Note:

This slideshow has now been superseded by an updated and more complete version, available from the authors by email (r.j.green@bham.ac.uk, n.vasilakos@bham.ac.uk,). The current version is submitted as a record of the Bath FlexNet assembly.

Market Behaviour with Large Amounts of Intermittent Generation

(preliminary – please do not quote without permission)

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Thinking Networks

Background and motivation

- EU renewables target by 2020: 20%
- For UK:
  - 14% renewable energy
  - 40% renewable electricity…
  - …great part of which is likely to be drawn from wind.
- Impact on market prices?

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Literature overview

- Sinden (2007) assesses patterns of winds and potential outputs, using **average correlations**.
- Elders et al (2008) suggest alternative scenarios for the amount of thermal plant in GB and overall level of demand.
- Optimal level of investment in wind: Strbac et al (2007), Kabouris and Vournas (2004), Neuhoff et al (2008).
- Market power: Twomey and Neuhoff (2005)
  - Wind generators to receive less than average price of power
  - Strengthened inverse relationship between price and wind generation
  - Long term contracts may partly alleviate former effect

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Data & Methodology

- Two components: theoretical model (based on Green, 2008; Yago et al, 2007) enhanced by actual hourly wind data for representative stations across GB.
- Hourly wind speeds drawn from Midas UKMO 1990-2005, which are then converted to output using standard conversion rules.
- Our dataset currently contains 15-17 stations, with at least one from each of the nine geographic wind regions as defined by BWEA.
- Earlier work confirms low wind speed correlations between selected regions.

Wind capacities by region, 2020 (in MW – BWEA)

	Cornwall	Wales	East Anglia	Cumbria	NE	SE Scot	SW Scot	Argyll	Highland	Offshore
Consent	105	143	251	21	355	526	402	78	468	2270
Application	82	299	232	126	508	382	2184	239	1289	2385
Construction	4	16	45	65	49	468	67	22	95	457
Existing	51	305	186	105	61	253	389	96	429	404
Total wind	**241**	**763**	**715**	**317**	**973**	**1629**	**3042**	**435**	**2282**	**2740**
Onshore	**10396**									
Grand total	**19152**									

Selected Stations by name

- East Anglia: Wittering.
- Argyll: Machrihani.
- SW Scot: Esdal Emuir.
- SE Scot: Dundrennan, Creebridge, West Freugh.
- Cumbria: Warcop Range, Spadeadam No2, Walney Island, Shap.
- Wales: Swyddf Fynnon, Bala, Bronydd-Mawr, Llangunllo.
- Cornwall: Cardinham.
- Highland: Braemar, Glenlivet.
- NE: Kielder Castle, Morpeth Cockle Park, Boulmer.

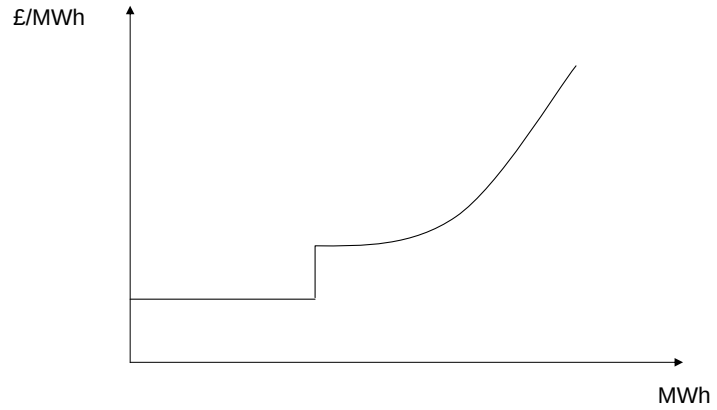
The Model - General

- Based on Green (2008) and Yago et al (2007).
- Symmetric generators compete in supply functions, offering a schedule of prices and quantities to the market.
- Industry cost function based on data from “2006 Energy Review” (DTI, 2006) – by type of plant. Start-up costs are currently not included.
- The output of nuclear plants and wind farms is subtracted from demand, before calculating equilibrium output from “strategic firms”

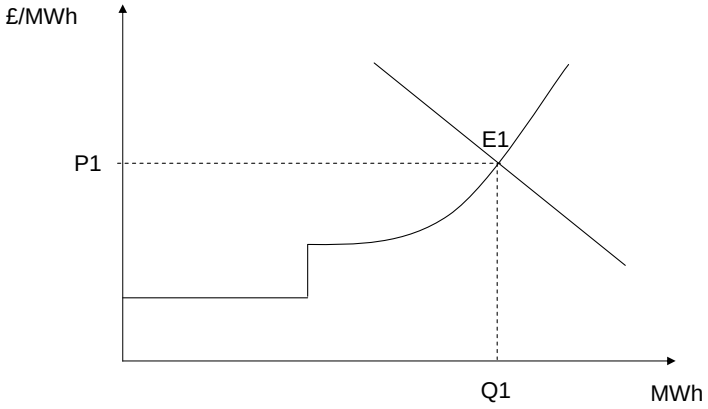
The Model – Equilibrium

- (Hourly) Equilibrium prices determined by intersecting:
  - Demand curves: based on average weekdays demands and prices during January 2004, scaled up to reflect assumed demand growth of 1.1% a year to 2020.
    - Linear demand slope of -80MWh per £/MWh
  - Strategic supply curves.
- Market power: two scenarios are currently considered; 2 and 6 firms.

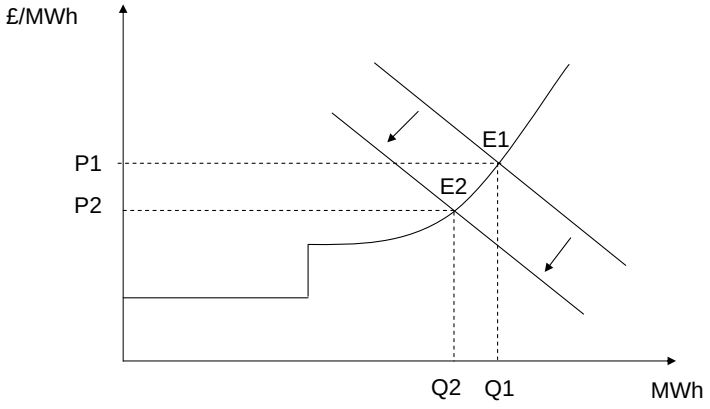
An illustration



An illustration



An illustration



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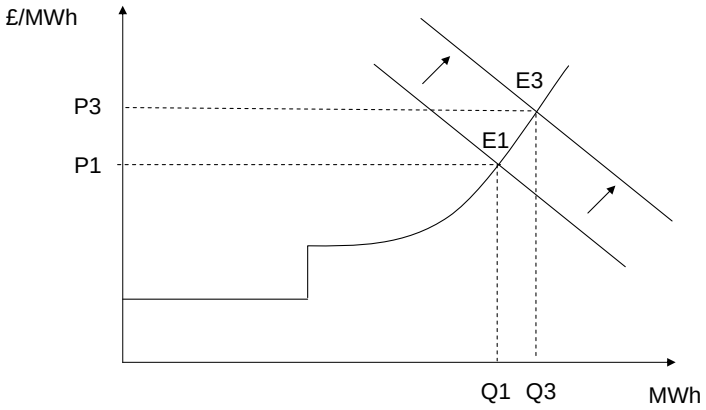
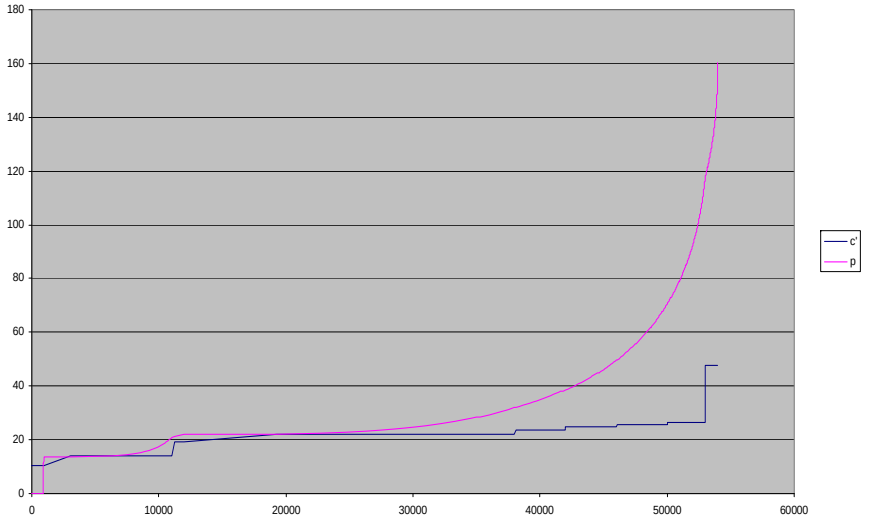
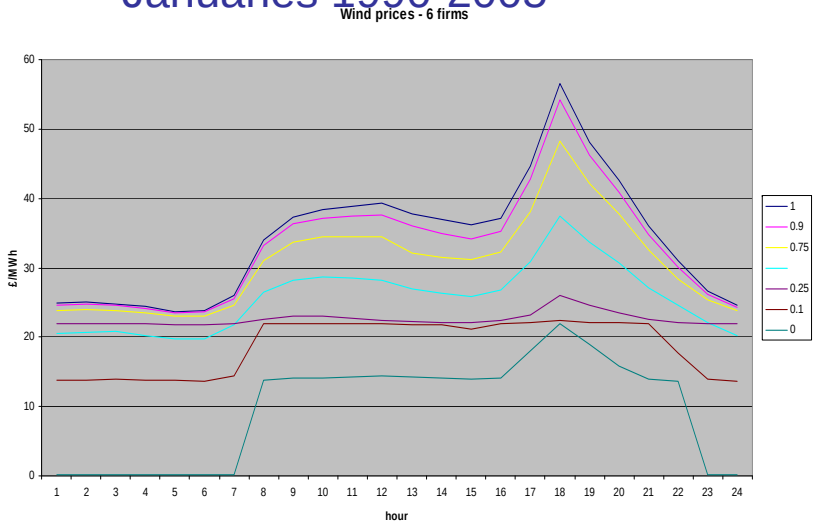


Supply and Marginal Cost functions



Hourly prices (6 firms) – Januaries 1990-2005



Conclusions and future plans

- Our preliminary results tend to indicate high variability of prices.
- Further generalisation plausible: We have now collected and processed hourly wind data for all other 11 months over the sampled time period.
- Further possible (and forthcoming) expansions:
  - Profits Vs Wind dispersion: Input for investment studies
  - Start up costs