Electricity Liberalisation in Britain: the quest for a satisfactory market design

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Refining Market Design, Cambridge

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http://www.econ.cam.ac.uk/electricity
Outline

• History of restructuring and privatisation
• Market and institutional design
  – the Pool
  – performance 1990-95
• Characterising equilibrium in the Pool
  – supply function equilibria and auction models
  – tacit coordination
• NETA
  – evolution of market structure and prices
  – impact on performance
British contrasts

• England and Wales
  – unbundle CEGB into 3Gencos, Transmission
  – privatise Regional Electricity Companies
  – Electricity Pool as wholesale market
• Scotland
  – retain 2 vertically integrated companies
The Electricity Pool

Gross first-price daily auction for energy, capacity and balancing

- non-firm bidding (day ahead) but firm grid access
- GOAL determines unconstrained SMP
- Capacity payment = LoLP*(VOLL-SMP, bid)

=> PPP = SMP + capacity payment

SO (NGC) pay “constrained-on” and “-off” payments

=> PSP = PPP + ancillary payments
Uplift Payments (at 1995/96 prices)

- **GBP million**
  - 500
  - 600
  - 700
  - 800

- **NGC incentive payments**
- **unscheduled availability**
- **ancillary services**
- **other operational output**
- **(o.w. notional reserve)**
- **(of which constraints)**

**Graph Details:**
- **Years:** 1990/1 to 1996/7
- **Bar Colors:**
  - Blue: NGC incentive payments
  - Light Blue: Unscheduled availability
  - Brown: Ancillary services
  - Yellow: Other operational output
  - Orange: (O.W. Notional reserve)
  - Red: (Of which constraints)
Audit of CEGB: first five years

- labour productivity doubled
- coal prices fell 20% real
- coal sales fell from 74mt to 30mt
- CCGT rose from 0 to 25%
- fossil fuel cost/kWh fell 45% real
- nuclear fuel cost/kWh fell 60% real
- emissions/kWh fell dramatically
Productivity of CEGB and successor companies compared to UK manufacturing industry
Plant capacity connected in England and Wales 1990-2003

MW

Peak demand

- OCGT
- Oil
- Coal
- CCGT others
- CCGT
- Npower+PGen
- import
- Nuclear

Apr-90 Apr-91 Apr-92 Apr-93 Apr-94 Apr-95 Apr-96 Apr-97 Apr-98 Apr-99 Apr-00 Apr-01 Apr-02
CEGB costs/unit equivalent output
at 1994/5 prices

Note: includes transmission costs
*corrects for changed balance gen:trans
### Net benefits of privatizing CEGB

**Cost savings:**  
\[ \text{PDV at 6\%} \quad £\text{ billion} \quad \$\text{ bill.} \]  
- Net fuel switching: 3.6 5.8  
- Efficiency gains: 8.8 14.1  
- Restructuring costs: -2.8 -4.5  
- Total privatising gains: 9.6 15.4  

**Environmental gains:**  
- \( \text{SO}_2 \) (£1b), \( \text{CO}_2 \) (£1.4b): 2.4 3.8  

*Levellised reduction per kWh*  5.7%
Who gained, who lost?

<table>
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<th>£ billion</th>
<th>$ bill.</th>
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<tr>
<td>Consumers</td>
<td>-1.3</td>
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<td>Govt. excl sales</td>
<td>-8.5</td>
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<td>After-tax profits</td>
<td>19.4</td>
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<td>Net benefits</td>
<td>9.6</td>
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<td>Govt. sales proceeds</td>
<td>9.7</td>
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<td>Net govt. position</td>
<td>1.2</td>
<td>1.9</td>
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## Who gained, who lost in Scotland?

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Electricity prices by town: 3,300 kWh at 2000 prices excl VAT
Pool prices since vesting

£/MWh
(Jan 2000 prices)

Nuclear outages reduce plant margin
French strike & station failure
SMP manipulation
Capacity withdrawal

Ofgem price review
Annual price cap agreed for 2 years
Low availability & Eastern bidding strategy

PG gaming
Plant divestment to Eastern
NP & PG manipulation

Scheduling problems
Price falls to meet price cap
Further plant divestment

Plant divestment

Further plant divestment

Price falls to meet price cap

Further plant divestment

Price falls to meet price cap

Further plant divestment

Price falls to meet price cap

Further plant divestment

Price falls to meet price cap
Criticisms of the Pool

- generators have market power
- capacity payments are unnatural
- biased against coal
- generators get PPP regardless of bid
- constraint payments unsatisfactory
- no demand side
- unsatisfactory governance structure
Feasible Supply Functions
Duopoly and Quintopoly

Calibrated for England 1990
Source: Hortacsu and Puller 2004
Collective dominance criteria

• Markets concentrated, transparent, mature
• Low elasticity of demand
• Homogenous product, similar costs, shares
• Little excess capacity, barriers to entry
• Excess pricing, profit
  – little response to cost fall, barriers to switching

*Electricity Pool a test case (except for entry?)*
Testing for collusion

• Sweeting has developed methodology
• need to update for final period of Pool
• concentrate on bidding behaviour of divested plant - e.g.
  – Jul 99 Edison Mission buys 4GW $472/kW
  – raises load factor from 25% to 40+ %
  – Oct 01 Edison Mission sells at $190/kW
a priori defence of NETA

- “The Pool is too transparent and discourages bilateral bargaining”
- “Making balancing market a poor guide to SMP will encourage contracting”
- “If there is no market of last resort then must-run stations have to accept lower bids”
The view from Australia

CoAG Independent Review of Energy Market Directions reported Dec 2002

• examined Nordpool, PJM and NETA
• NETA’s incentive to individual balancing “a significant inefficiency that adds cost to the system”

(CoAG, p103)
CoAG on gross vs net or no pools

“gross pool model possesses some advantages…
– encourages generators to supply according to marginal cost
– reduces barriers to entry
– simplicity of .. single spot price
– provides transparent .. data .. enabling more informed investment and usage decisions”

• “market power will not change .. by a move to a net pool” (ACCC)
Offer “encourages” sales

Gencos trade horizontal for vertical integration

NETA live

Source: John Bower (Oxford Institute for Energy Studies)
Conclusions on causes of price fall

• competition known to be important
• increases effect of excess capacity
  – with non-storable output reduces market power
• contract prices would have fallen in a competitive pool
• end-of-collusion story implausible?
• And NETA cost more than £700 million
Security of supply under NETA

- NETA abolished capacity payments
- competition + XS capacity => price collapse
- price collapse => bankruptcy, mothballing
- Joint Energy Security of Supply 6 mth reports
- JESS 1 and 2 “capacity margins adequate”
- NGC sounds alarms mid 2003
Electricity plant margins in England and Wales

Source: NGC

NGC planning margin (20%)

forecast plant margins
Network investment looks fine but generation falls with price

11 Electricity capital expenditure – GB

- Change in generation capacity
- Generation
- Transmission
- Distribution


- Source: JESS Report Nov 2003
UK Electricity Winter ‘03 Base-load Forward Prices

- NGC reserve margins was expected to be as low as 16.5 % winter 03/4
- Markets reacted by an increase of 20 % of forward electricity prices since last spring
- However prices on the order of £22/MWh were still insufficient to allow new entrants to recover fixed costs

Source: OFGEM press release
British Generator CCGT Gas Spark Spread under NETA

- Spark spread
- Annual MA return to capital high
- Annual MA return to capital low
- Required return on capital

Mar-01 | May | July | Sep | Nov | Jan-02 | Mar | May | July | Sep | Nov | Jan-03 | Mar | May | July | Sep | Nov | Jan-04 | Mar | May

£/kW/year
Vertical integration: solution to investment but at expense of supply competition?

Supply and Generation in Great Britain, 2002

(2001/2 estimates, adjusted for the London/Seeboard, Innogy/Northern and PowerGen/TXU mergers)

Source: Richard Green
Does the balancing market prejudice security?

Returns to peaking capacity
Spot and cash-out weekly moving averages June 01-Ap 04
Cost of 24-hour failure under the Pool and NETA

Cost net of avoidable cost £/MWh

Percent time cost higher than marginal cost by amount on y-axis

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Assessment

• Market power distorted the Pool
• but market power ended before NETA
• and could then deliver:
  – energy, capacity and balancing prices in a transparent single price market
• NETA was costly but has better governance
  – but dual cash-out average pricing creates problems even if it works “reasonably well”
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