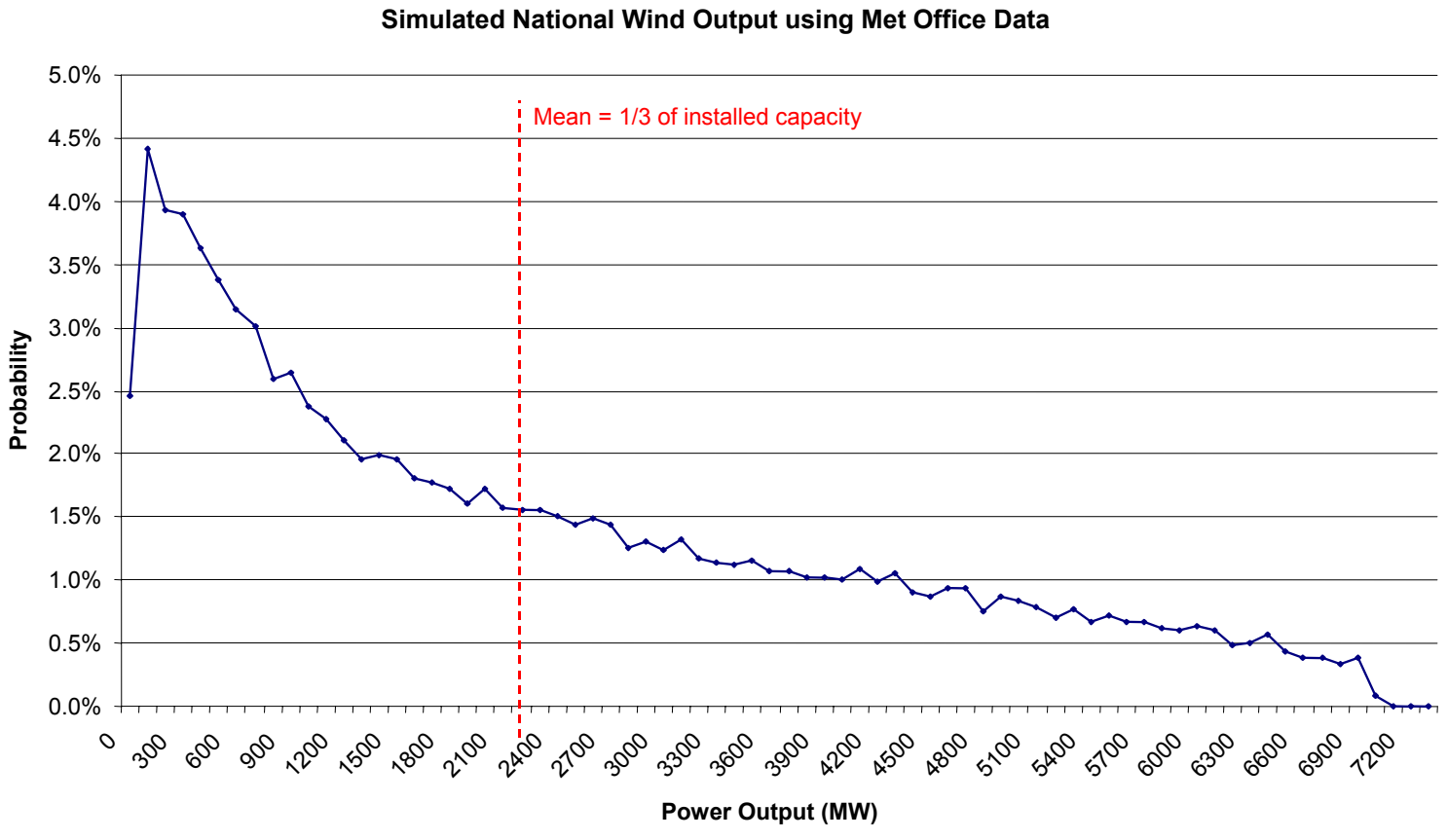
Wind statistics - expected output



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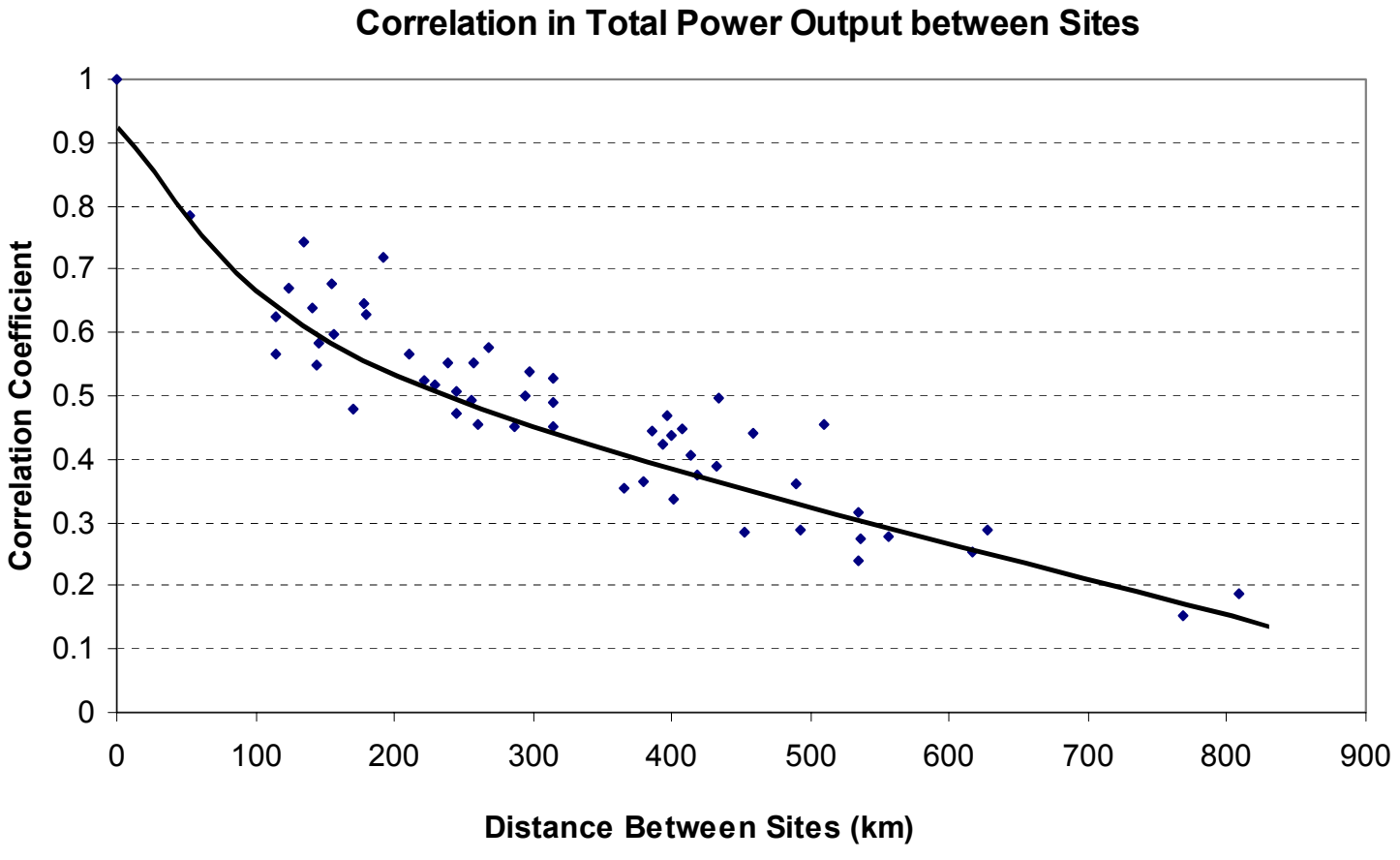
Wind statistics - correlation of wind outputs



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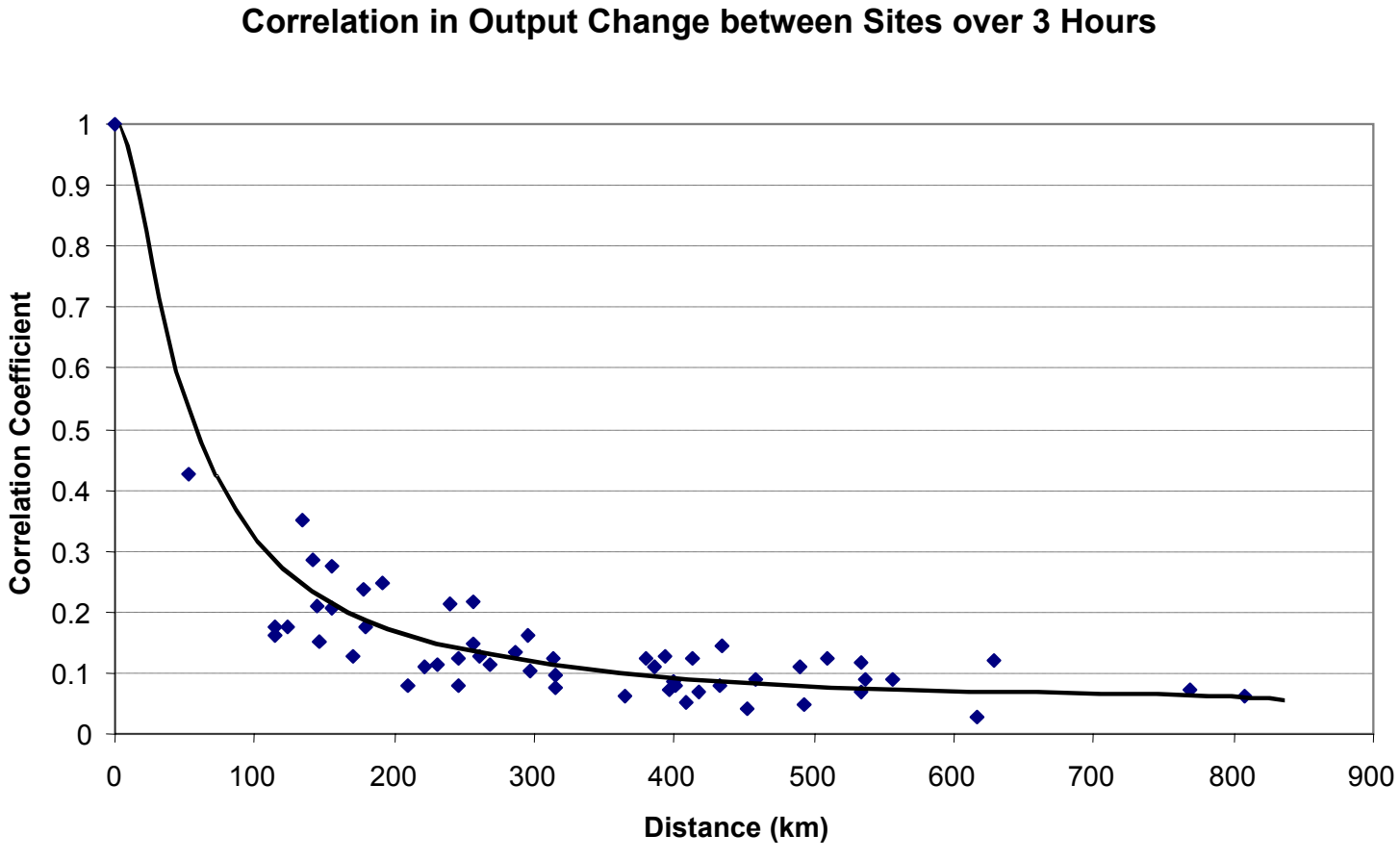
Wind statistics - correlation of wind changes



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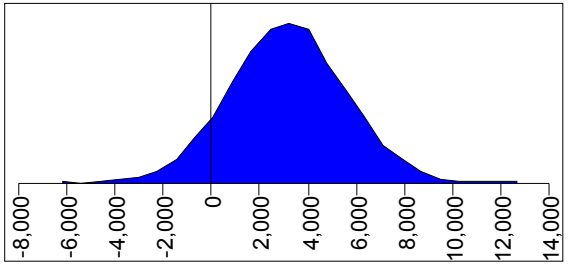
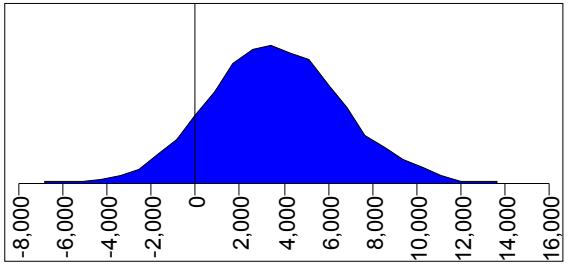
Generation capacity requirements

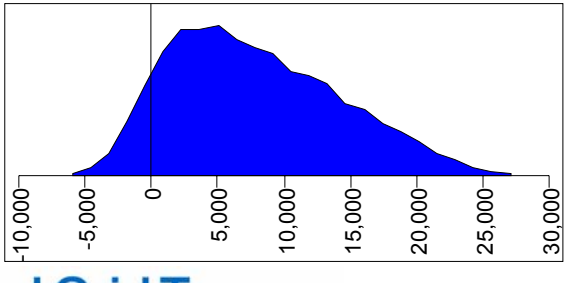
To meet 70GW GB demand with historic (GSS) security levels:-



500 MW wind
84,000 MW conventional
84,500 MW total (20% plant)



7,500 MW wind
81,000 MW conventional
88,500 MW total (26% plant)



25,000 MW wind
79,000 MW conventional
104,000 MW total (49% plant)

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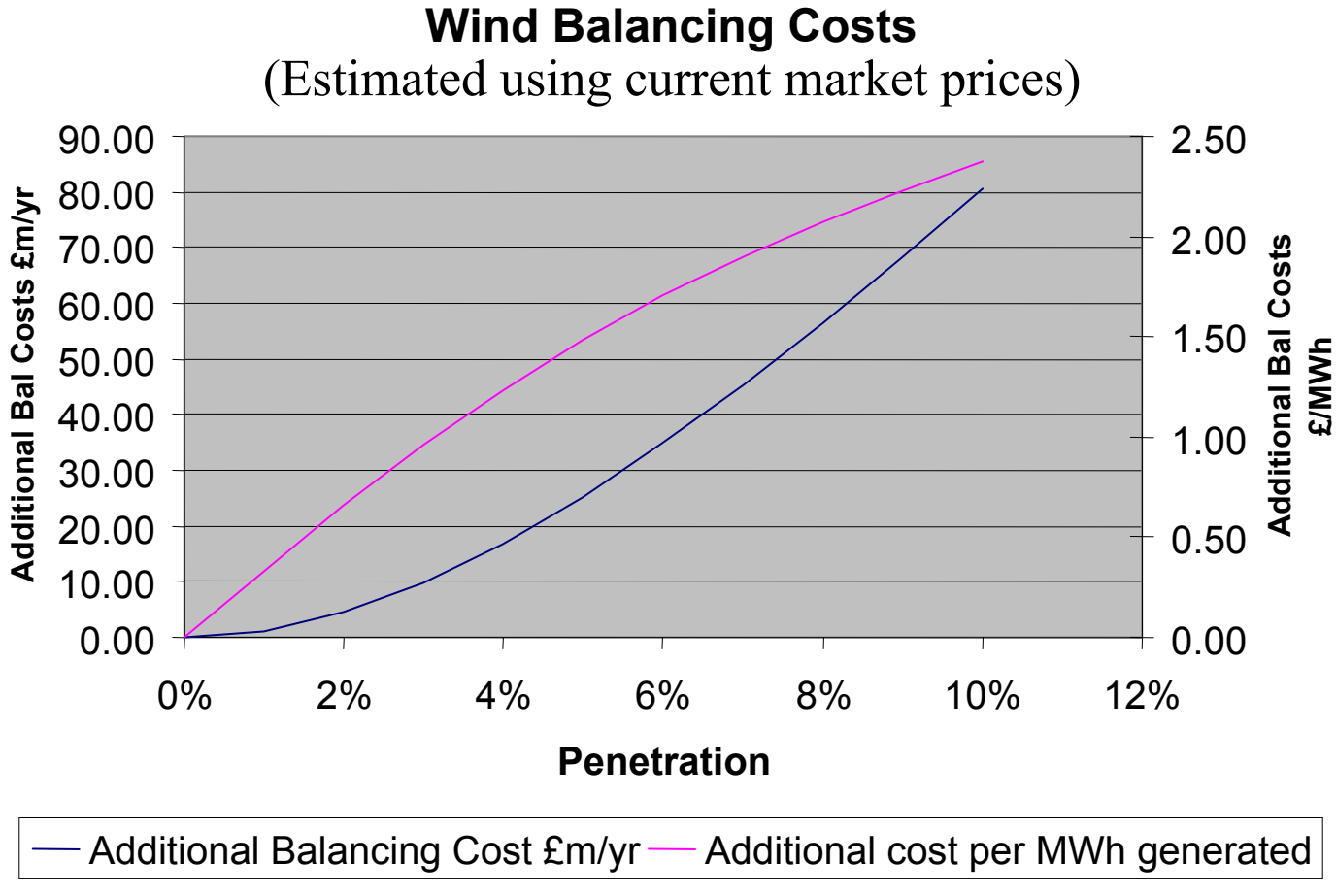
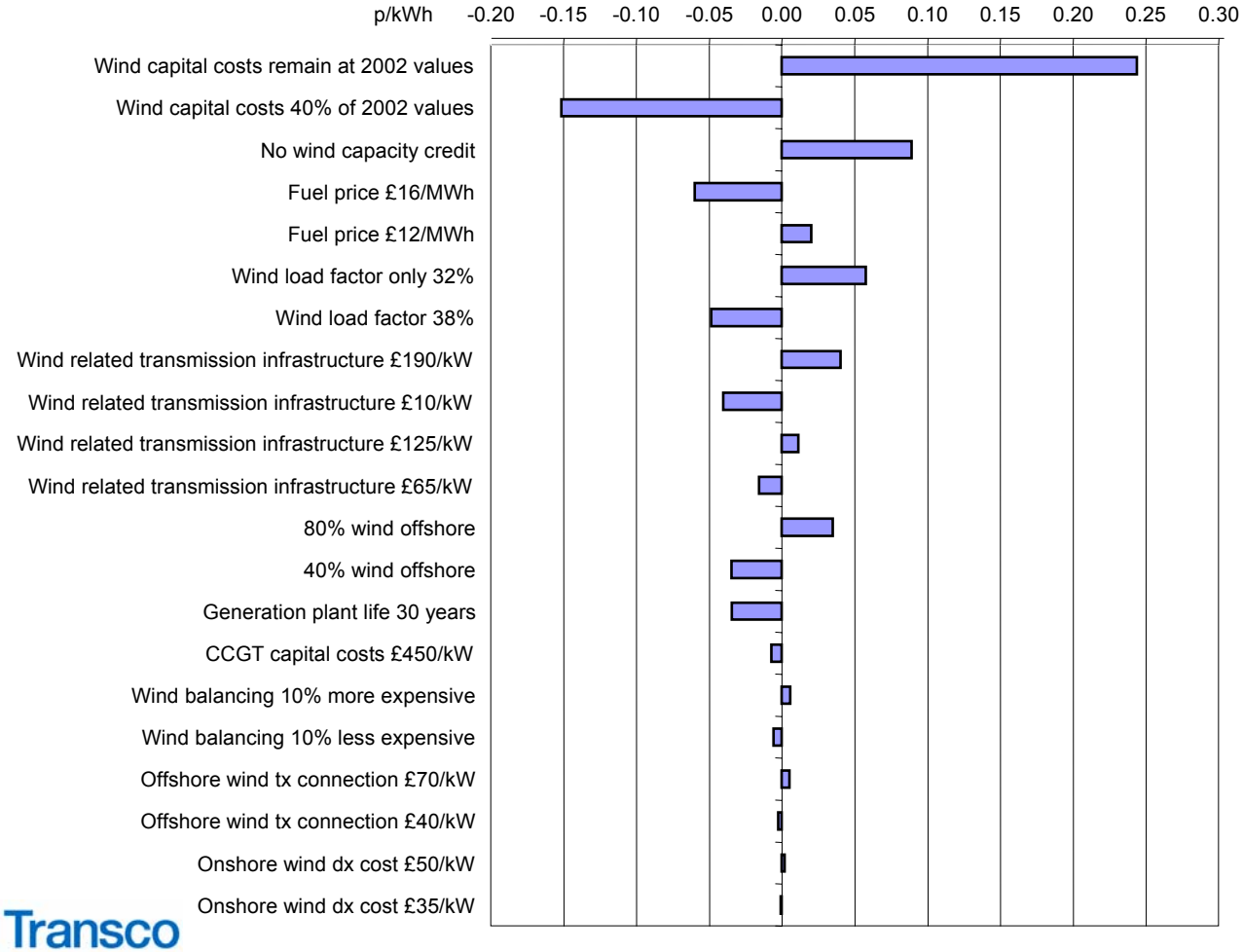
Short-term balancing requirements

- Reserve and frequency response required to meet existing (approximately) bell-shaped requirements
- Short-term wind fluctuations not correlated geographically
  - transmission system aggregates wind uncertainty to bell-shaped distribution
  - wind standard deviation 3% of capacity over 1 hr
- Total requirement with wind is diversified bell-shaped distribution

2.2 Indicative balancing costs



Analysis sensitivities



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Issues - widespread wind power

- Major capital investment required in generation and networks
- Increasing balancing volumes and costs
  - (CF efficiencies and increasing competition in services)
- Market response to short-term wind intermittence
- Lower utilisation of conventional plant capacity
  - Flexibility rewarded? Or closure?
- Potential for interaction of policies
  - maintain security of supply
  - develop renewables

Generation cost assumptions

- Wind capacity costs
  - Onshore £455/kW
  - Offshore £600/kW (incl cable to shore)
  - 60/40 offshore/onshore
  - Limited learning by doing assumed
- Conventional plant costs
  - capital £400/kW
  - fuel £13/MWh
- Generation capital costs annuity over 20 yrs @ 10%
- Network connections
  - Wind connection £50/kW (distribution or transmission)
  - Infrastructure £100/kW (transmission)
- Network capital costs annuity over 40 yrs @ 6.25%