Cross border pricing of transmission

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Outline

• Short term
  – Basic design options
  – Implications uncertainty
  – Implications market power
  – Size of zones
  – Integration of markets

• Long term
  – Physical v.s. financial
  – Allocation of contracts
  – Reference node

• Intermittency
EC Regulation on congestion management

- TSO shall put in place coordination and information exchange mechanisms. (5.1)
- Publish safety, operational, and planning standards. (5.2)
- Non-discriminatory, market based, no curtailment (6.1)
- Use it or lose it (6.4)
- Netting, as far as technically possible (6.5)
- Congestion revenue is to be used for operation & investment, netted with reg. income (6.6)

Ref: Regulation (EC) No 1228/2003, July 2003
Basic design options

Decentralised auction

Coordinated auction

Market coupling

Nodal pricing

 Nacional/regional system operator
 Transmission auctioneer
 Market Participant

National/regional power exchange
Declare available capacity
Participation in auction

How to allocate transmission capacity?

LT contracting (applies to all)

Day ahead (focus of section)

Balancing (less clarity)

Submit bids to transmission auction

Results from transmission auction published

Submit bids to energy spot markets

Results of energy spot markets published

Submit bids to energy spot markets

SO determines nodal prices and dispatch

Nodal pricing

Separate markets
Europe – many markets to integrate

ROLLING MONTHLY AVERAGE PRICES
30/05/04 - 29/06/04

Source: Europex.org, APX, Netherlands; EEX, Scandinavia, EEX, Germany; POWERNEXT, France; OMEL, Spain; Borzen, Slovenia; GME, Italy
Inefficiency of separate market design – 2 node

Ref: Neuhoff 2003
Inefficiency of separate market design: 3 nodes

Analysing flow from A to B

Analysing flow from A to C

- Assume additional demand for T from A to C
- Option 1: Swap 2 T AB for 1T AC
- Option 2: Swap 1 T AB & 1 T AD for 2T AC
- Efficient network use requires complex swaps.

Neuhoff 2002
Market Power Consequences

- Inefficient dispatch
- Distorted investment signals
- Possible bias against certain technologies
- Wealth transfers
- Dead-weight welfare loss
Analytic comparison

Output of both strategic generators

Market coupling

Separate transmission and energy markets

Demand difference $D$

Generation $q_1$ \( \rightarrow \) Generation $q_2$

Net demand $D_1$ \( \rightarrow \) Net demand $D_2$
Numerical analysis of MP in meshed network

- New model for strategic gen. under nodal pricing
- Traditional model for separate E&T market
- Benelux country data set
Integrated markets reduce Benelux price levels

Can we use countries as zones?

• Higher resolution difficult with physical T contracts.
• Pragmatic – that is where we start from (Arriaga).
• Inaccurate representation of loop flows -> inefficient use of network (Smeers).

Ref: Boucher/Smeers (2003), The European Regulation on Cross Border Trade: can one do without a standard market design?”, Smeers (2003), International Congestion Management,
TSO incentives to resolve intrazonal constraints

• Trade-off between use of capacity for internal and international transmission. (Boccard, Glachant)
  – TSO wants to avoid local constraints with their re-dispatch costs.
  – TSO will distort downward capacity available for international transfers/Neighbours’ loop flows.

• UK success: Incentivise TSO to minimise intra-zonal congestion cost – might only work on an island?

• Expose TSO to inter-zonal congestion cost to make right trade-off (Wangensteen 2000) … but how?

Glachant and Pignon (2003), ”Nordic electricity congestion’s arrangement as a model for Europe: Physical constraints or operators’ opportunism?”, Ivar Wangensteen, Alternative models for congestion management and pricing, Impact on network planning and physical operation, CIGRE 2000, Paris aug/sept 2000
What is the optimal size of a zone?

• Constraints within zones require re-dispatch:
  – Inefficient demand choice (small effect)
  – Distorted signals for investment decisions
  – Allows for Inc-Dec game\(^1,2\)
• With changing/increasing flow patterns we need to split zones into smaller areas
• But this reduces liquidity of T markets
  – Serious with T contracts requiring exact match
• And reduces liquidity in local energy markets
  – No problem for integrated markets, as divided zones are treated as one zone if unconstrained.

1. Harvey and Hogan, 2000, Nodal and zonal congestion management and the exercise of market power.
2. NGT (UK) is lucky, few constraints, can be incentivised to contract (unbundled, island)
Creating competition might require endurance

Ref: Neuhoff/Newbery 2004
Markup is not monotonic in concentration

![Graph showing the relationship between concentration and price charged, with monitoring and regular intervention indicated.]
Implications for regulation

• Unconstrained transmission
  – Initial competition increase can increase p.
  – Insufficient Comp/reg. effort, if impact on neighbour’s customers not internalised.

• (Temporarily) constrained transmission
  – Ensure that not only G but reg/comp authority understands and acts on local MP.
EC regulation does not (yet) specify methodology

- Preamble (17): It should be possible to deal with congestion problems in various ways.
- Appendix mentions both ‘market splitting’ and explicit auctions.
- Preamble (18): provision … [to] allow the adoption of decisions and guidelines with regard to … capacity allocation by the Commission.
- Preamble (22): harmonised framework … cannot be achieved by the Member States …by reason of the scale and effect of the action, be better achieved at Community level.

Ref: Regulation (EC) No 1228/2003, July 2003
Timing of different market designs

Splitting of T: • NTC definition • split auction/integrated market

T-auction

Bids to Energy Market

Energy Market clears (& T allocation Under market splitting)
Movements from synchronised auctions may be costly

- Total social benefit (measured in some welfare units)
  - Integrated market design: 1.9
  - Market splitting in part of network: 0.4
  - Separated market design: 0.8

Both designs include transmission contracts

- Transmission contracts are crucial
  - Remove base risk for forward contracting
  - Reveal future demand, signal for investment
  - Can provide incentive for TSO (Joskow, Tirole)
- Contracts can be obligations in both designs
  - Similar question of credit guarantees
- Physical contract is fall back option for market failure.

Ref: Joskow and Tirole (2003) "Merchant Transmission Investment", if transmission ownership/maintenance is incentivised with transmission contract, then security constrained dispatch decision should be performed by separate entity. But separation potentially creates moral hazard and inefficiencies that require additional incentives.

Hogan, W.W., Financial Transmission Right Formulations. 2002
Where do physical and financial contracts differ

- Financial contracts focus on price hedging
  - Agg. of periods/zones reduces # contracts
  - Increases liquidity, reduces transaction costs
- Physical contracts have to match final position
  - Capacity is sliced in auctions for ST liquidity
  - This implies lower LT contract volume available
- Puzzle – why do players prefer physical contracts?

Transmission contracts impact market power

- T contracts held by importing Gencos amplify market power
  - by increasing sales whose price they influence
- T contracts held by exporting Gencos can reduce market power in the exporting country
  - true in the 2-node with no cross-border holding
  - can fail in a meshed network
- legacy T- contracts held by Gencos bad idea

Ref: Joskow and Tirole 2000
Transmission contracts impact market power 2

- If traders can compete effectively with Gencos
  - they value T-contracts more highly than Gencos
  - ⇒ they will outbid Gencos in efficient auctions
  - but monopolists will not sell any T contracts
  - oligopolists may not sell all T contracts

- Effective trader competition requires liquid spot, contract and balancing markets

Ref: Gilbert, Neuhoff, Newbery 2003
Transmission auction design

• Pay-as-bid auctions typically inefficient
  – Gencos can outbid traders
• Single price auctions allow efficient arbitrage
  – Gencos should be outbid by traders
  – Market imperfections may restore Genco advantage
• Might not suffice with uncertainty/asym. info
• Restrictions on ownership (e.g. Netherlands)

Ref: Gilbert, Neuhoff, Newbery 2002
How to implement restrictions on T ownership?

- Gen. restricted to T contracts to ref node
- Demand buys T contract from ref node
  - Allows complete T price hedging
  - High liquidity (few contract types)
- What node to choose as ref node?
  - Should have representative system price
  - Relative cross price response < 1
UCTE: relative cross price response

- Appropriate reference nodes exist

Ref: Olmos, Neuhoff 2004
Trans European Networks - Priorities

• Support operation of internal electricity market (4.1a)
• Island energy diversification, renewables, networks-interconnection (4.1b)
• facilitate the integration/connection of renewable energy production (4.2a)
• interoperability of electricity networks with accession and neighbouring countries (4.2b)

MP and Intermittency – the principle

- Uncertain demand not covered by LT contract
- Hence spot market volume increased
- Generators exercise MP both when long and short
- Generators exercise MP and make profits in spot market
Intermittent gen. deserves below av. price

- Intermittent output large – MC of system low
- Intermittent output small – MC of system high
- Hence volume weighted p below average p
Output volatility decreases wind revenue competitive world
In addition MP discriminates against intermittent gen.

- Intermittent output large
  - Consumers long on fossil gen.
  - Sell back fossil gen. below MC
  - Prices below competitive level

- Intermittent output small
  - Consumers buy additional fossil gen.
  - Fossil gen. Sell above MC
  - Prices above competitive level

- Intermittent gen. earns less than under comp.
- Traditional LT contracts don’t help
But MP of conventional G amplifies effect
Assumptions for Numeric Calculation

On average 1/3 of production is wind: $2Q_{\text{w},0} \div Q_{\text{g},0}$.

70% wind uncertainty $Q_{\text{w},0}/2 \div Q_{\text{g},0}/8$.

Assume cost increase from 5£/MWh to 25$/MWh at $Q_{\text{g},0}$:

$\begin{align*}
a &= 5£/\text{MWh} \\
\Rightarrow &= 20$/\text{MWh}/Q_{\text{g},0}.
\end{align*}$

95% contracting level conventional generator: $L_g \div 95 \div Q_{\text{g},0}$.

Assume 10% mark up by monopolist: $p_e \div 27.5£/\text{MWh}$.

This implies $1/3, b \div \frac{Q_{\text{g},0}}{50£/\text{MWh}}$. 
Short term market power biases against wind

- Wind power, 34% market share, 70% volatility
- **Competitive G**, average p: 25.00 £/MWh
- Increasing MC reduces wind rev: 21.42 £/MWh
- Cost of volatility: 3.58 £/MWh

- **Monopolist G**, average p: 27.50 £/MWh
- Inc. MC+monop. red. wind rev: 20.20 £/MWh
- Cost of volatility: 7.30 £/MWh

- Wind power does not share 10% market power mark-up but loses 5% due to market power.

Ref: Neuhoff, Twomey 2004
## Conclusion

### Short term
- Basic design options
- Implications uncertainty
- Implications market power
- Size of zones
- Integration of markets
- Integration of systems

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<tr>
<th>Sep v.s. Int</th>
<th>PT diff in net</th>
<th>need flexibility</th>
<th>smaller is better</th>
<th>together with reg evolution helps</th>
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### Long term
- Physical v.s. financial
- Allocation of contracts
- Reference node

### Intermittency – renewables
- unexplained diff matters
- more analysis
- flex., no ST MP