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SUPERGEN

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

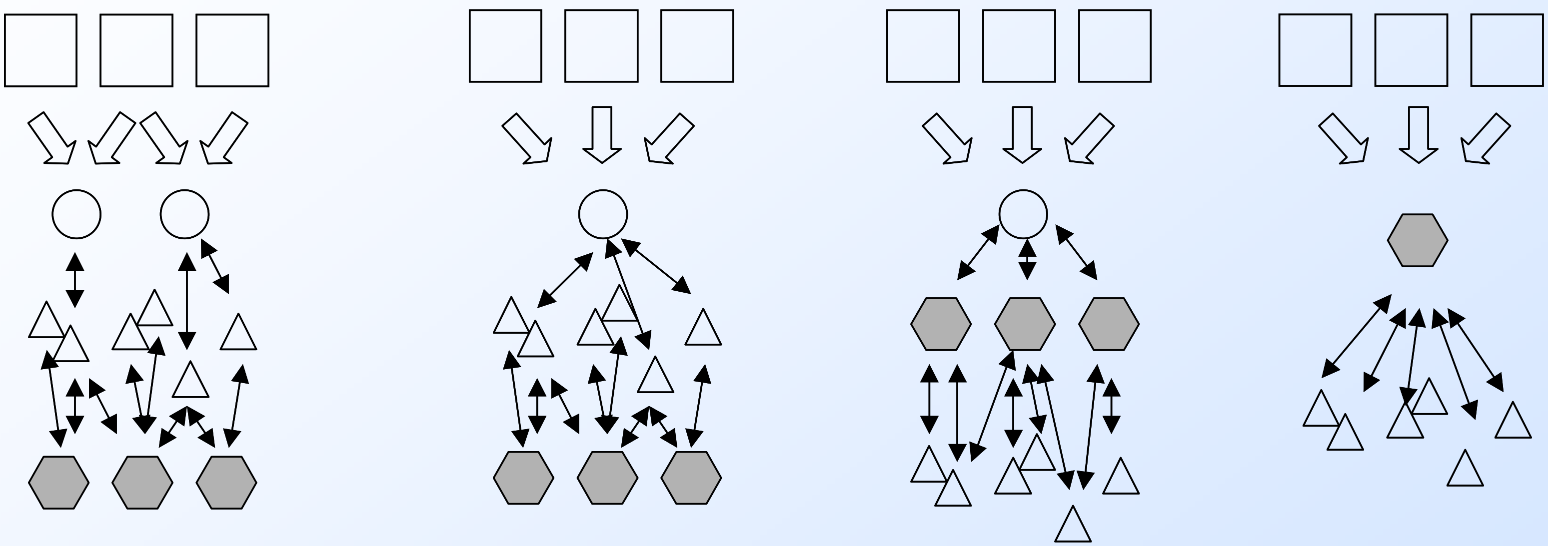
EC Regulation on congestion management

- 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

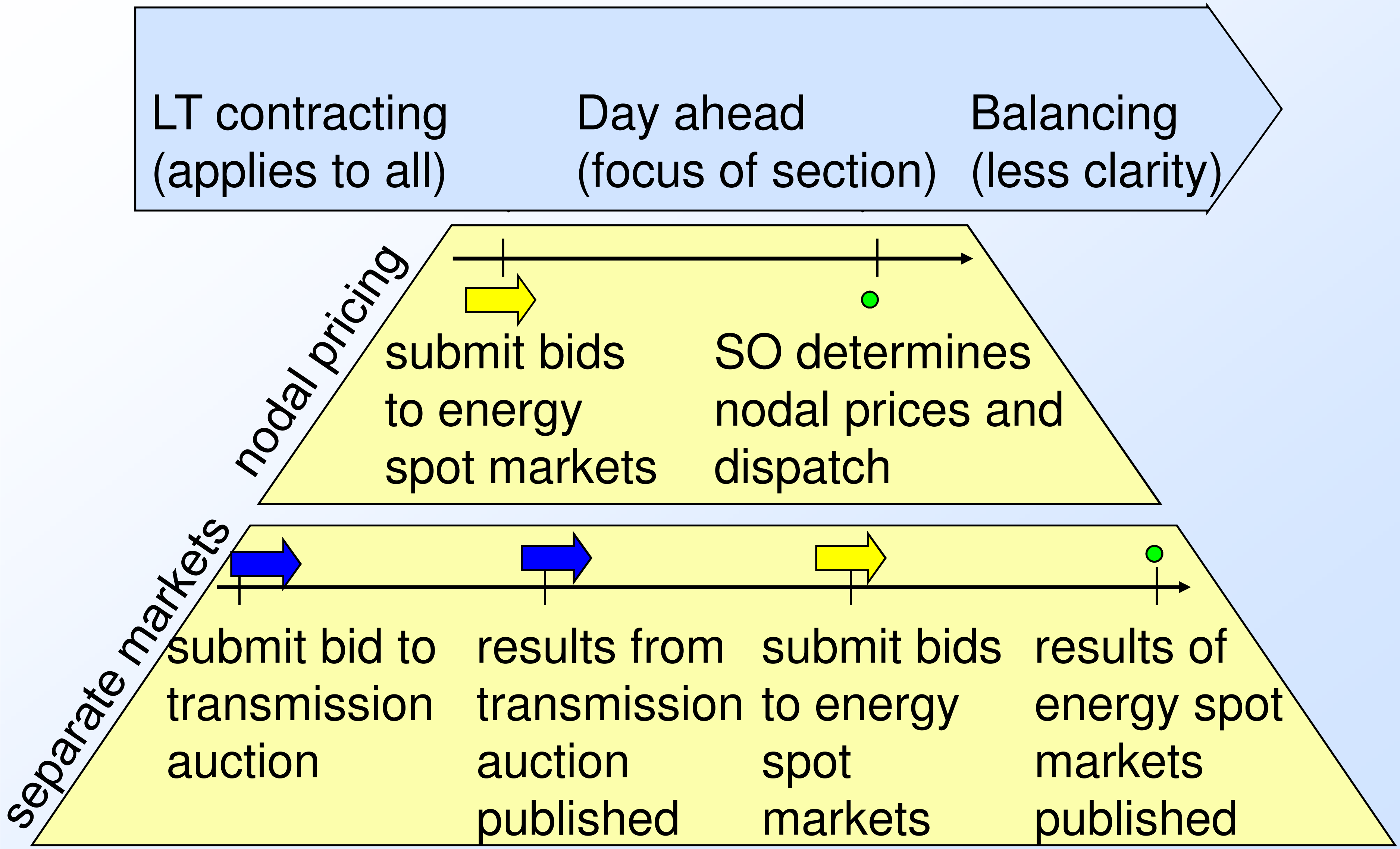
Decentralised auction | Coordinated auction | Market coupling | Nodal pricing



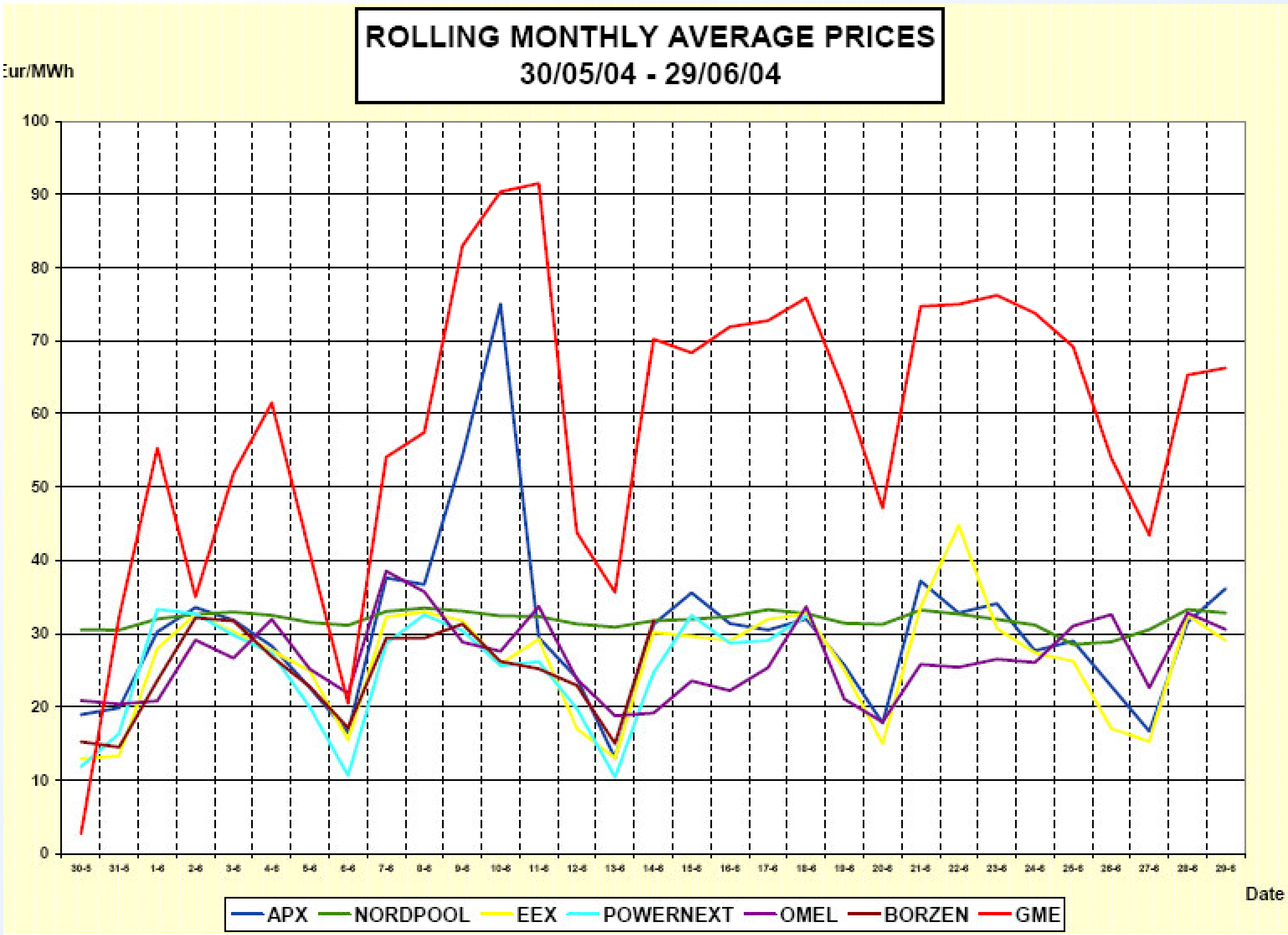
- National/regional system operator
- Transmission auctioneer
- Market Participant
- National/regional power exchange
- Declare available capacity
- Participation in auction

Ref: Coordinated auction: Arriaga, Omos 2004, ETSO 2001, O'Neill, R.P., et al., The Joint Energy and Transmission Rights Auction: A General Framework for RTO Market Designs. 2001, Market coupling see Nordpool or europex.org (2003), Nodal pricing: Schweppe, F., et al., Spot pricing of electricity. 1988, summary in Brunekreeft, Neuhoff, Newbery 2004

How to allocate transmission capacity?

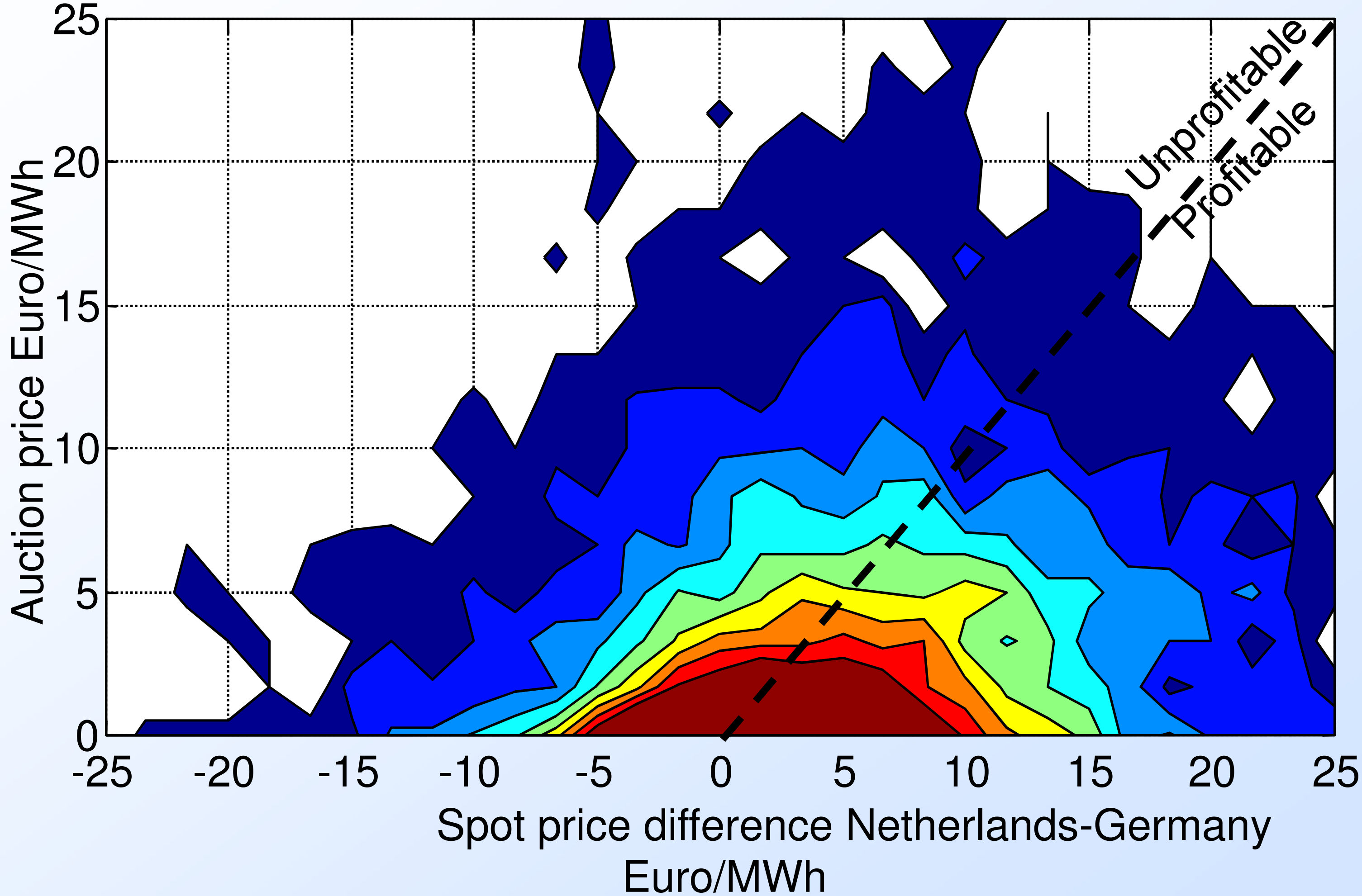


Europe – many markets to integrate



Source: Europex.org, APX, Netherlands;
EEX, Scandinavia, EEX, Germany; POWERNEXT, France; OMEL, Spain; Borzen, Slovenia; GME, Italy

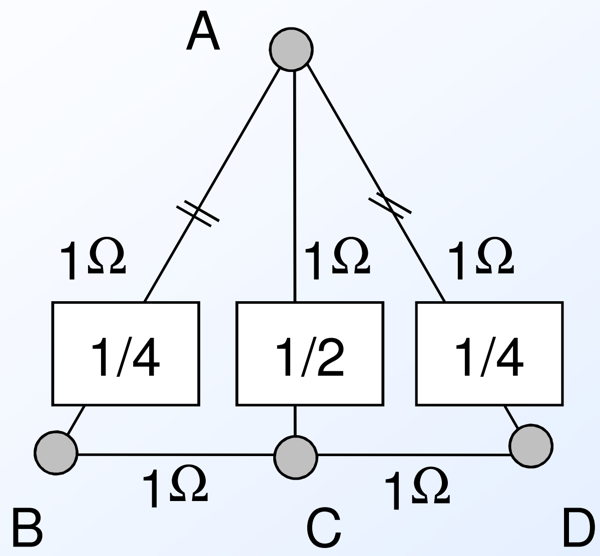
Inefficiency of separate market design – 2 node



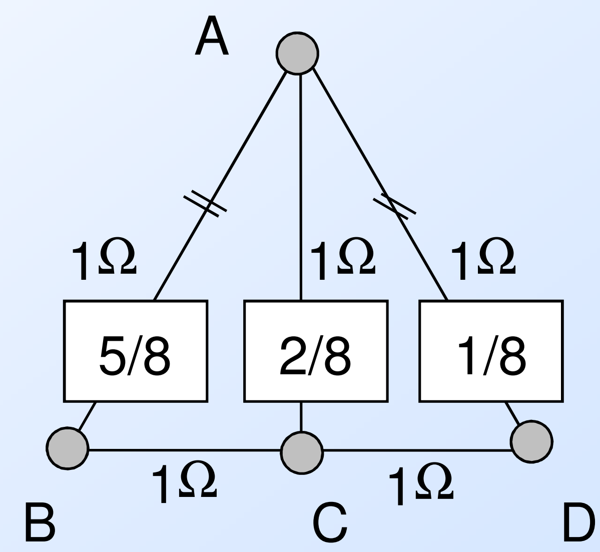
Ref: Neuhoff 2003

Inefficiency of separate market design: 3 nodes

Analysing flow from A to C



Analysing flow from A to B

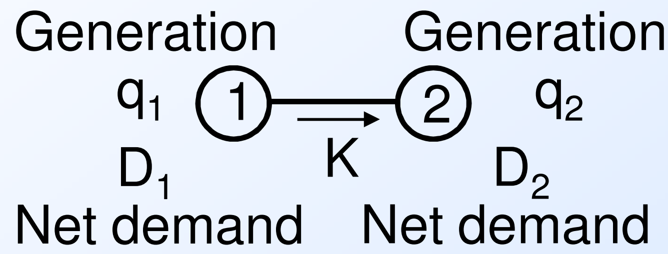


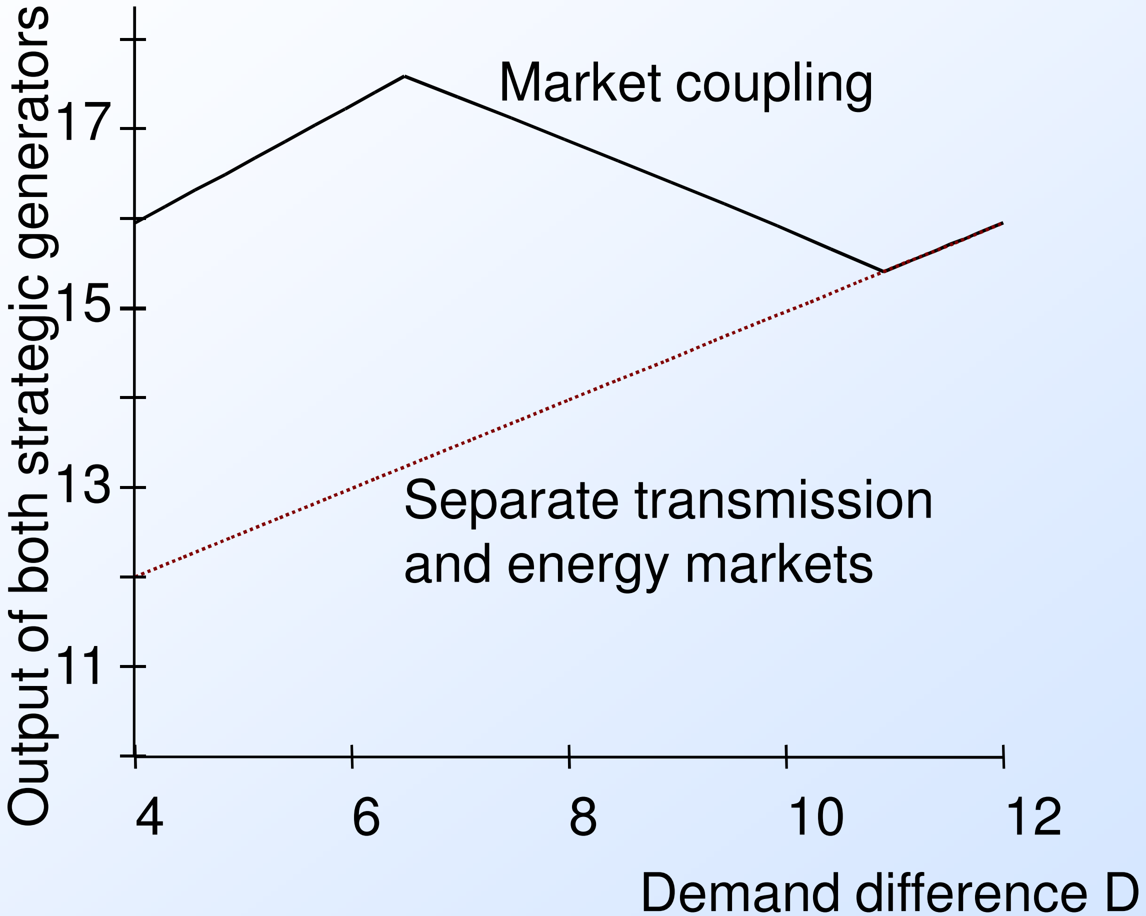
- Assume additional demand for T from A to C
- Option 1: Swap 2 T AB for 1T AC
- Option 2: Swap 1 T AB & 1 T AD for 2T AC
- Efficient network use requires complex swaps.

Market Power Consequences

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

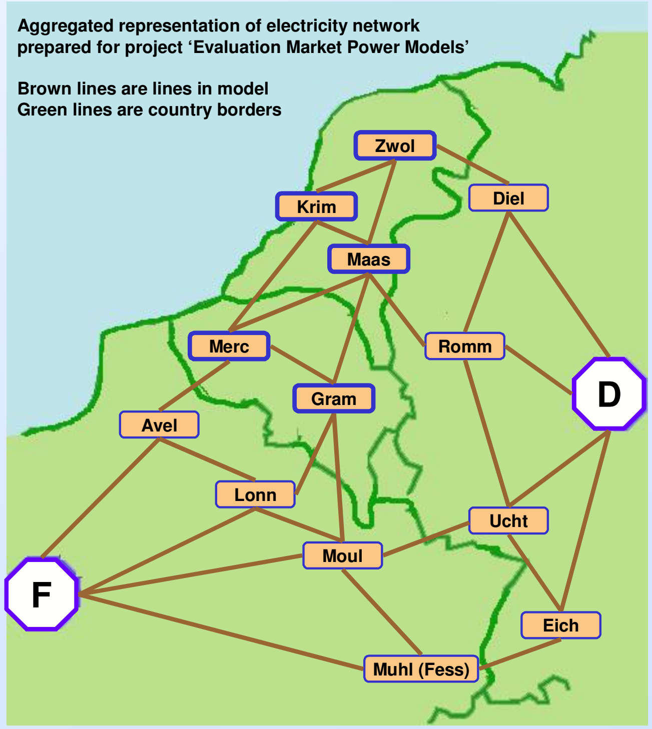
Analytic comparison



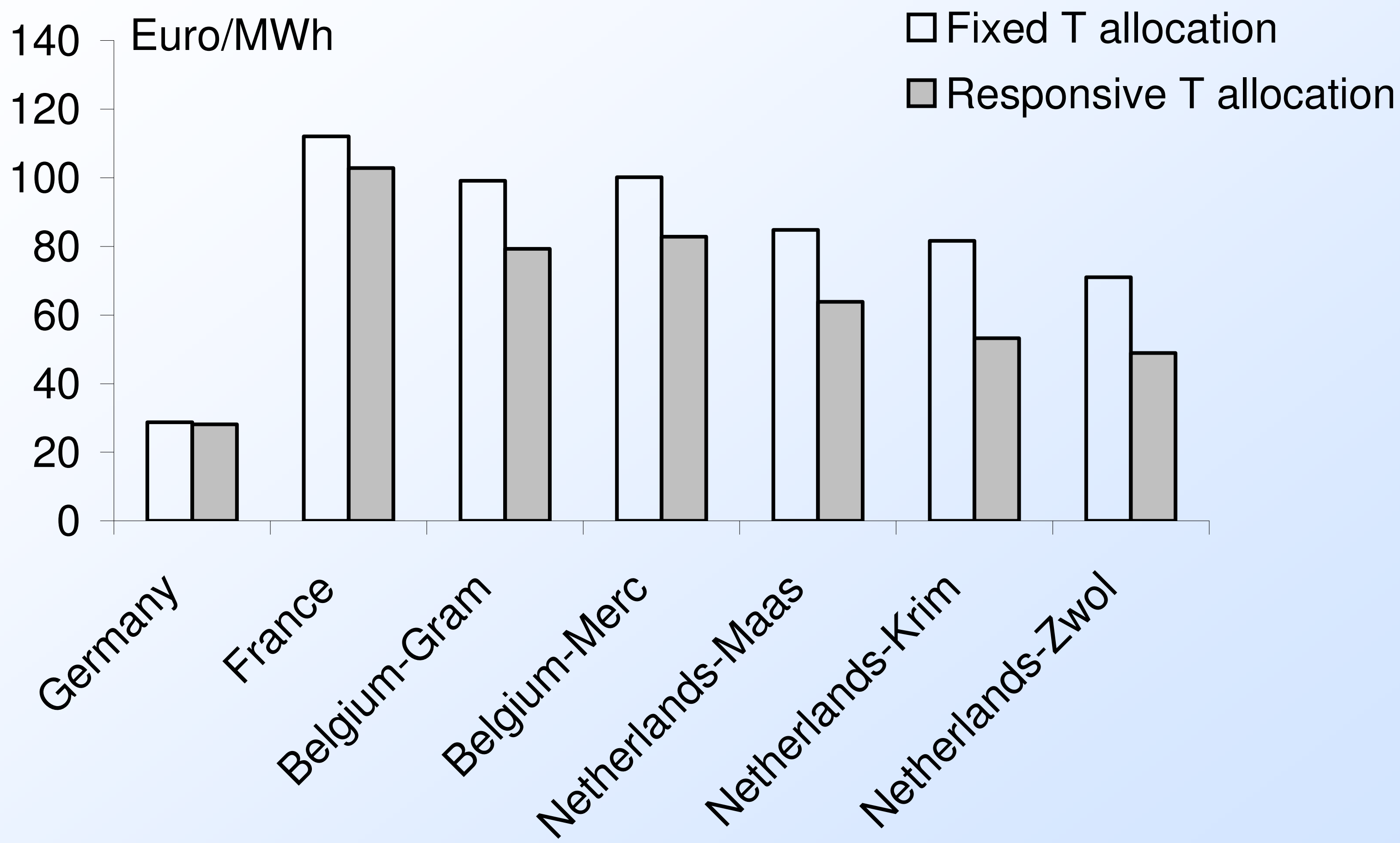


Numerical analysis of MP in meshed network

- 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



Ref: Ehrenmann, Neuhoff 2003, Barquin, J., Boots, M.G., Ehrenmann, A., Hobbs, B.F., Neuhoff, K. and Rijkers, F.A.M. (2004)

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?

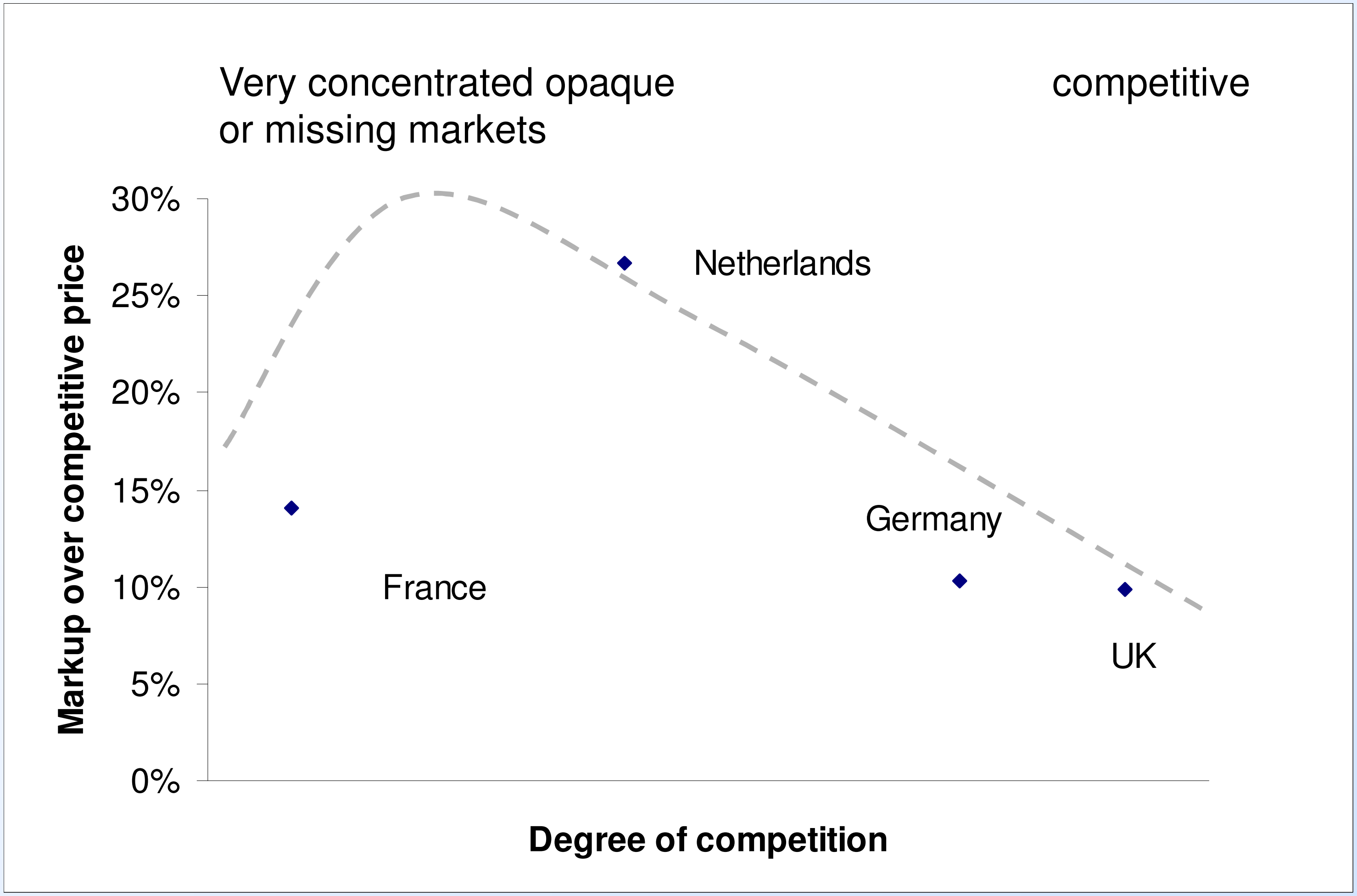
Boccard and Benintendi (2002) "An Efficient Mechanism for Cross-Border Congestion Relief", Toulouse Conference, 2002
Glachant and Pignon (2003), "Nordic electricity congestion's arrangement as a model for Europe: Physical constraints or operators' opportunism?", Ivar Wangensteen, Alternative models for 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.

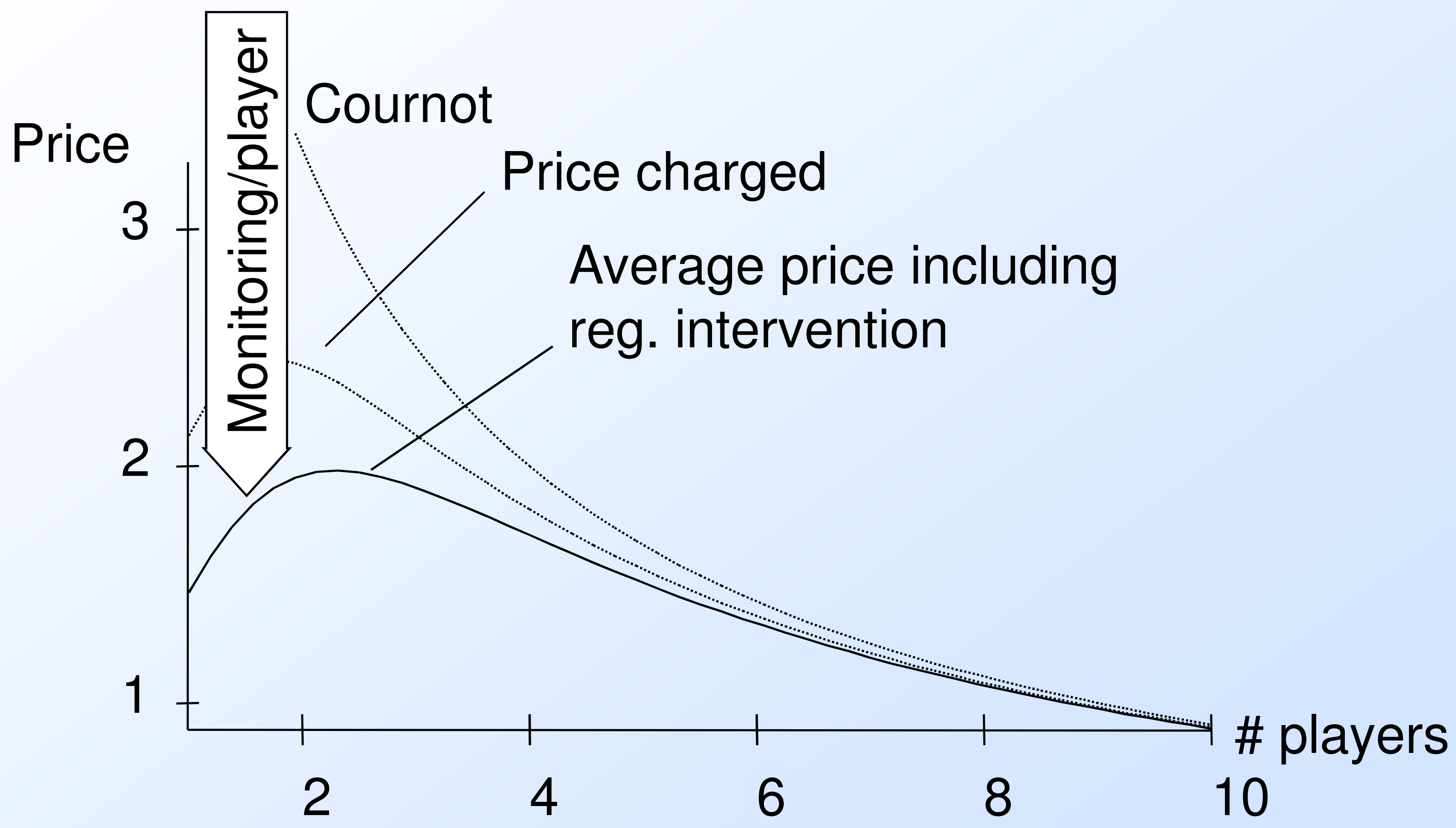
1. Harvey and Hogan, 2000, Nodal and zonal congestion management and the exercise of market power.
2. NGT (UK) is lucky, few constraints, can be incentivised to contract (unbundled, island)

Creating competition might require endurance



Ref: Neuhoff/Newbery 2004

Markup is not monotonic in concentration



Implications for regulation

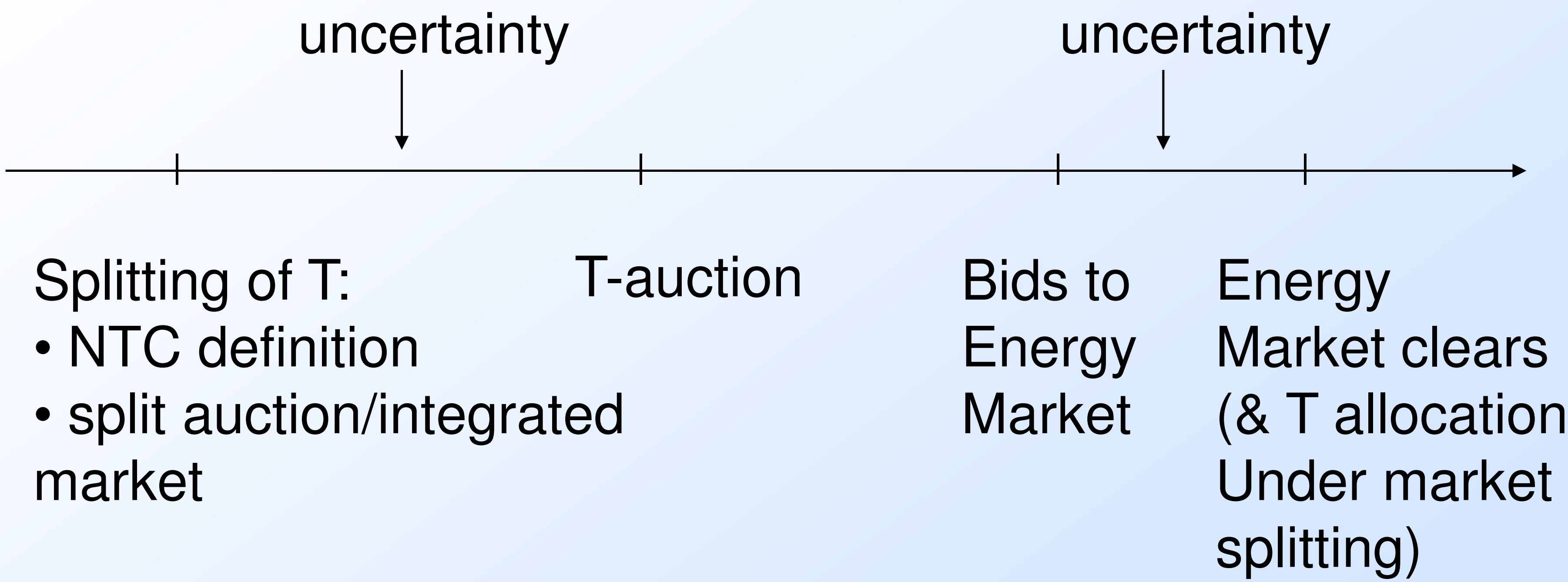
- Unconstrained transmission
  - Initial competition increase can increase p.
  - Insufficient Comp/reg. effort, if impact on neighbour's customers not internalised.
- (Temporarily) constrained transmission
  - Ensure that not only G but reg/comp authority understands and acts on local MP.

EC regulation does not (yet) specify methodology

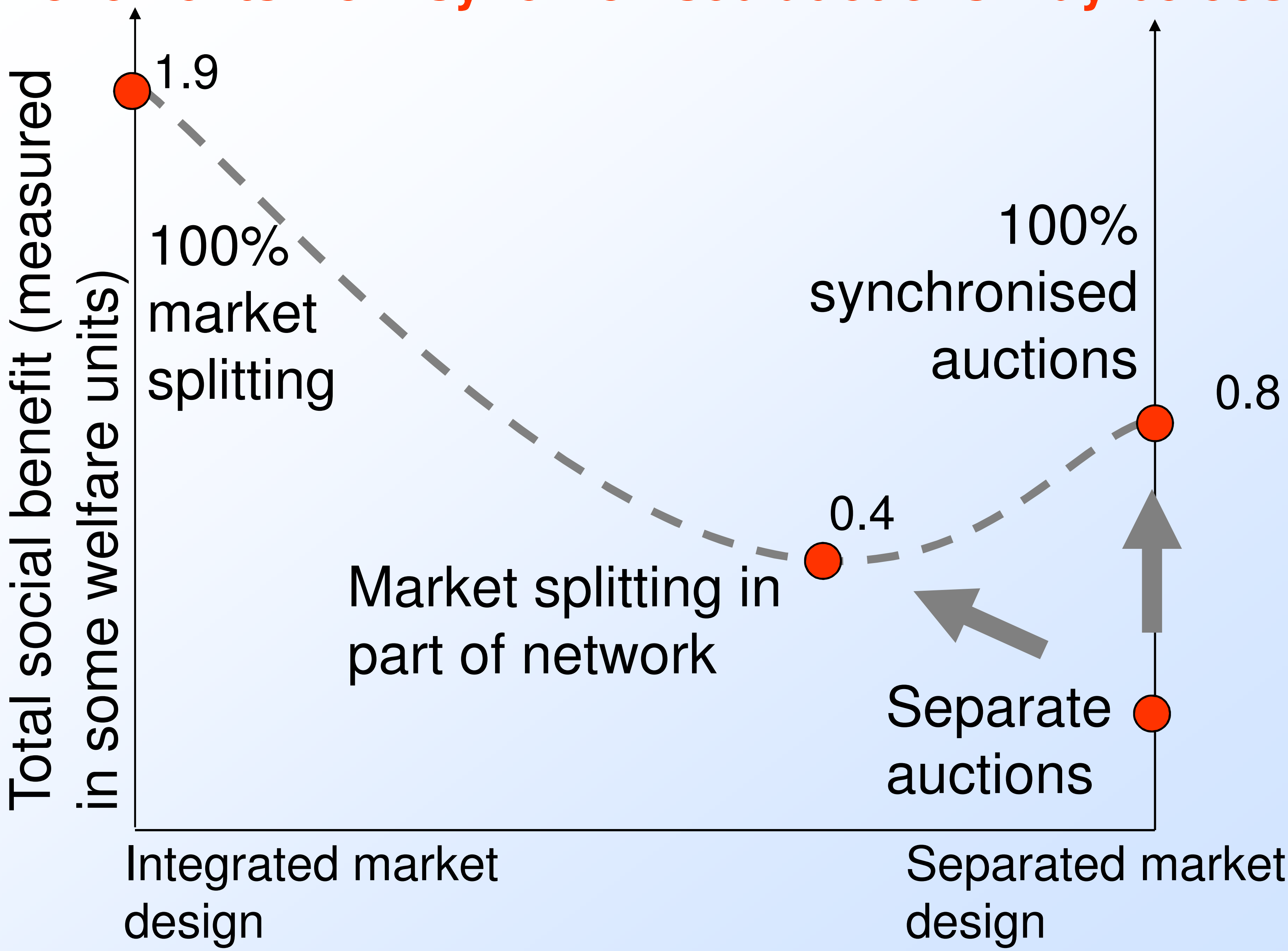
- Preamble (17): It should be possible to deal with congestion problems in various ways.
- Appendix mentions both 'market splitting' and explicit auctions.
- Preamble (18): provision … [to] allow the adoption of decisions and guidelines with regard to … capacity allocation by the Commission.
- Preamble (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



Movements from synchronised auctions may be costly



Ref: Neuhoff, Newbery 2004.

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?

Ref: Hogan, W.W., Contract Networks for Electric Power Transmission. Journal of Regulatory Economics (1992), elegant presentation Bushnell and Stoft (1997)

Transmission contracts impact market power 1

- 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
  - $\Rightarrow$ 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

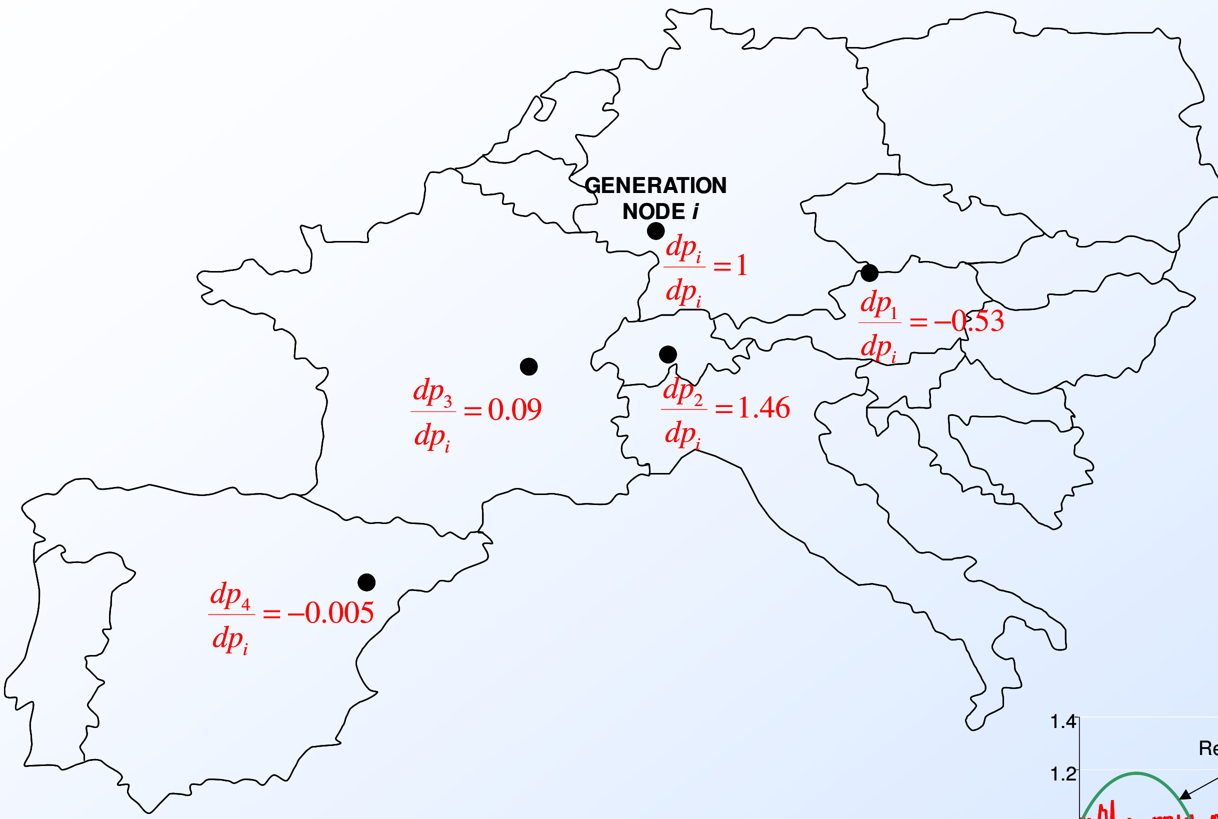
- Pay-as-bid auctions typically inefficient
  - Gencos can outbid traders
- Single price auctions allow efficient arbitrage
  - Gencos should be outbid by traders
  - Market imperfections may restore Genco advantage
- Might not suffice with uncertainty/asym. info
- Restrictions on ownership (e.g. Netherlands)

Ref: Gilbert, Neuhoff, Newbery 2002

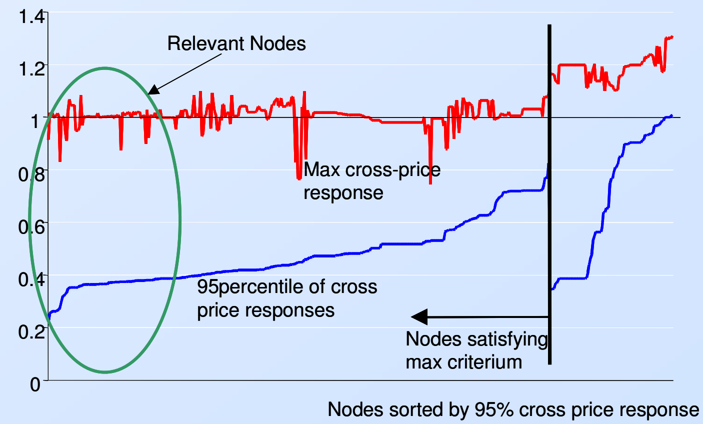
How to implement restrictions on T ownership?

- 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)

Ref: Decision No 1229/2003/EC of the European Parliament and of the Council of 26 June 2003

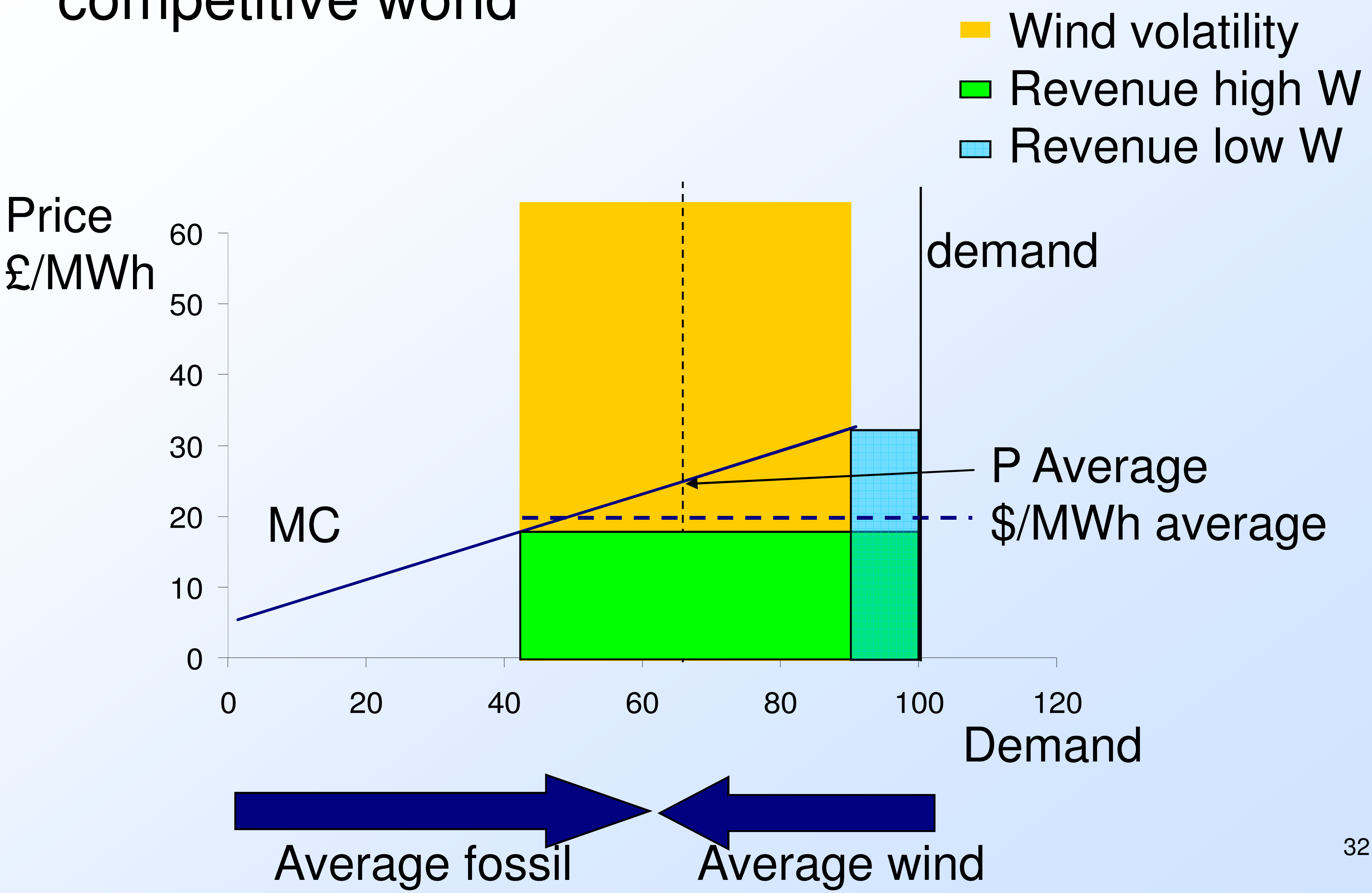
MP and Intermittency – the principle

- 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

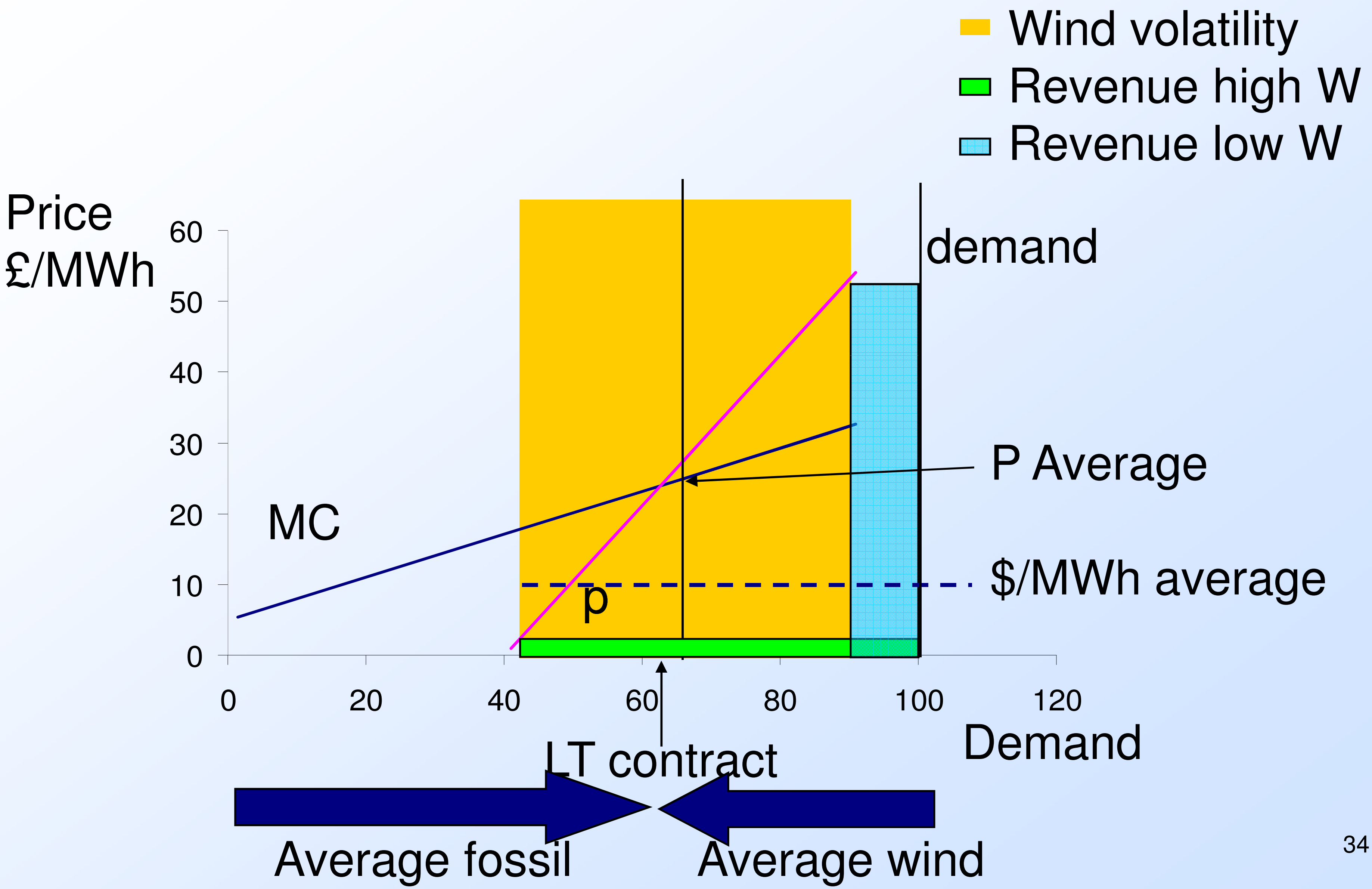
Output volatility decreases wind revenue competitive world



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: $2Q_{w,0} = Q_{g,0}$.

70% wind uncertainty $\sigma_w^2 = Q_{w,0}^2/2 = Q_{g,0}^2/8$.

assume cost increase from 5£/MWh to 25$/MWh at $Q_{g,0}$:
$a = 5£/MWh \qquad c = 20\$/MWh/Q_{g0}$.

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

assume 10% mark up by monopolist: $p_e = 27.5£/MWh$.

This implies $\alpha = 1/3$, $b = \frac{Q_{g,0}}{50£/MWh}$.

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 — Sep v.s. Int
  - Implications uncertainty — PT diff in net
  - Implications market power — need flexibility
  - Size of zones — smaller is better
  - Integration of markets — together with reg
  - Integration of systems — evolution helps
- Long term
  - Physical v.s. financial — unexplained diff
  - Allocation of contracts — matters
  - Reference node — more analysis
- Intermittency – renewables — flex., no ST MP