



UNIVERSITY OF  
CAMBRIDGE | **Electricity Policy  
Research Group**



# How liberalised have liberalised electricity markets become?

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**Market Design 2009**

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<http://www.electricitypolicy.org.uk>



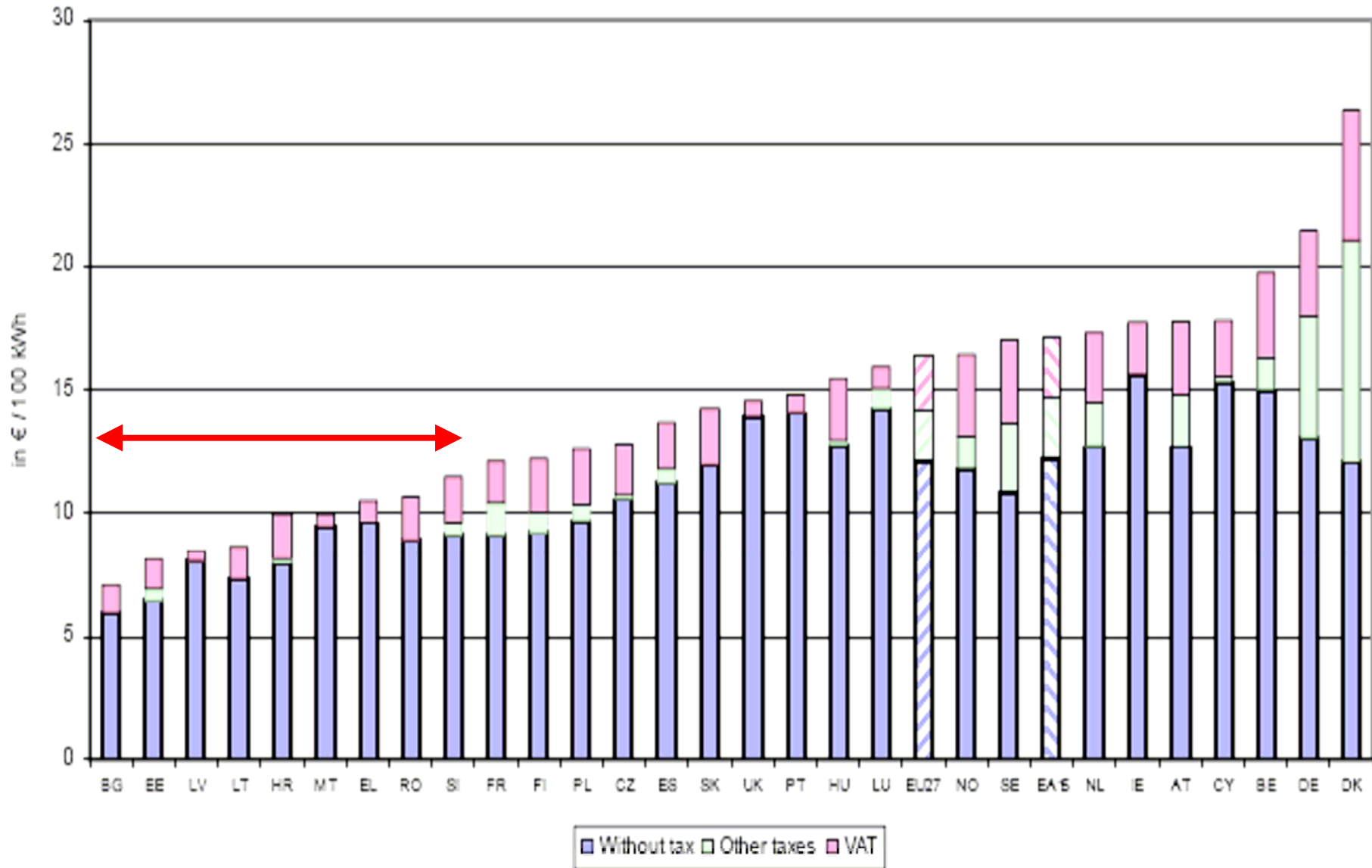
# Outline

- Progress and problems
- Challenges: CO<sub>2</sub> and Renewables Directive
- Unfinished business: integration
- Energy policy: targets or markets?
- Investment, risk and market design
- Support policies for RD&D

# Progress and problems

- Second directive still not fully implemented
- concentration remains high in many MSs
- congestion rents remain high €1.7bn
  - out of total transmission revenues of €11bn
- but congestion management improving
  - some progress to market coupling
  - rivalries impede further integration
- cross-border investment difficult
  - but some progress

# Electricity prices for households 2008



# Electricity Regional Initiative

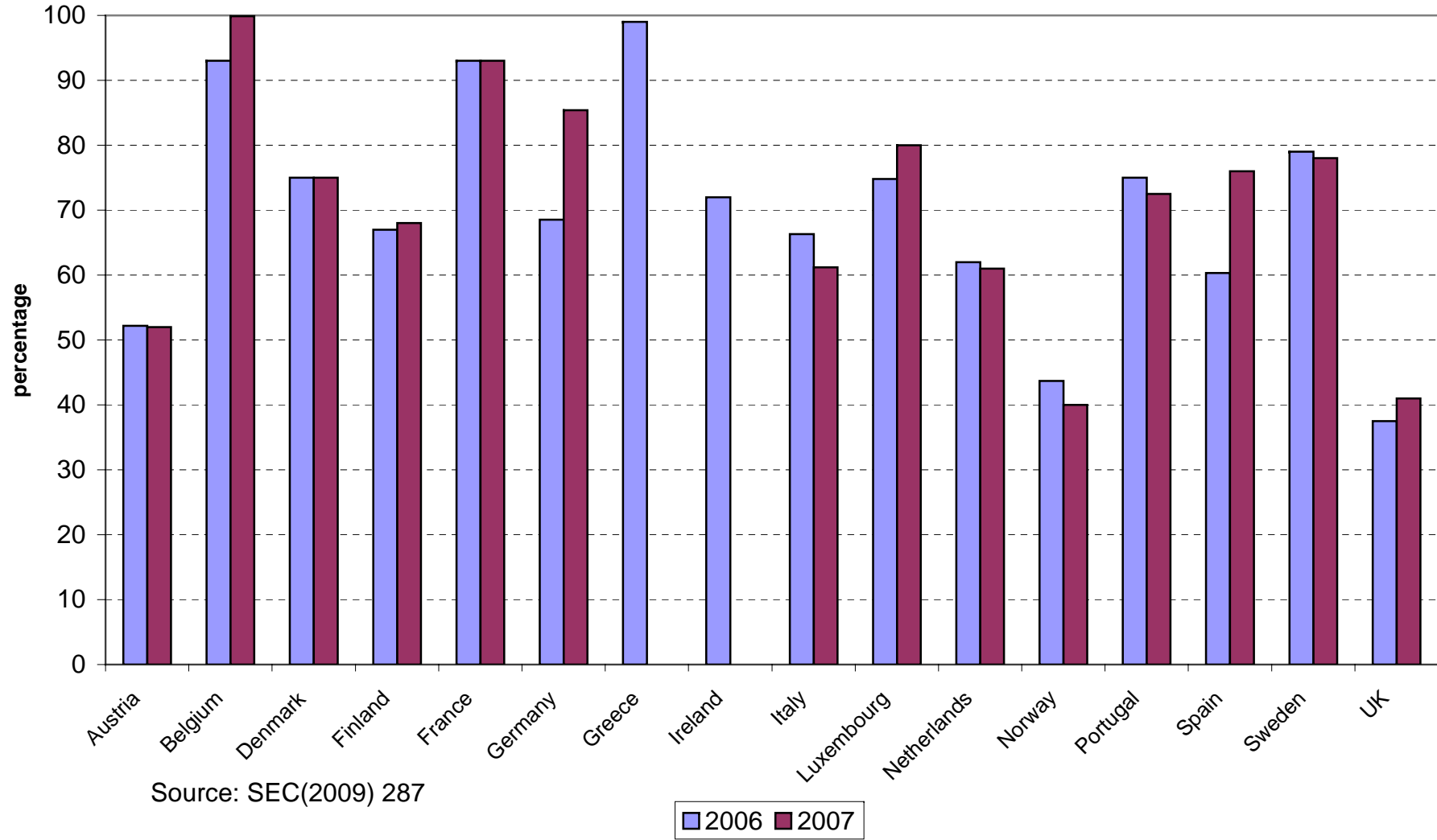
- ERGEG sets up ERI => 7 overlapping regions
  - identify barriers to market integration
  - propose practical improvement
  - implement at regional level
- Convergence and Coherence reports (07, 08)
  - congestion management
  - transparency
  - balancing markets

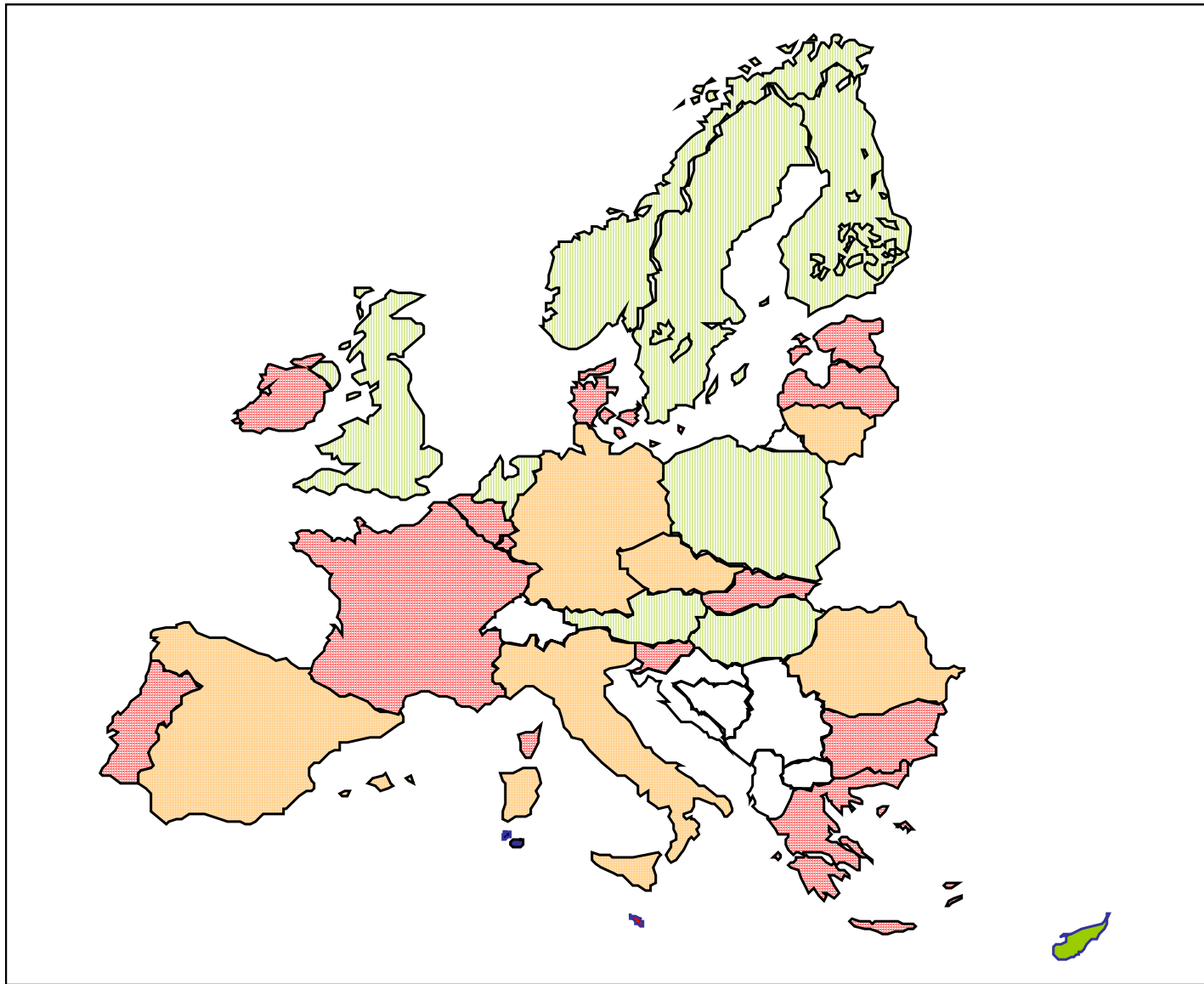
***Aim to converge to single electricity market***

# Challenges

- SEM requires strong coherence/co-ordination
  - but weak incentives to co-operate
- ERI focussed on improving existing system
  - interconnection (IC) still problematic
  - system designed for conventional plant
- Renewables/intermittency  $\Rightarrow$  demand IC  $\uparrow\uparrow$ 
  - and changes to market design, balancing
- investment delays  $\Rightarrow$  IC  $\uparrow\uparrow$
- Divergent coal, gas and C prices  $\Rightarrow$  IC  $\uparrow\uparrow$

### 3-firm concentration ratios for EU15 electricity





- very highly concentrated  
– HHI above 5000
- highly concentrated –  
HHI 1800-5000
- moderately concentrated  
– HHI 750-1800

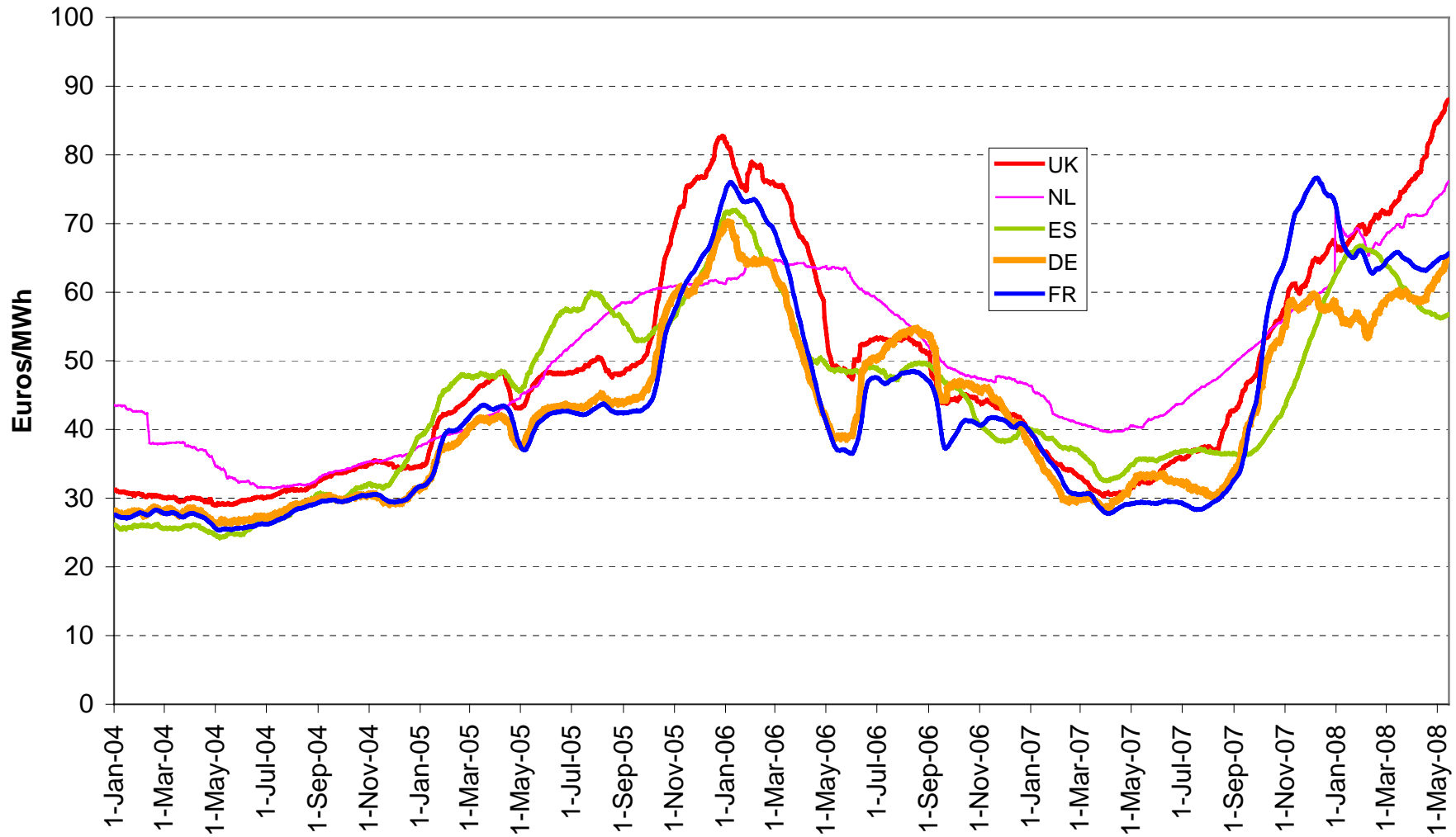




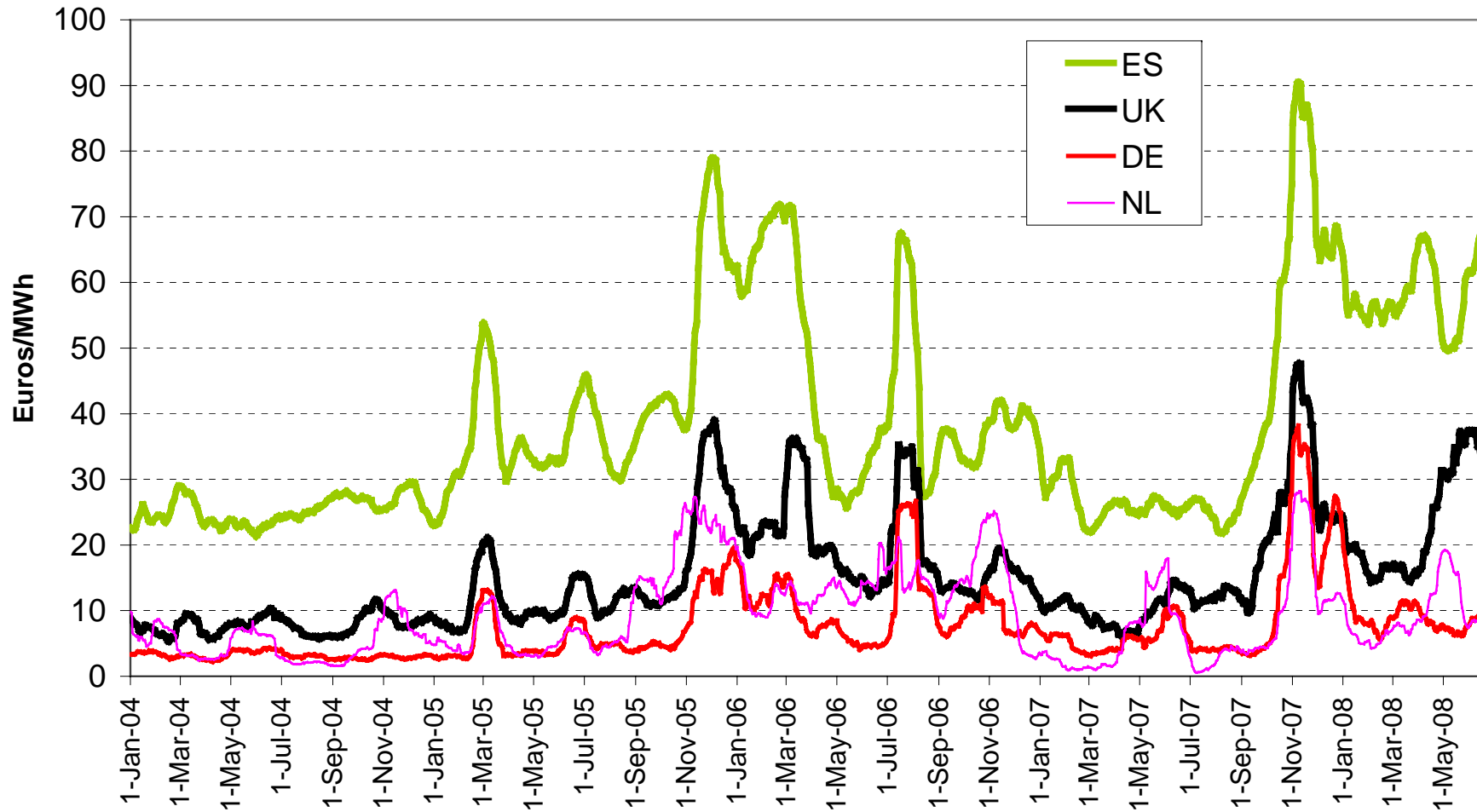
# Unbundling

- Apr 08: CEC Report on progress
  - functional unbundling incomplete
  - Interconnectors: unbundled TSOs invest twice as much as legally unbundled TSOs
  - closer correlation of cross-border prices
    - driven by close co-movements in fuel+C costs?
    - but still considerable absolute differences
    - and fuel prices could diverge again
- Feb 08: E.ON announces divesting networks
  - June 08: RWE plans to sell of gas network

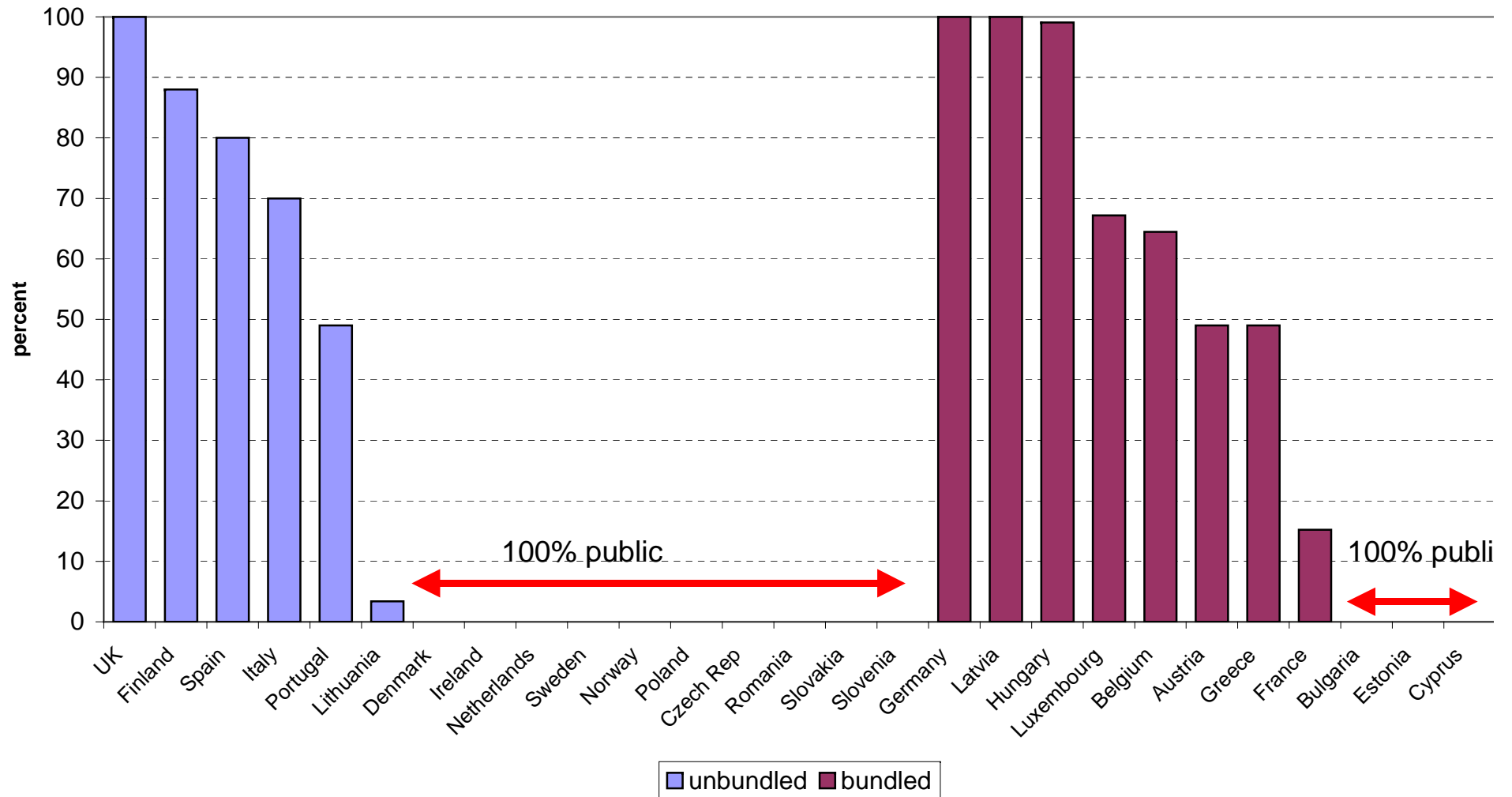
Quarterly moving average PX prices 2004-May 2008



## Algebraic hourly differences, centred monthly averages relative to France, 2004-8

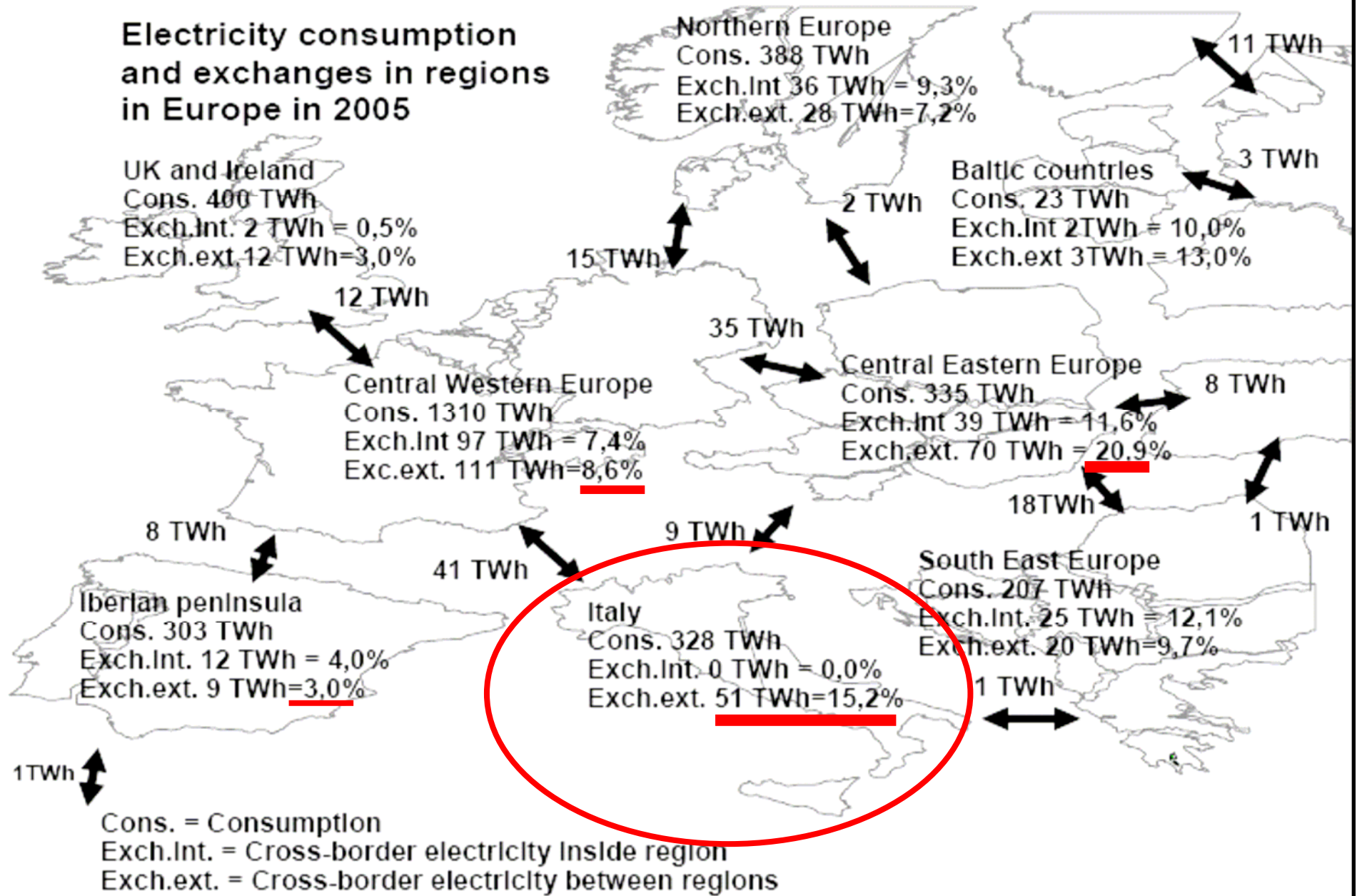


# Private ownership of TSO



Source: SEC(2009) 287

# Electricity consumption and exchanges in regions in Europe in 2005





## Cross-border investment

- 3rd Energy Package: 10-yr investment plan should be published by TSOs every 2 years

=> First UCTE plan published June 08

+90 GW consumption

+220 GW generation (o.w. 80 GW wind)

mismatch makes transmission planning hard

– mostly planning to undertake “studies”

- € 17 billion *should* be invested over 5 yrs

***Most TSOs lack locational price signals***

# Interconnection

- Under-investment in connecting markets
  - benefits of robustness, competition undervalued
- optimal transmission investment needs information on generation investment plans
  - when, where and what (wind or dispatchable?)
  - ETS, gas liberalisation reduce need for IC?
  - but wind increases need for interconnection
- Hampered by vertical integration, opacity
- Who pays and how?

# Models for transmission investment

- ISO/RTO or coordinating unbundled TSOs
  - Brattle: no evidence TSOs better
    - Nordpool - under-invests?
    - BETTA (RTO: extra coordination costs £5m p.a.?)
  - Contrast investment within and between MSs
    - within: responsibility of TSO anyway
    - between: RTO/ISO overcomes conflict of interest
- need for pan-European IC planning?*





# Financing interconnection

- Who should pay? Beneficiaries?
  - Easy with merchant lines and zonal pricing
  - Normed very profitable
  - but vulnerable to future investments in G and T
  - and incentive to under-invest
- Resilience and reduction of market power undervalued

***How well does cross-border tariffication work?***



## Inter-TSO compensation (ITC)

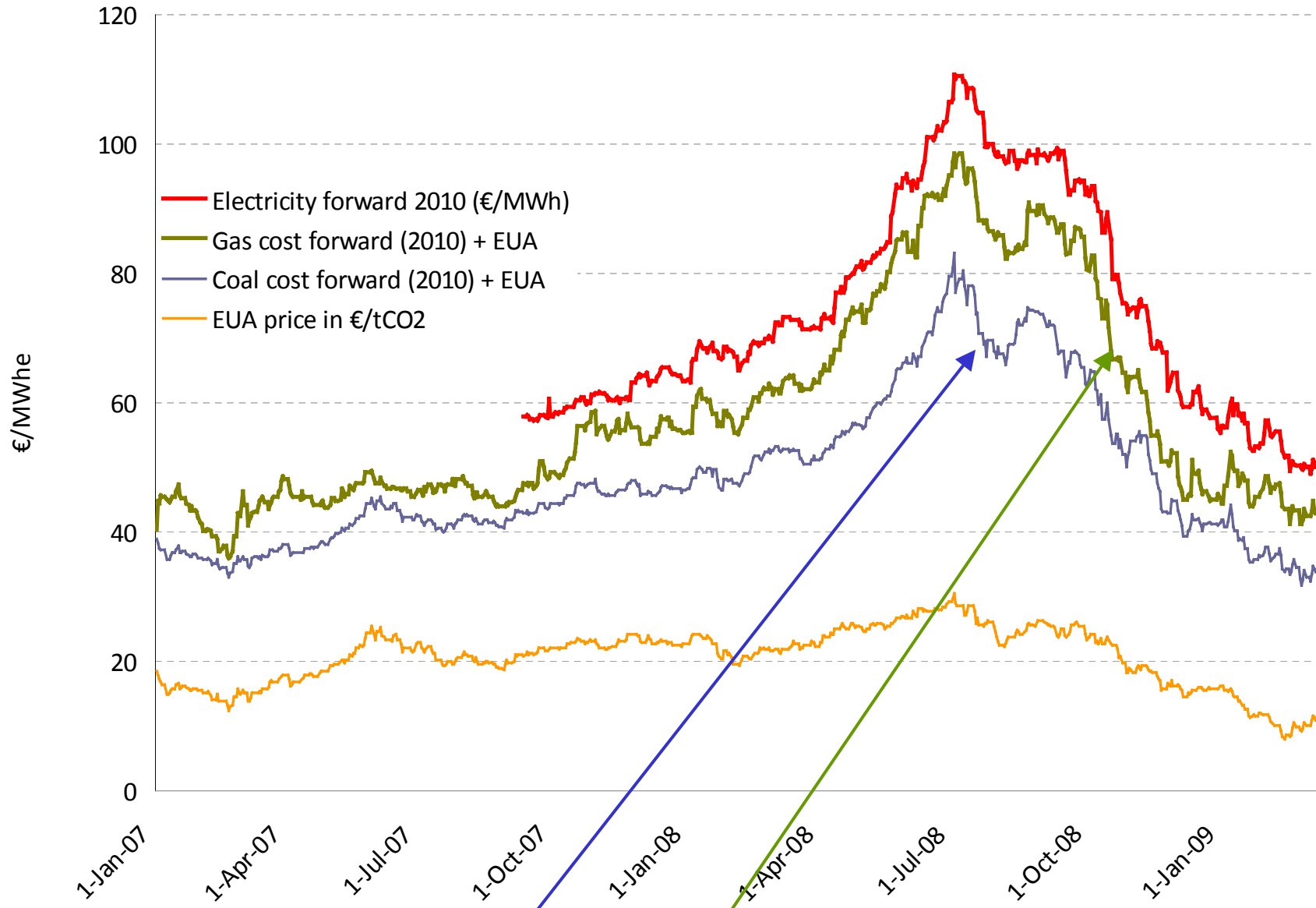
- CBT for existing network is zero-sum game
    - unlikely to lead to efficient pricing
  - New cross-border links should add value
    - issue is how to finance to deliver net gains
- => Leave agreed CBT for existing network?
- Design mechanism for new links
    - planning agency selects best projects
    - simulates gains, proposes charges to TOs
    - tenders for construction

# Investment in liberalised markets

- CEC presses for single electricity market
  - based on market principles
  - with substantially more interconnection
- Capacity margins projected to fall 2016 with LCPD => investment needed
- Transmission investment needed
  - for wind, interconnection

*What are the risks facing investors?*

UK price movements: 2007 to 2009 in €



**Correlation of coal+EUA on gas+EUA high at 96%**



# Criteria for market design

- Foster competition and entry => efficiency
- Incentives for timely, efficient (**location** and type) and adequate investment in G and T
  - reflecting comparative advantage
- Reflect **social** cost of carbon
- allow RD&D support **without distortion**
- deliver efficient **dispatch**
- at acceptable cost to final consumers



# Implications for Europe

- European market operates as integrated whole
  - efficient Europe-wide dispatch
  - efficient SO/balancing across borders
- Renewables built where cheapest
  - but costs share equitably
- Cost-effective interconnection as needed
  - to reduce cost of intermittency

*None of these currently guaranteed*



# UK's 2020 renewables target

= 40% renewable **ELECTRICITY** (SKM mid scenario)

= **150 TWh**; wind = 38GW; total 110 GW

– 56 GW conventional @ 31% fossil fuel load factor

– investment cost of renewables = **€70 bn + €15 bn grid**

– of non-renewables = **£12 b**, (£coal=3.9b; nuclear = £3.9b)

= **€95/t CO<sub>2</sub>** c.f. €14/t current EUA

- 38 GW > demand for many hours

=> volatile supplies, prices, congestion, ....

- Offshore wind dependent on electricity price

– now looks unfavourable even with banded ROCs

– FIT cheaper than HMG's banded ROCs (Redpoint)

# Implications of substantial wind

- Much greater price volatility
  - mitigated by nodal pricing in import zones
  - requires CfDs and nodal reference spot price
- Reserves (much larger) require remuneration
  - VOLL\*LOLP capacity payment?
  - or contracted ahead by SO?
  - Or will spot price volatility induce contracts that cover availability costs?

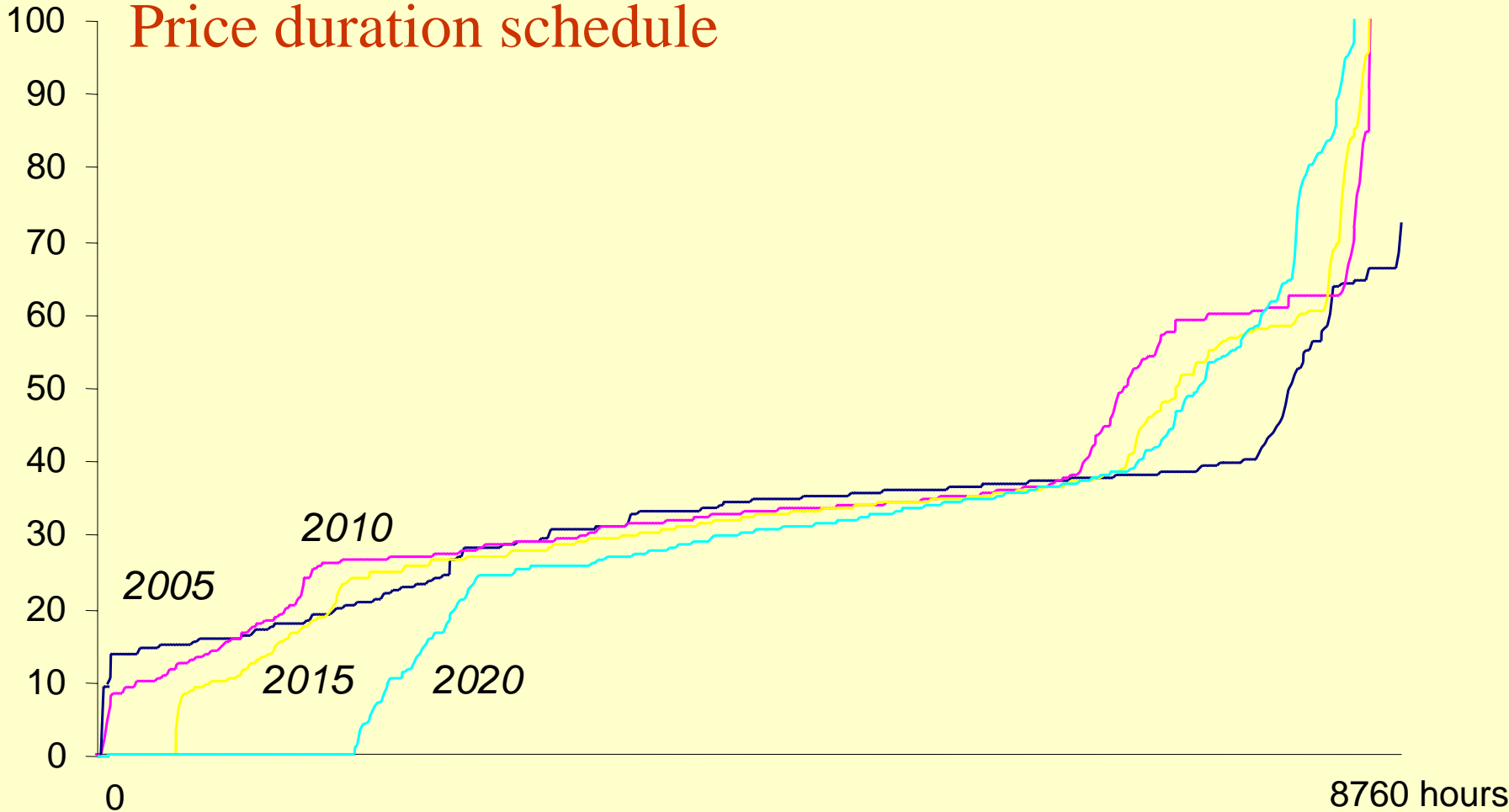


# Simulation – more volatility, harms baseload (nuclear)

Euro/MWh

*Illustrative*

## Price duration schedule



# Is nuclear viable in liberalised markets?

- Credit supply drying up
  - low risk free rate (indexed bonds)
  - but high cost of capital to most companies
- Low debt-equity needed for construction
- electricity price-cost margin very volatile
  - issue electricity indexed bonds?
  - or require long-term carbon price guarantee?

*Is any electricity investment viable without an off-take contract?*

# Towards a Single Buyer?

- The cost of off-shore is huge
  - unsustainable in current conditions?
  - Precipitate move to long-term contracting?
  - Spot market too risky to support investment?
  - Balancing market works overtime with wind
- Any investment without a long-term contract?
  - But then need a Single Buyer?
  - With short-fall in spot market revenue via capacity payment charged through grid?

*How long before a viable market design?*

# The argument for change

- A flawed system can be improved  
=> potentially everyone can be made better off
- The challenge:
  - identify the efficient long-run solution
  - that can co-exist with an evolving regime for incumbents
  - apply new regime to all new generation
  - which compensates incumbents for any change
  - while encouraging them to migrate

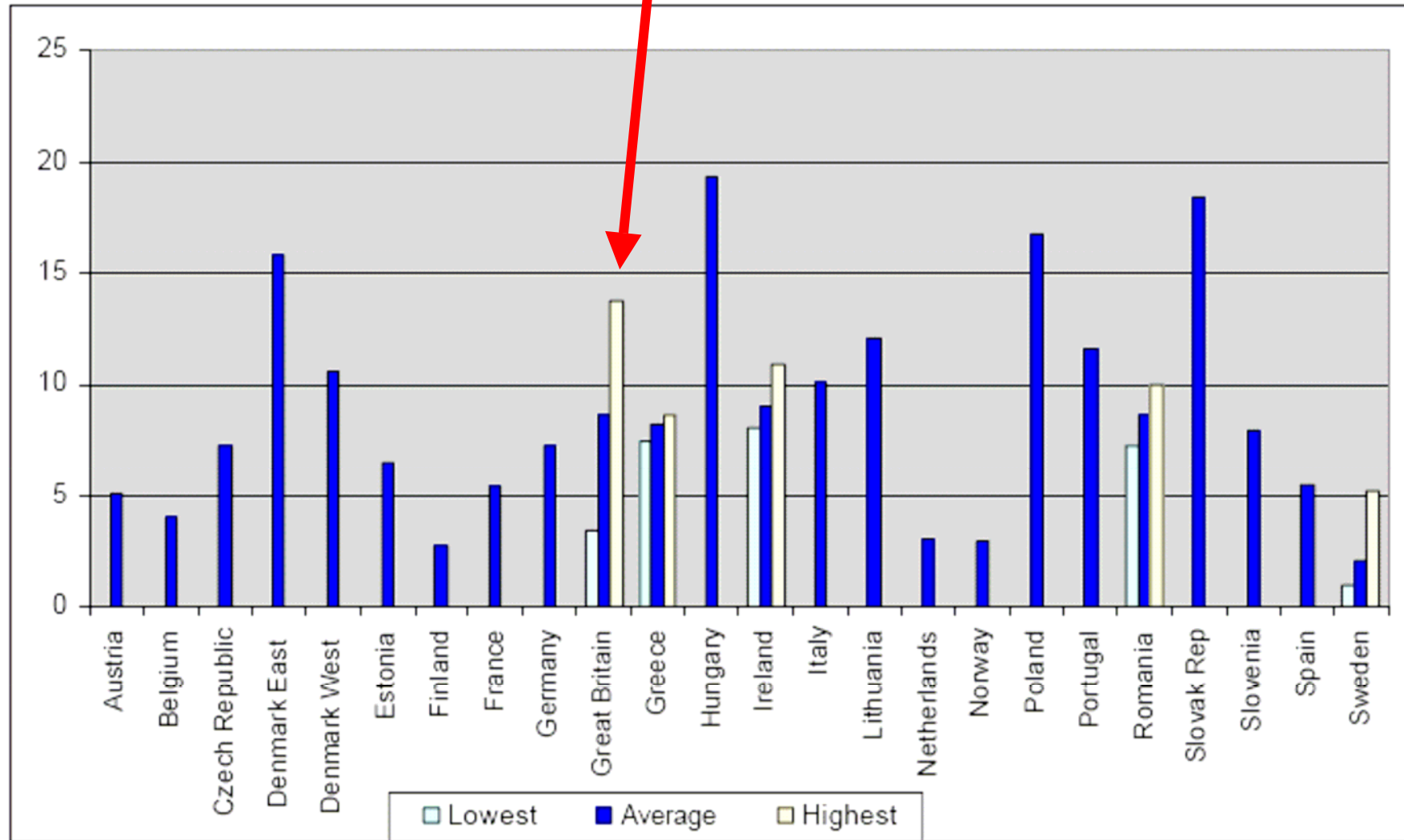
# Efficient congestion management

- Nodal pricing or LMP for optimal spatial dispatch
- All energy bids go to central operator
- Determines nodal clearing prices
  - reflect marginal losses with no transmission constraints
  - Otherwise nodal price = MC export (or MB of import)
- Bilateral energy contracts
  - Can submit firm bids => pay congestion rents
  - Can submit price responsive bids => more profit
- Financial transmission contracts hedge T price risk

# Comparison of transmission tariffs G+ L: impact of location

Euro per MWh

Locational pricing rare





# Spatial and temporal optimisation

=> nodal pricing + central dispatch

- Nodal price reflects congestion & marginal losses
  - lower prices in export-constrained region
  - efficient investment location, guides grid expansion
- **Central dispatch** for efficient scheduling, balancing
- Market power monitoring – benchmark possible
- PJM demonstrates that it can work
  - Repeated in NY, New England, California (planned)

# Transition for existing plant

- Existing G receives long-term transmission contracts but pays grid TEC charges
  - for output above TEC, sell at LMP
- ⇒ G significantly better off than at present
- ⇒ No T rights left for intermittent generation

***Challenge: devise contracts without excess rents and facilitate wind entry***



# Politics and constraints

- Aim: **Security, Sustainability, Affordability**
- choose any two of three?
  - Or minimise cost of achieving efficient level of security while meeting CO<sub>2</sub> and renewables objectives
- Currently costs all levied on consumers
  - and excessive because of ROCs etc

***Creates additional policy uncertainty***

# Support for RD&D

- Renewables subsidy above C price justified by learning benefits => commercialise to save the planet
- Why charge electricity consumers for that?
  - VAT on energy better but still inefficient
  - except to correct energy subsidies

***Solution - fund from general taxation or  
EUA auction revenues (as with CCS)***

# Conclusions-1

- Low-C electricity requires proper C price
- Renewables target justified by learning benefits
  - requires *and currently lacks*
    - efficient transmission access regime
    - efficient market design for dispatch and balancing
- Efficient decisions require either Single Buyer or nodal pricing + pool/SO control
- both require transition arrangements/contracts
  - for new/old Generation

## Conclusions-2

- Renewables and other targets undermine liberalised market
  - => threatens *all* generation investment
- Current UK support for RES risky and costly
  - => required shift to long-term contracting marks end of liberalised market?

Nuclear power needs an attractive offering to compete politically with renewables:

*attractive real return with sensible C price*

## Conclusions - 3

- Carbon pricing: ETS needs CfDs
  - or a central carbon bank to stabilise EUA price
- RD&D support needed to lower costs
  - to commercialise in BRICs etc
- needs design driven by **learning objective**
  - burden sharing via country targets helps
  - but emphasises least cost not most learning
  - support should be from public expenditure



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# Acronyms

C-price: carbon price

CBT: Cross-border tariffication

CCS: carbon capture and sequestration

CEC: European Commission

CfD: contract for difference

EUA: European emission allowance (for 1 tonne CO<sub>2</sub>)

ERI: Electricity Regional Initiative (of ERGEG)

ETS: Emission Trading System

FIT: feed-in tariff

GHG: greenhouse gas

G: generation

IC: Interconnector

# Acronyms

LCPD: large combustion plant directive

LMP: locational marginal pricing

LOLP: Loss of load probability

MC, MB: marginal cost, marginal benefit

PV: photo-voltaic

RES: renewable electricity supply

ROC: renewable obligation certificate

RTO: Regional Transmission Operator

SEM: Single Electricity Market

(I) SO: (Independent) System operator

T: transmission

TEC: transmission entry capacity (to access grid)

TSO: transmission system operator

VOLL: Value of lost load