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E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Governance of electricity networks

David Newbery

Joint Cambridge-MIT Conference

Electricity Markets

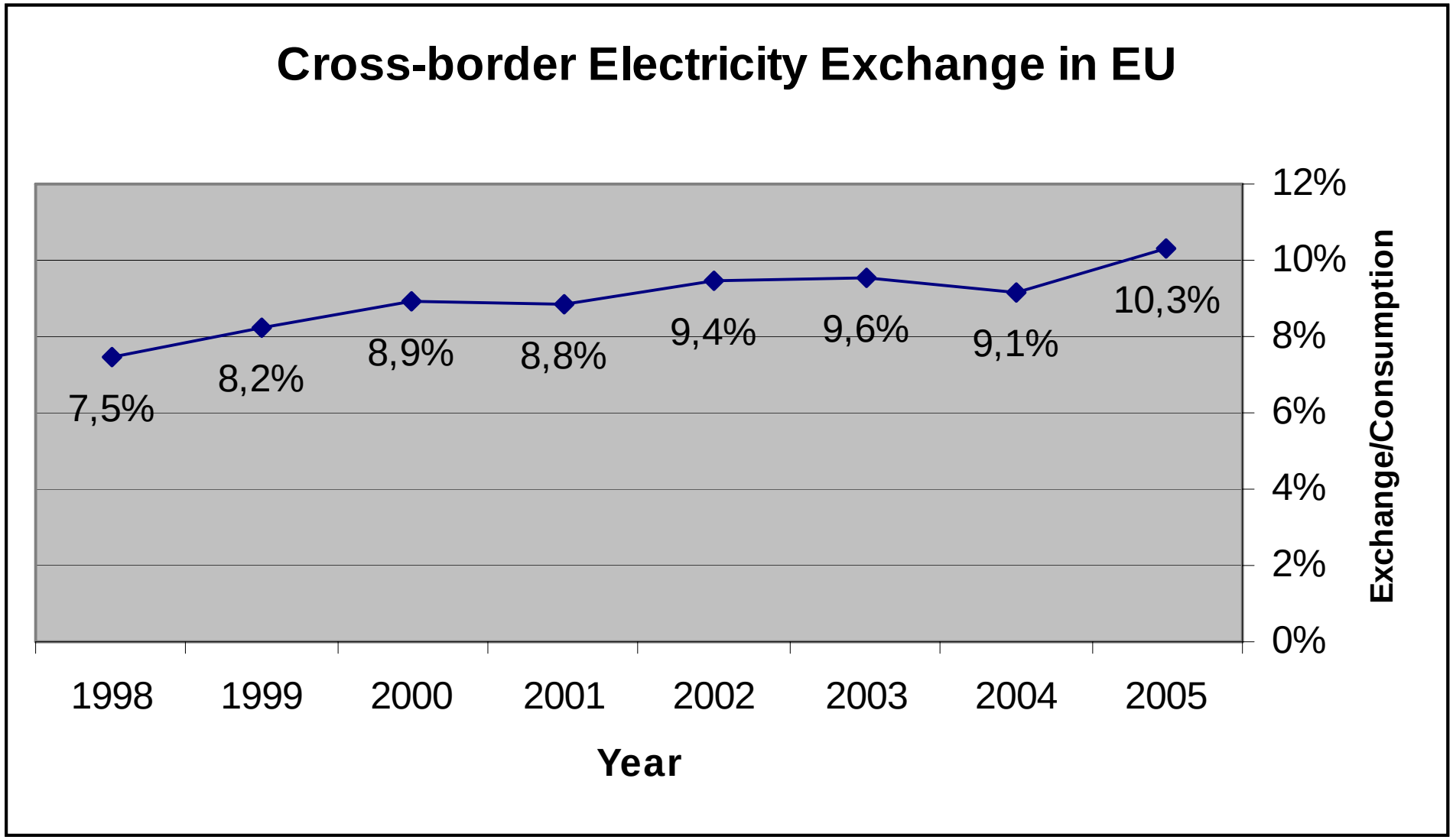
Paris, EdF 4 July 2008

http://www.electricitypolicy.org.uk

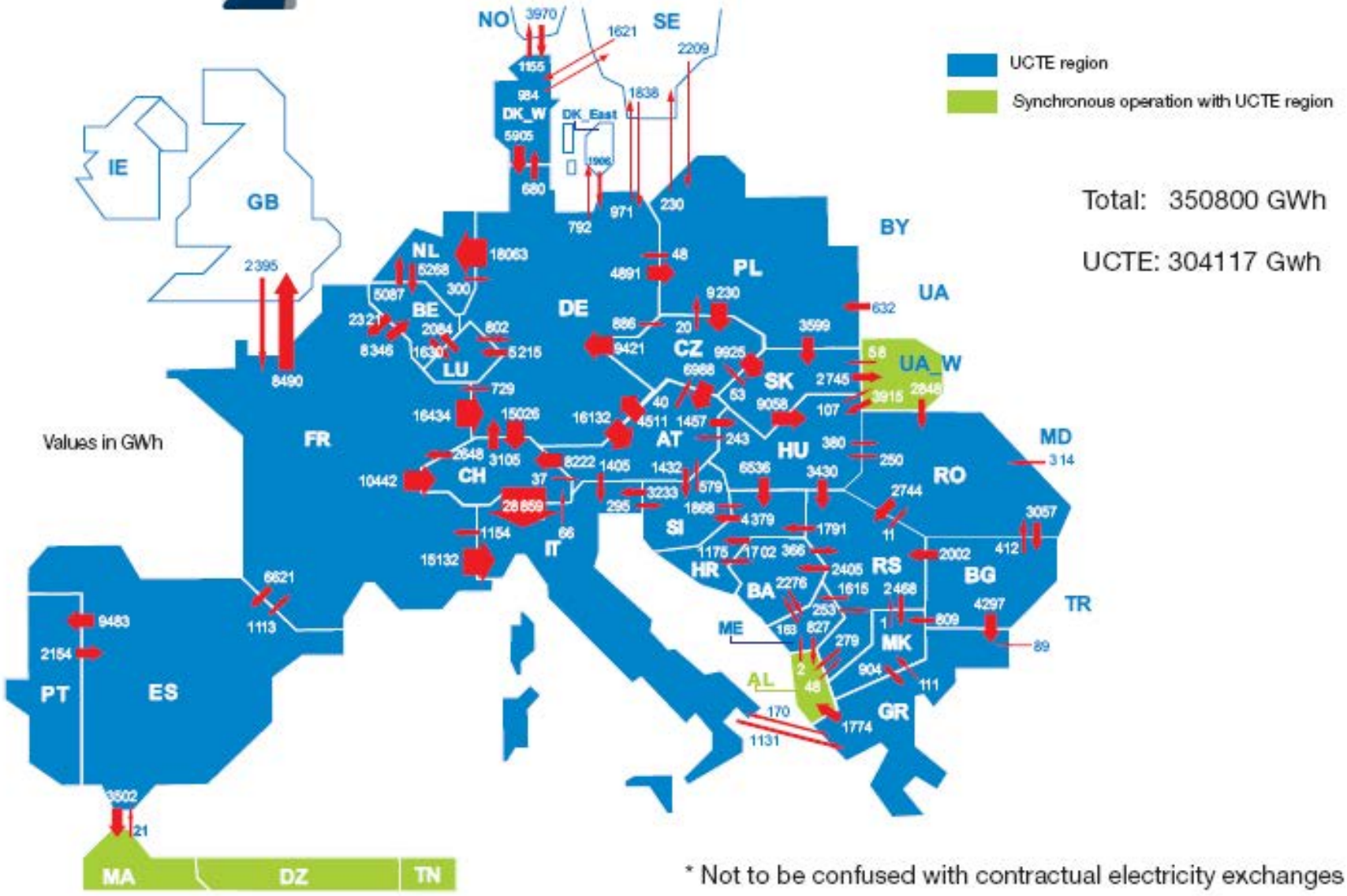
EDF

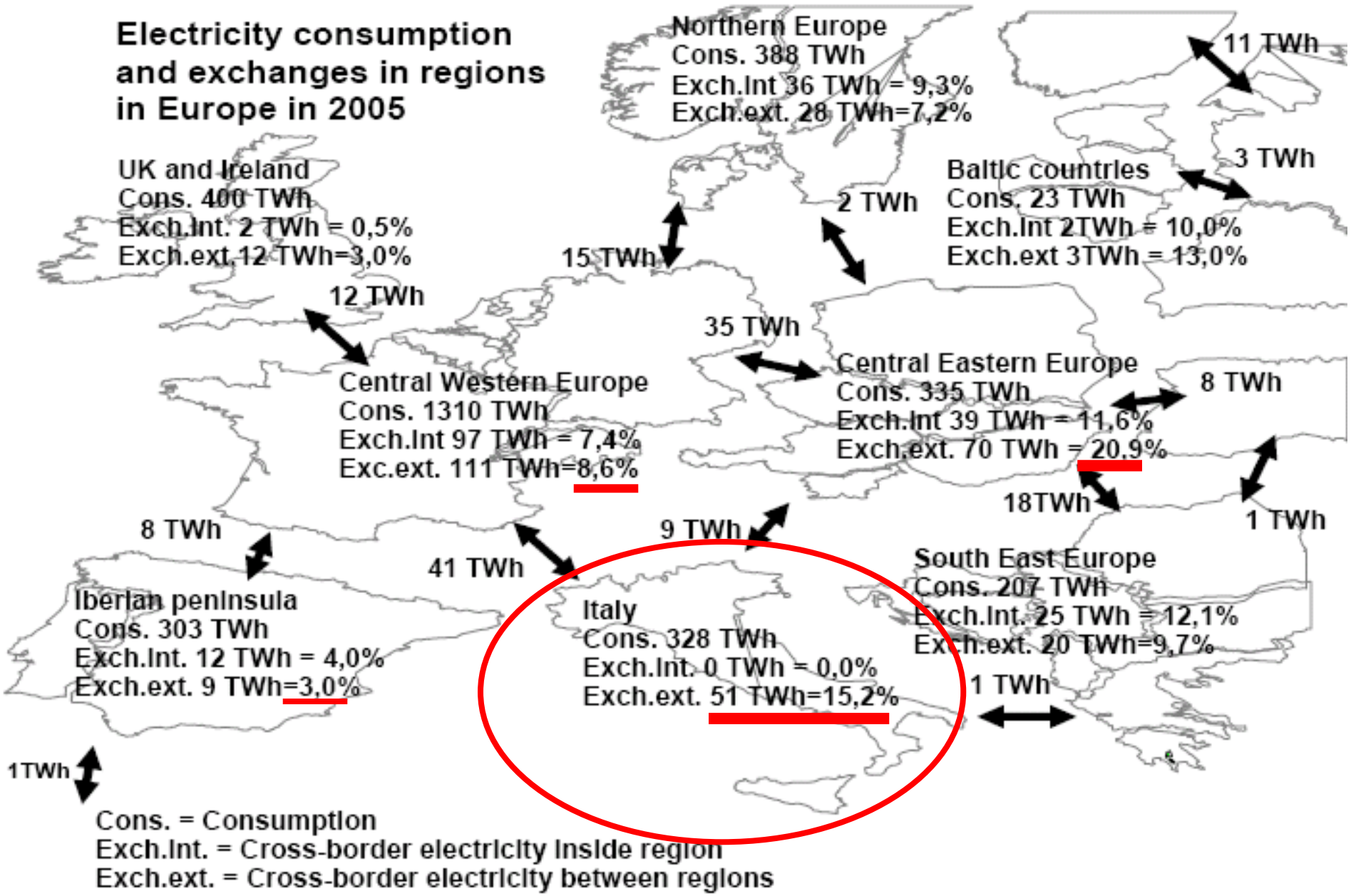
Challenges for managing EU networks

- Managing existing network
  - unbundling
  - efficient use of transmission
  - congestion management, plant operation
- Cross-border investment
  - ISO or RTO?
  - Who pays? Cross-border tariffication
  - handling increasing wind penetration


Cross-border Electricity Exchange in EU
12%
10%
8%
6%
4%
2%
0%
Exchange/Consumption
7,5%
8,2%
8,9%
8,8%
9,4%
9,6%
9,1%
10,3%
1998
1999
2000
2001
2002
2003
2004
2005
Year

Physical energy flows 2007 *

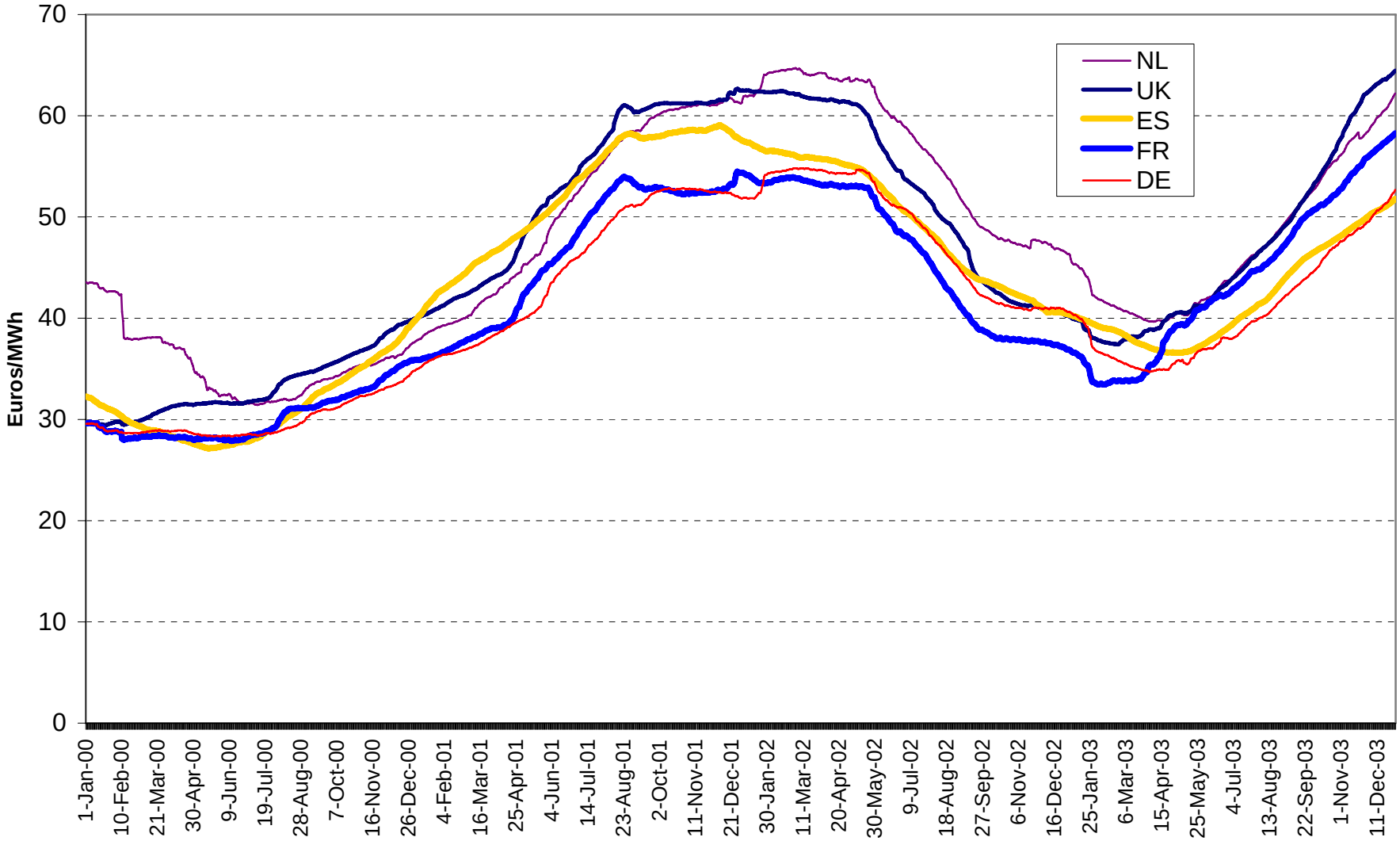



Electricity consumption and exchanges in regions in Europe in 2005
Northern Europe
Cons. 388 TWh
Exch.Int 36 TWh = 9,3%
Exch.ext. 28 TWh=7,2%
11 TWh
3 TWh
Baltic countries
Cons. 23 TWh
Exch.Int 2TWh = 10,0%
Exch.ext 3TWh = 13,0%
2 TWh
15 TWh
UK and Ireland
Cons. 400 TWh
Exch.Int. 2 TWh = 0,5%
Exch.ext.12 TWh=3,0%
12 TWh
35 TWh
Central Western Europe
Cons. 1310 TWh
Exch.Int 97 TWh = 7,4%
Exc.ext. 111 TWh=8,6%
Central Eastern Europe
Cons. 335 TWh
Exch.Int 39 TWh = 11,6%
Exch.ext. 70 TWh = 20,9%
8 TWh
18TWh
1 TWh
8 TWh
9 TWh
41 TWh
Iberian peninsula
Cons. 303 TWh
Exch.Int. 12 TWh = 4,0%
Exch.ext. 9 TWh=3,0%
Italy
Cons. 328 TWh
Exch.Int. 0 TWh = 0,0%
Exch.ext. 51 TWh=15,2%
South East Europe
Cons. 207 TWh
Exch.Int. 25 TWh = 12,1%
Exch.ext. 20 TWh=9,7%
1 TWh
1TWh
Cons. = Consumption
Exch.Int. = Cross-border electricity inside region
Exch.ext. = Cross-border electricity between regions

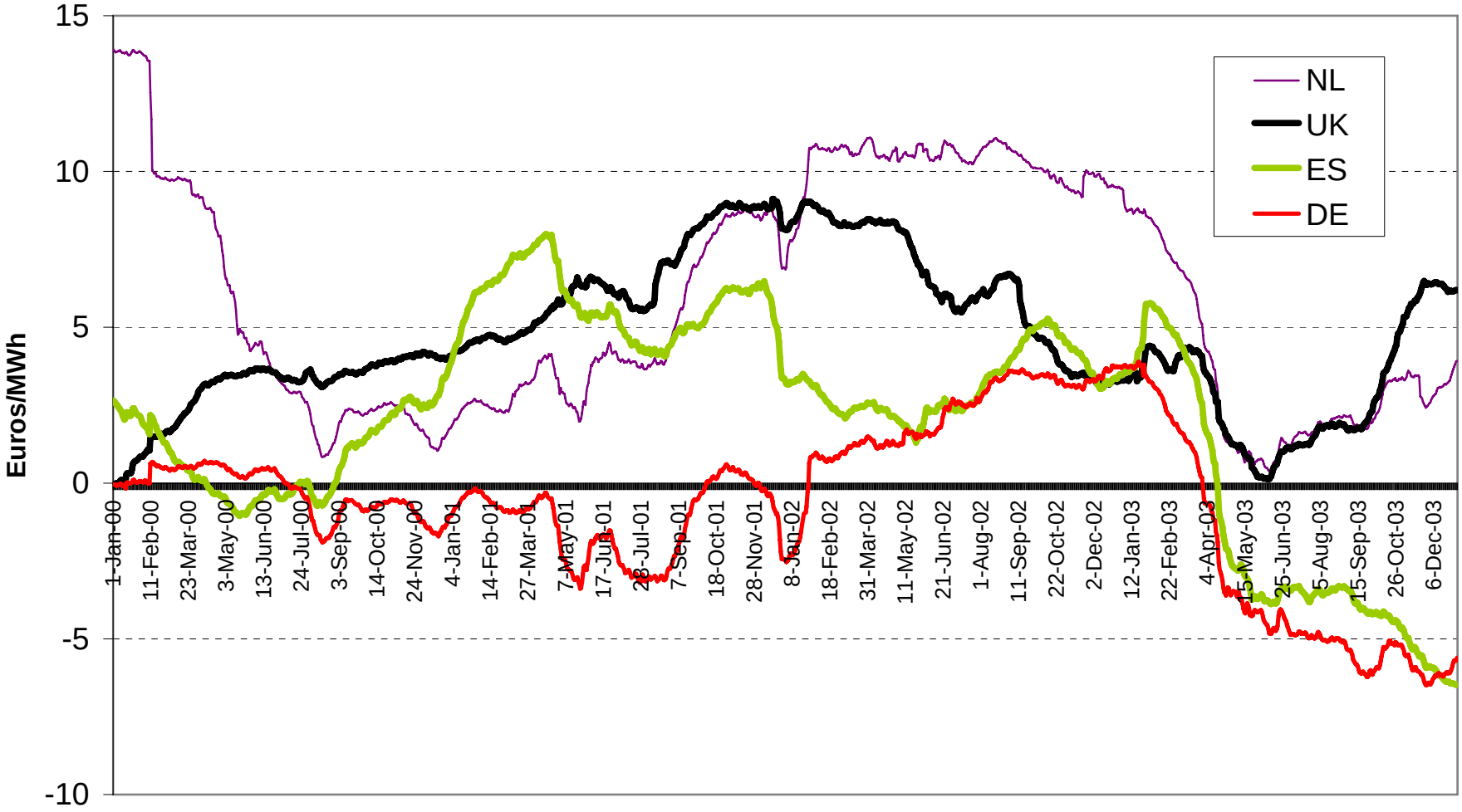
Cross-border trade

- Under-investment in connecting markets
  - benefits of robustness, competition undervalued
- existing network inefficiently used
  - inadequate arbitrage between markets
  - ETS should reduce price differences
  - but congestion supports market power
- Hampered by vertical integration, opacity

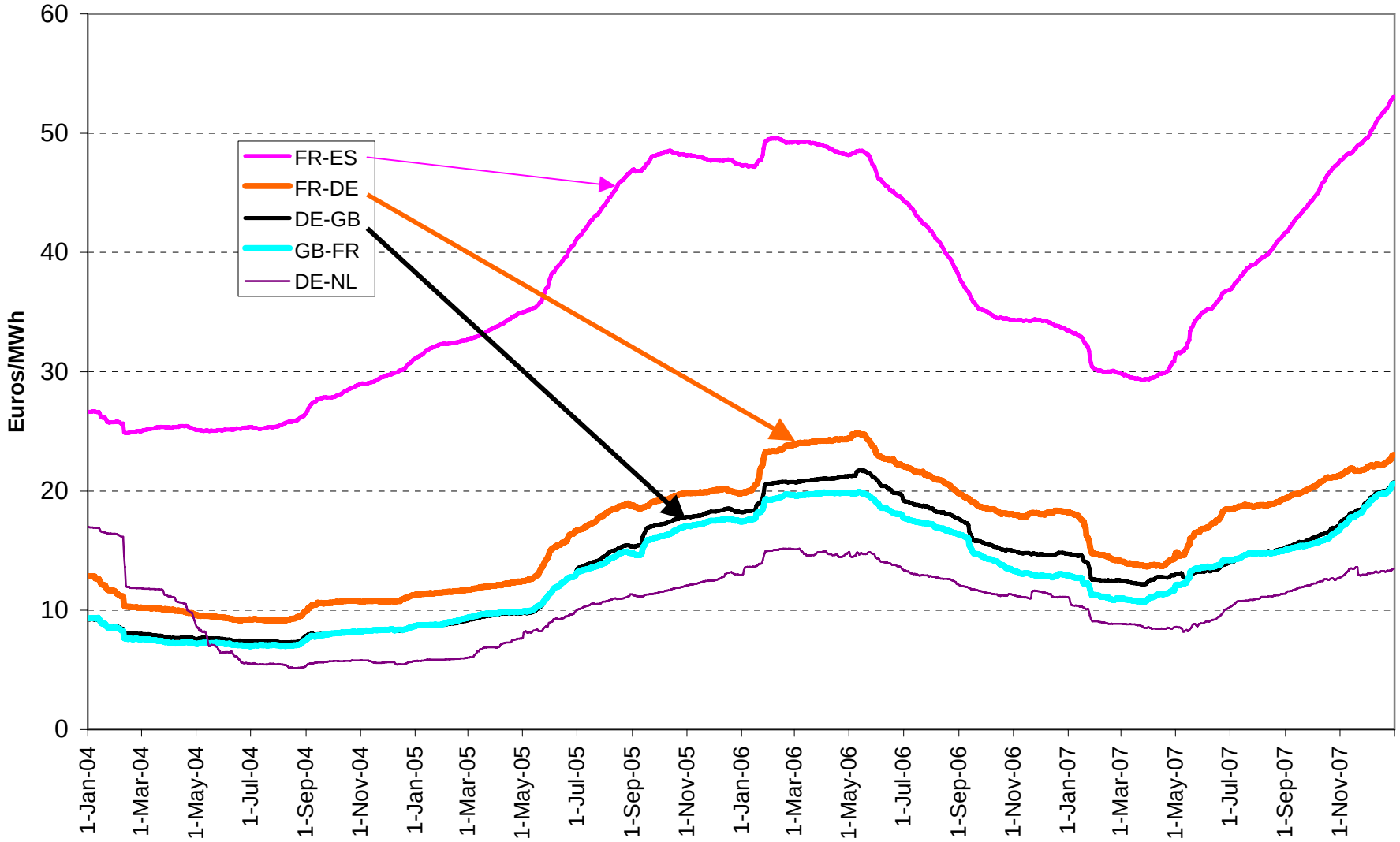
Centred moving average annual PX prices 2004-7



Algebraic differences, centred annual averages relative to France, 2004-7



Absolute price differences between countries, centred annual averages, 2004-7



Unbundling

- Apr 08: CEC Report on progress
  - functional unbundling incomplete
  - Interconnectors: unbundled TSOs invest twice as much as legally unbundled TSOs
  - B-D-F-LUX-NL agree flow-based cross-border capacity allocation
- Feb 08: E.ON announces divesting networks
  - June 08: RWE plans to sell of gas network

Integrating markets better

- improved use of interconnectors could
  - reduce market power
  - lead to more efficient dispatch
  - lower average costs
- TLC (APX) market coupling useful example

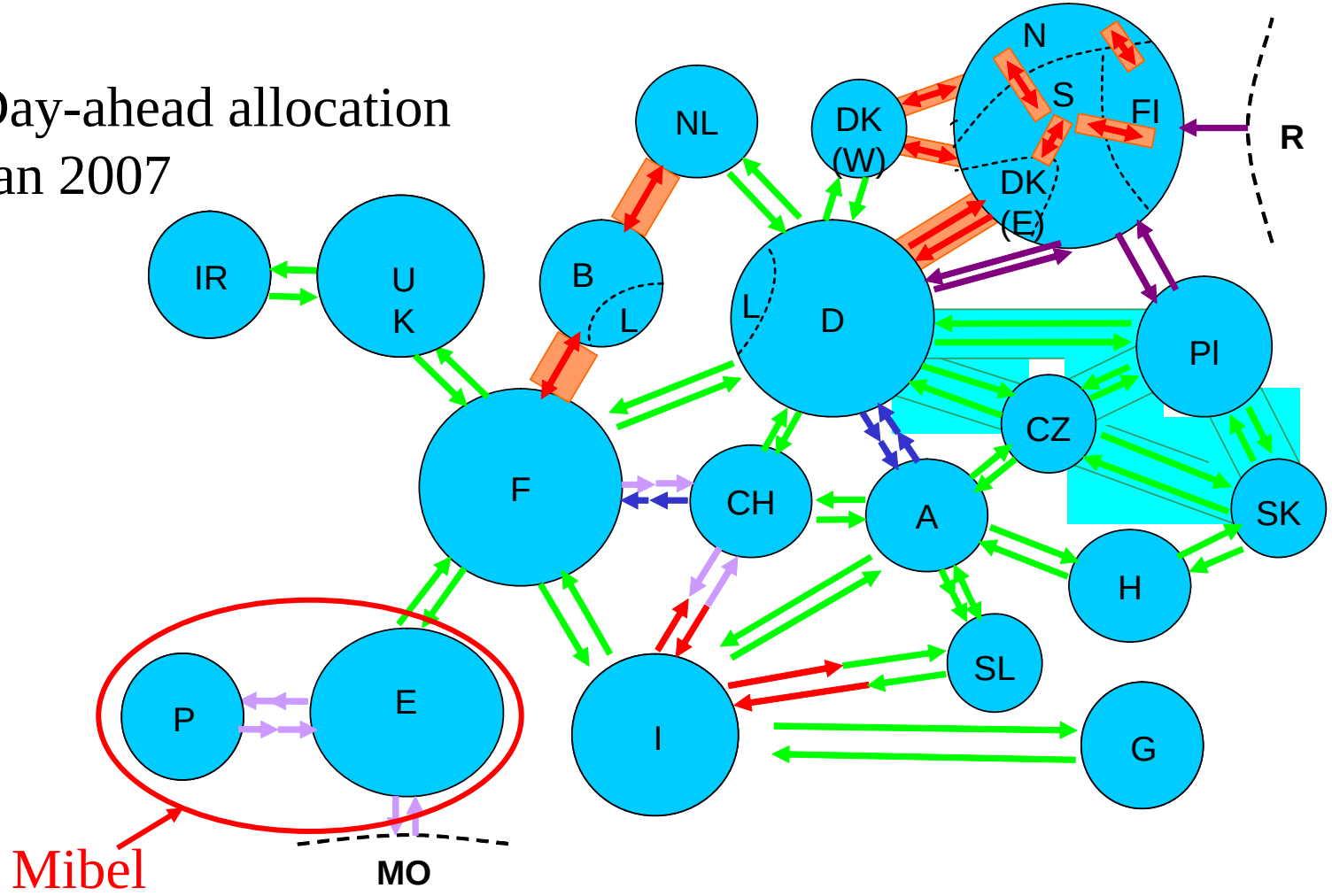
Efficient use of network

- Florence Forum: ETSO+Europex to address capacity allocation by March 2008
- CB auctions + PXs inefficient, replace with:
  - market splitting: Nordpool, Mibel
  - market coupling: TLC = NL+BE+FR
  - transmission models: NTC => flow based

  => intraday markets and balancing

Incremental but slow progress

Day-ahead allocation
Jan 2007



Implicit auction

Explicit auction

No congestion

Access limitation

Other method

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”

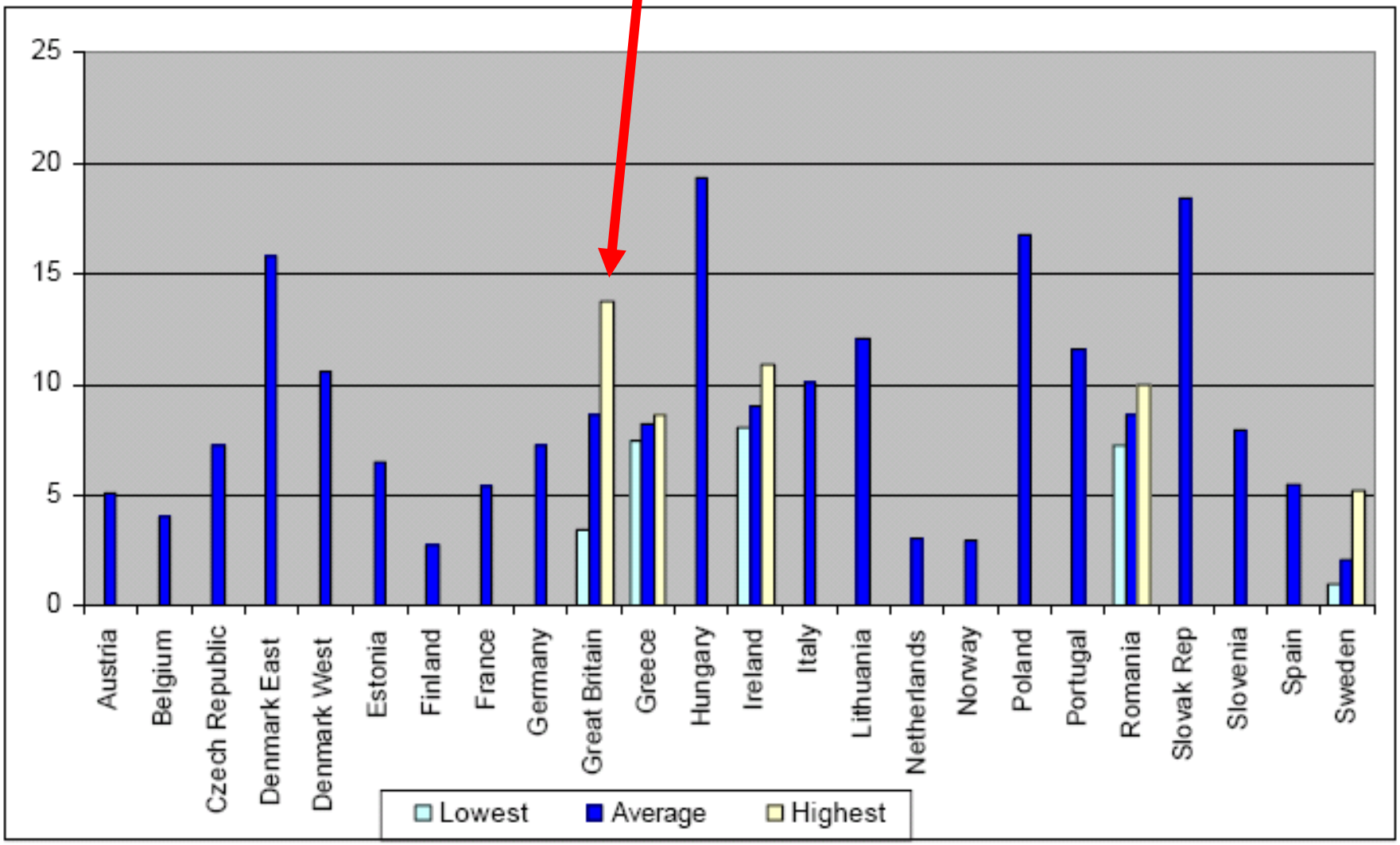
- € 17 billion ***should*** be invested over 5 yrs

Most TSOs lack locational price signals

Comparison of transmission tariffs G+ L: impact of location

Euro per MWh

Locational pricing rare



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?)
  - wind increases need for interconnection
- Hampered by vertical integration, opacity
- Who pays and how?

Financing interconnection

- Who should pay? Beneficiaries?
  - Easy with merchant lines and zonal pricing
  - Norned 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 current compensation work?

Inter-TSO compensation (ITC)

- 2002: 8 TSOs sign voluntary ITC agreement
- 2004: regulation 1228/2003 effective, guides ITC
- Florence process to choose ITC
  - ETSO prefers With & Without Transits method: WWT
  - IIT proposes Average Participation method: AP
- 2007: 28 (+7?) countries agree ITC for 2008/9
- Choice will impact transmission charges
  - and returns to cross-border transmission investment

IIT study for 2002 for DGTren

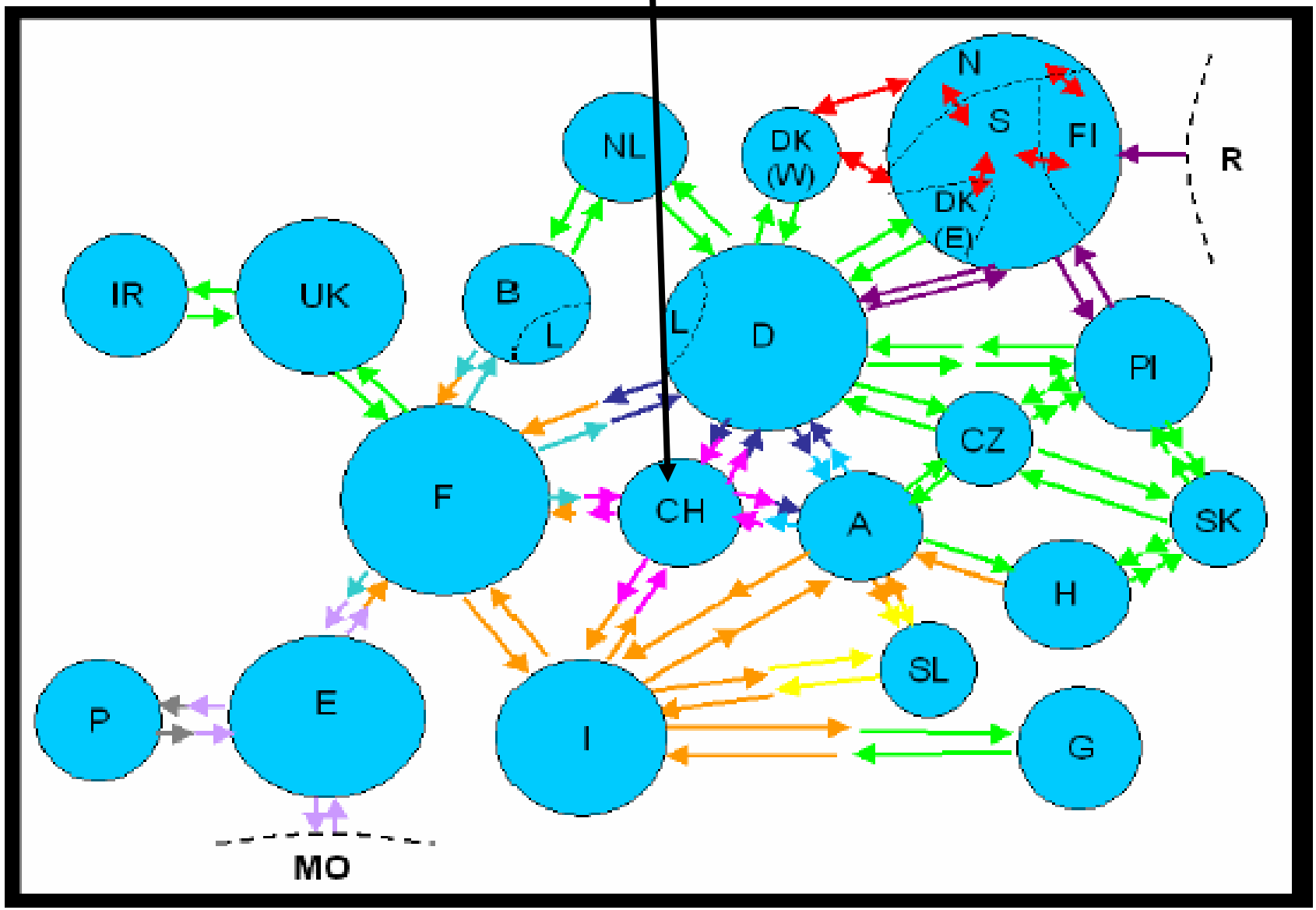
- Based on 24 hour/month flows
  - assumes 35,200 Euro/km/yr cost of 400kV line
- Switzerland, CH, as example (key transit zone)
- CH data in MW:

  G=5,197, L=4,499, X=3,489, M=2,932

  net X-M=557 (cf F at 8,194, I at 5,693)

  transit=2,932 (second after DE at 4,438)

Starting from European flows look at CH



Payments (Provisional Method) for 2002

Payments to

Payments by countries mill. euros

	A	B	CH	CZ	D	E	F	H	I	NL	P	SLO	SK
A	14.5	0.0	0.0	0.2	0.7	0.0	0.0	0.1	0.0	0.0	0.0	0.5	0.1
B	0.0	22.4	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
CH	0.0	0.0	21.5	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	1.6	0.0	0.0	10.9	2.7	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.4
D	1.2	0.0	2.0	0.7	156.5	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
E	0.0	0.0	0.0	0.0	0.0	103.6	0.0	0.0	0.0	0.0	1.3	0.0	0.0
F	0.0	1.5	2.7	0.0	3.7	0.8	256.5	0.0	0.0	0.0	0.0	0.0	0.0
H	0.1	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.5
I	1.6	0.0	8.3	0.0	0.6	0.0	0.1	0.0	82.5	0.0	0.0	0.9	0.0
NL	0.0	0.8	0.0	0.0	2.1	0.0	0.0	0.0	0.0	26.6	0.0	0.0	0.0
P	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	22.0	0.0	0.0
SLO	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	0.0
SK	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	6.9
Use of	20.3	24.8	34.6	12.2	167.2	106.6	256.8	8.1	82.5	27.3	23.3	4.3	7.9
Use by	16.1	23.0	22.4	15.7	160.9	104.9	265.3	8.2	94.1	29.6	24.2	3.9	7.8
receipt	4.2	1.9	12.3	-3.5	6.3	1.8	-8.6	-0.1	-11.5	-2.3	-1.0	0.4	0.1
	5.8	2.4	13.1	1.3	10.7	3.0	0.3	0.6	0.0	0.7	1.3	1.5	1.0
	1.6	0.5	0.8	4.8	4.4	1.3	8.8	0.7	11.6	3.0	2.2	1.1	0.9

Total use of CH's network =34.6, use by CH =22.4, so net receipt by CH is 12.3 m Euros

Payments under WWT method

	A	B	CH	CZ	D	E	F	H	I	NL	P	SLO	SK
A	99.0	0.2	1.6	-0.5	1.9	-0.4	0.0	0.7	0.0	0.3	-0.1	0.1	0.2
B	1.4	141.1	2.2	-0.6	2.7	-0.7	0.0	1.0	0.0	0.5	-0.1	0.1	0.2
CH	2.0	0.6	97.8	-1.0	4.3	-1.3	0.1	1.6	0.0	0.8	-0.2	0.2	0.4
CZ	2.2	0.5	3.6	202.3	4.2	-0.8	0.0	1.5	0.0	0.8	-0.4	0.2	0.5
D	1.8	0.7	3.5	-1.3	1261.8	-1.9	0.0	1.7	0.0	0.6	-0.4	0.2	0.6
E	1.4	0.3	2.2	-0.6	2.4	849.9	0.0	0.9	0.0	0.6	-0.1	0.2	0.2
F	15.3	3.3	24.2	-6.9	28.4	-6.2	1198.3	10.4	0.1	5.4	-1.3	1.5	2.7
H	0.7	0.2	1.2	-0.4	1.5	-0.4	0.0	70.8	0.0	0.2	-0.1	0.1	0.2
I	11.3	2.3	17.6	-5.0	20.6	-4.0	0.4	7.4	516.1	4.1	-0.9	1.1	2.0
NL	3.6	0.9	5.7	-1.8	7.8	-1.6	0.1	2.6	0.0	227.8	-0.5	0.3	0.9
P	0.5	0.1	0.7	-0.2	0.8	-0.2	0.0	0.3	0.0	0.2	154.9	0.0	0.1
SLO	0.5	0.1	0.8	-0.2	1.0	-0.2	0.0	0.3	0.0	0.2	-0.1	22.6	0.1
SK	0.9	0.2	1.4	-0.4	1.6	-0.3	0.0	0.6	0.0	0.3	0.0	0.1	74.7
	140.6	150.5	162.4	183.3	1339.0	831.8	1199.1	99.8	516.4	241.9	150.7	26.7	83.0
	103.1	147.8	105.2	214.7	1267.4	857.4	1275.2	73.8	573.0	245.9	157.2	25.2	79.1
	37.5	2.7	57.2	-31.4	71.6	-25.6	-76.0	25.9	-56.6	-4.0	-6.5	1.5	3.8
	41.6	9.3	64.6	-19.0	77.2	18.1	0.8	29.0	0.3	14.0	-4.2	4.1	8.2
	4.1	6.6	7.4	12.4	5.6	7.5	76.8	3.0	56.9	18.1	2.3	2.6	4.4

CH's network used 162.5, uses others 105.2, receives 57.2

Payments under AP method

	A	B	CH	CZ	D	E	F	H	I	NL	P	SLO	SK
A	86.0	0.0	0.0	7.4	6.5	0.0	0.0	1.5	3.5	0.0	0.0	3.4	1.0
B	0.0	123.1	0.0	0.0	0.5	0.0	7.2	0.0	0.0	11.0	0.0	0.0	0.0
CH	0.8	0.0	93.4	0.0	11.6	0.0	14.5	0.0	12.4	0.0	0.0	0.0	0.0
CZ	14.9	0.0	0.0	146.4	16.7	0.0	0.0	1.2	0.2	0.0	0.0	0.3	3.3
D	13.7	0.8	11.3	7.7	1228.8	0.0	5.8	0.0	2.7	26.9	0.0	0.1	0.0
E	0.0	0.0	0.0	0.0	0.0	791.2	14.6	0.0	0.0	0.0	17.2	0.0	0.0
F	0.0	22.1	20.0	0.0	29.1	11.1	1121.9	0.0	27.4	0.4	0.0	0.0	0.0
H	2.0	0.0	0.0	1.3	0.0	0.0	0.0	68.1	0.0	0.0	0.0	0.0	4.0
I	9.1	0.0	30.8	0.1	5.3	0.0	31.2	0.0	463.6	0.0	0.0	4.9	0.0
NL	0.0	2.5	0.0	0.0	9.9	0.0	0.1	0.0	0.0	195.1	0.0	0.0	0.0
P	0.0	0.0	0.0	0.0	0.0	27.2	0.0	0.0	0.0	0.0	133.3	0.0	0.0
SLO	7.3	0.0	0.0	0.2	0.1	0.0	0.0	0.0	1.9	0.0	0.0	14.2	0.0
SK	1.7	0.0	0.0	5.6	0.0	0.0	0.0	7.5	0.0	0.0	0.0	0.0	58.8
	135.4	148.4	155.6	168.7	1308.5	829.6	1195.2	78.3	511.7	233.4	150.6	23.0	67.1
	109.4	141.8	132.6	183.1	1297.7	823.0	1232.0	75.3	545.0	207.5	160.6	23.6	73.6
	26.0	6.6	22.9	-14.4	10.8	6.6	-36.8	3.0	-33.3	25.8	-10.0	-0.7	-6.5
	49.5	25.3	62.2	22.3	79.7	38.4	73.3	10.2	48.1	38.3	17.2	8.8	8.3
	23.5	18.7	39.2	36.7	68.9	31.8	110.1	7.3	81.4	12.4	27.2	9.5	14.8

CH's network used 155.6, uses others 132.6, receives 22.9

Non-zero sum games

- 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

The challenge of renewables

- 20% EU renewables target by 2020 agreed

=15% renewable **ENERGY** for UK

=30-40% renewable **ELECTRICITY**

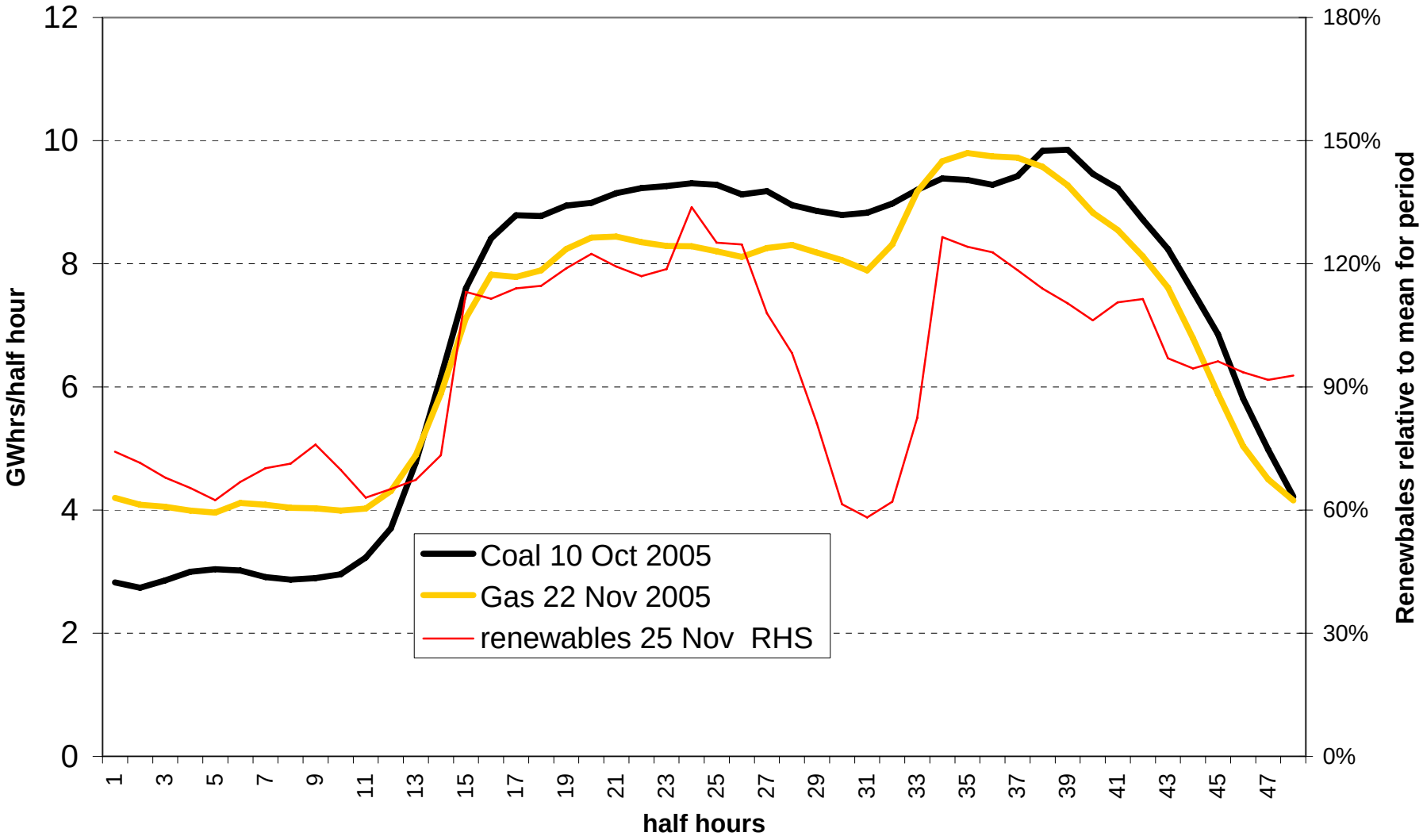
- likely to be large shares of wind
  - Much in Scotland: queue of 11 GW, 9GW Wales
- At 25% capacity factor, 25% wind
  - = 100% peak demand

=> volatile supplies, prices, congestion, ….

Transmission and market design

- Standard EU model: small PX (<10% G), self-dispatch, SO balances
  - decentralised, simple cross-border trade
  - not well-suited to intermittent generation
- US model: nodal pricing, central dispatch, combined balancing, closer to Pool model
  - more efficient dispatch
  - simplifies access of intermittent generation

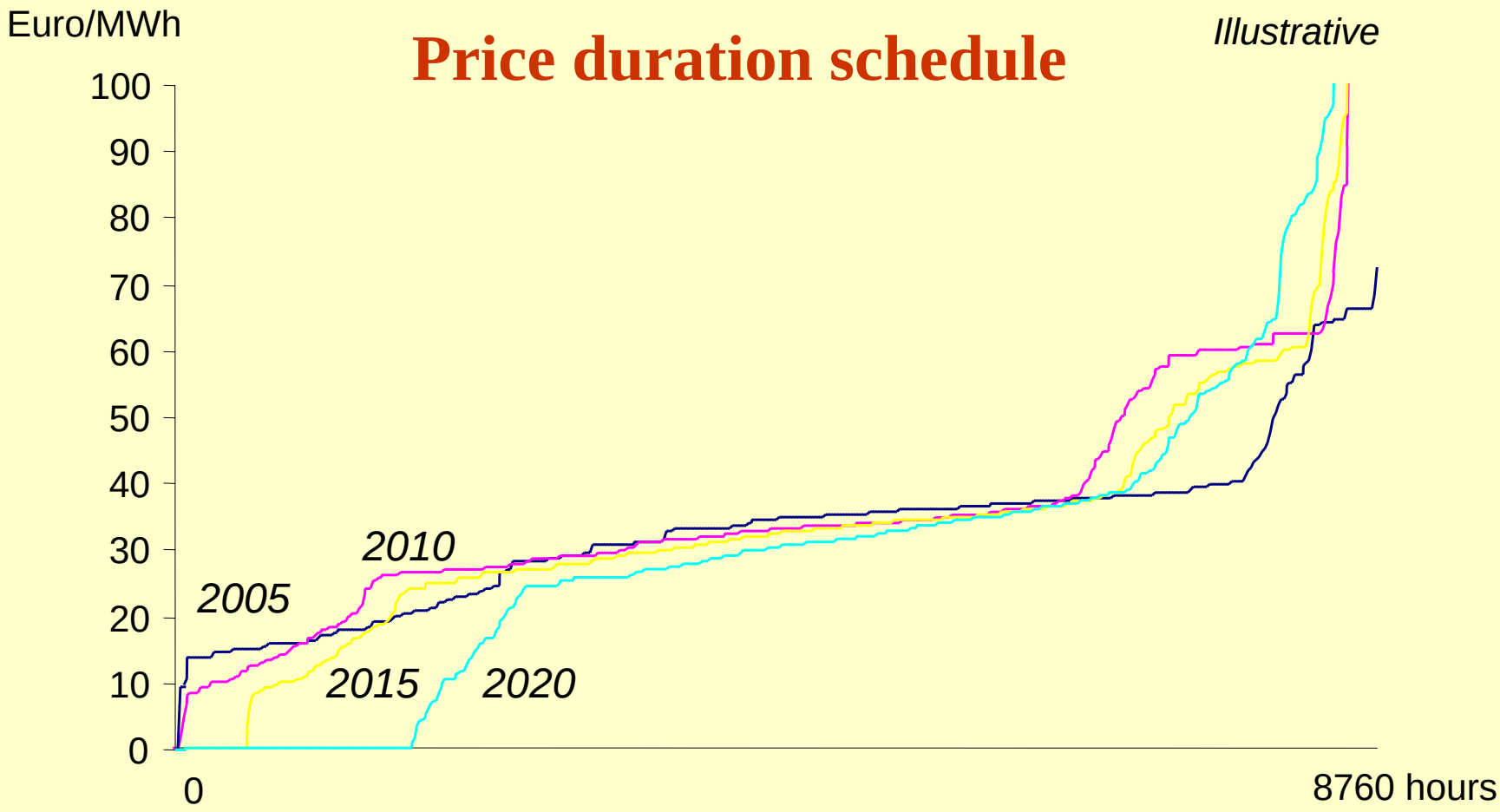
Ability to vary thermal output



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 of export (or MB of import)
- Financial transmission contracts hedge T price risk

More wind => more volatility



Implications of substantial wind

- Much greater price volatility
  - mitigated by nodal pricing in import zones
  - requires CfDs and nodal reference spot price
- Encourages interconnectors (esp to Norway)
- Coal and gas for peaking/balancing?

  => Greater need for wider area balancing

=> increased need for contracting (good)

=> further stimulus to integration? (not so good)

Conclusions

- Improved management => easy gains
  - needs unbundling/ISOs and market coupling

  => move to wide area nodal pricing?
- Increased interconnection
  - reduces market power, aids renewables
  - needs financial model, detach from CBT
- Wind => volatility => increases gains from better transmission management

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