



# Smart market design and Regional Initiatives

David Newbery

*A Smart EU Energy Policy*

Florence, 29 April 2009

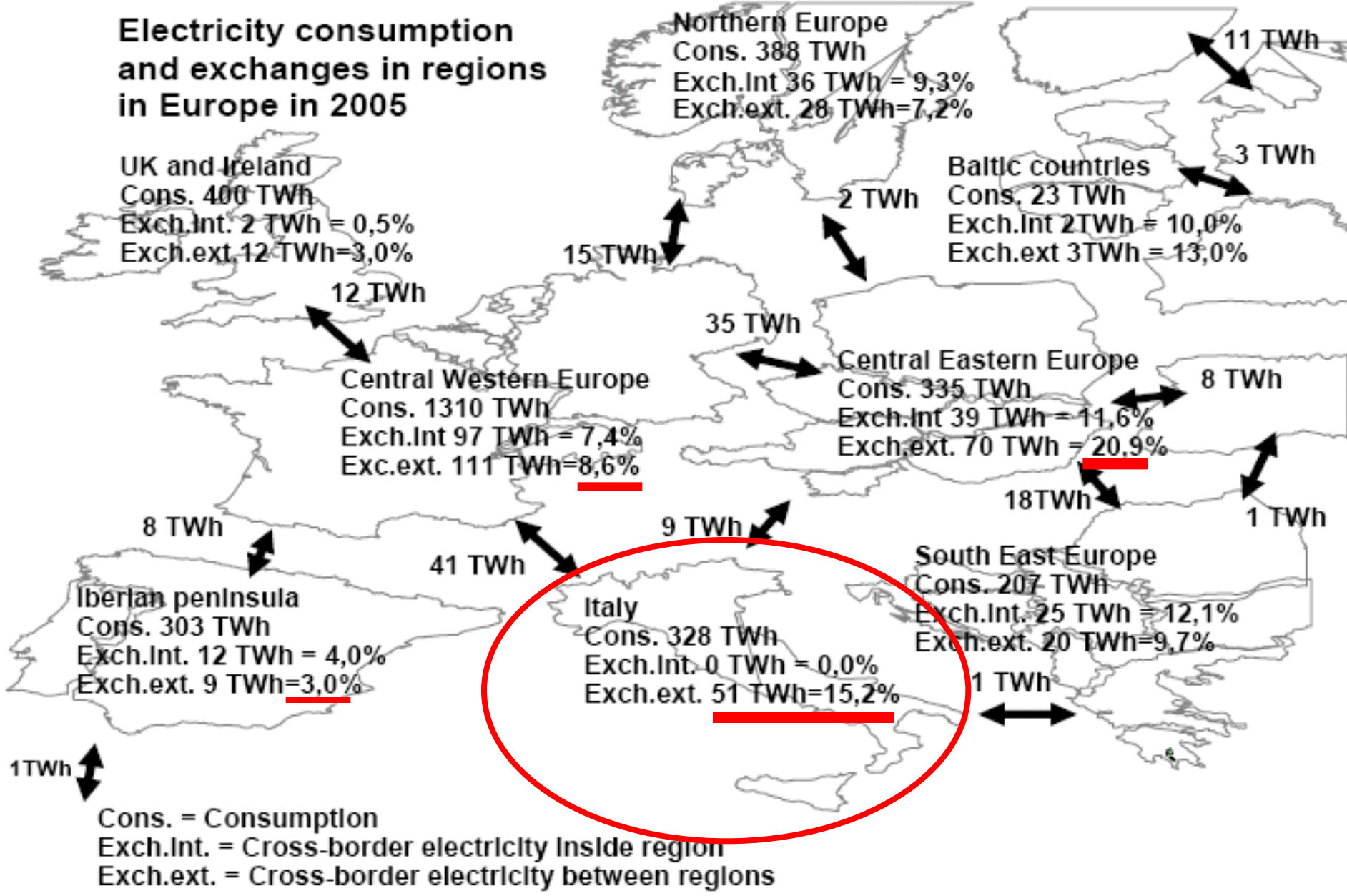
<http://www.eprg.group.cam.ac.uk>

# 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

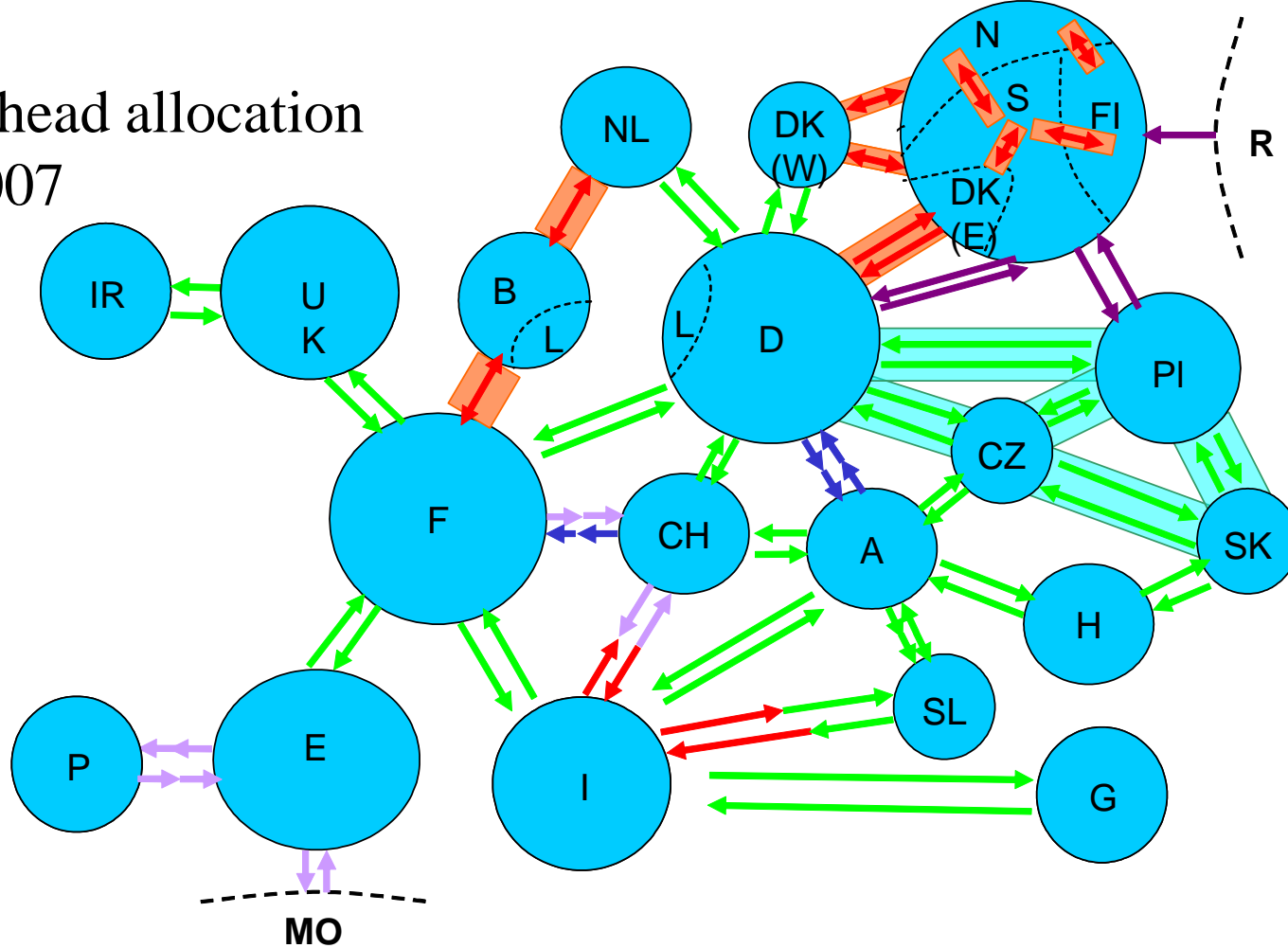
***Aim to converge to single electricity market***






# Electricity consumption and exchanges in regions in Europe in 2005



# Day-ahead allocation

## Jan 2007



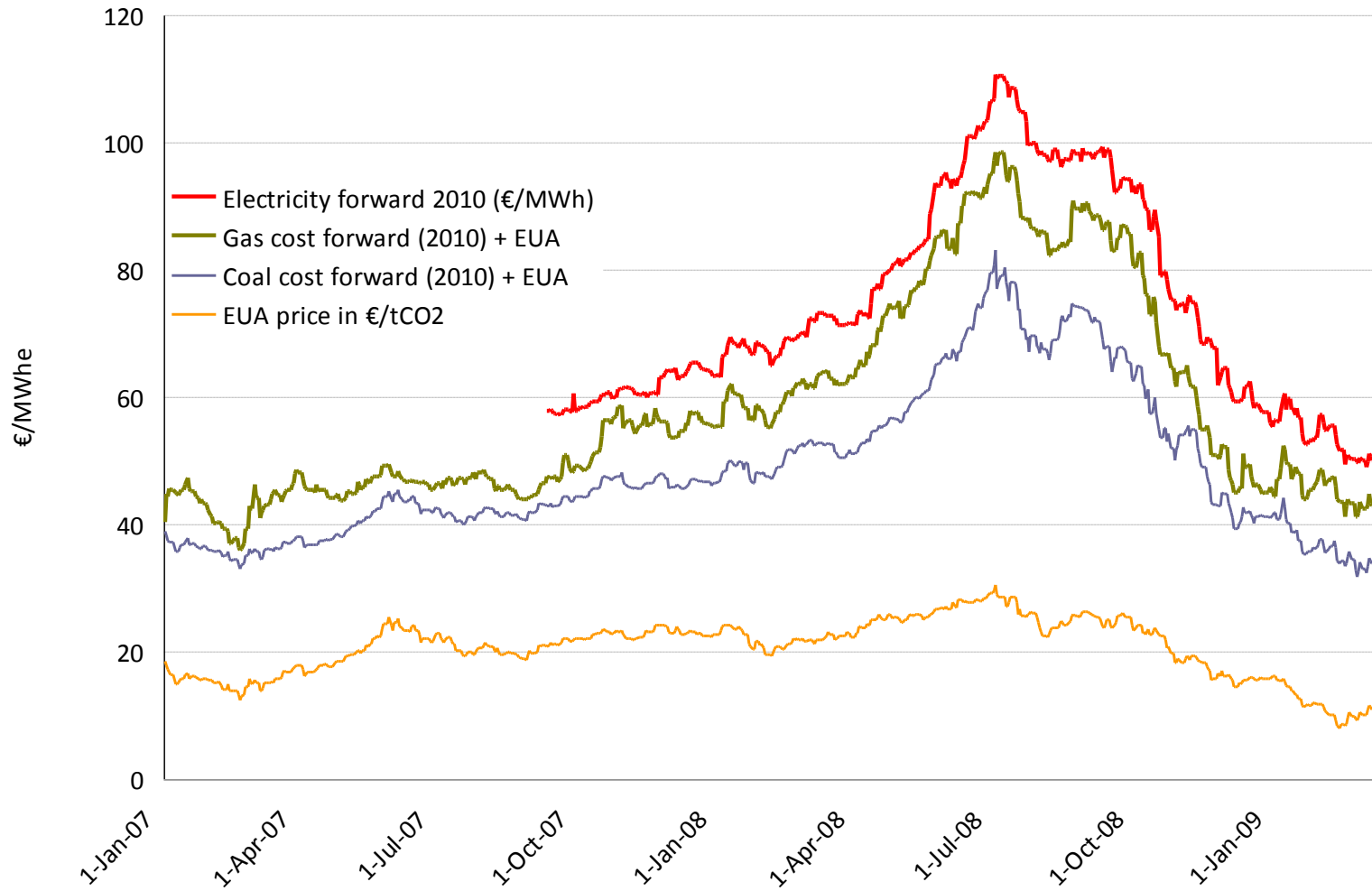
-  **Implicit auction**
-  **Explicit auction**
-  **No congestion**
-  **Access limitation**
-  **Other method**

# 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  $\uparrow\uparrow$

# Remarkable co-movement of energy prices

UK price movements: 2007 to 2009 in €

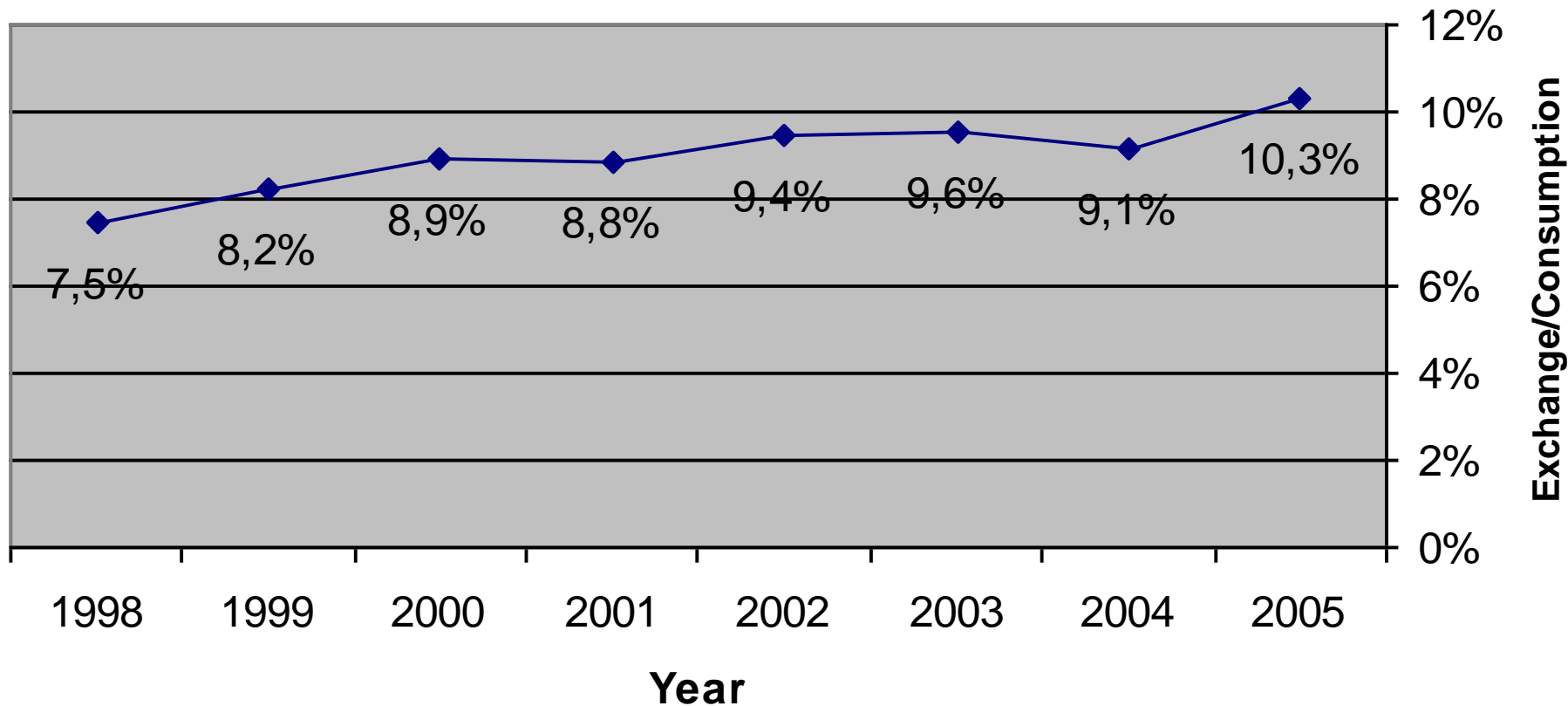


# ERI progress

- Markets coupled: Nordic area and BE-NL-FR
- MIBEL Jul 2007
- Market coupling DK-DE Sep 2008 ...
- Agreement on flow-based capacity allocation
  - => move to regional PTDF matrix
    - unnecessary F-UK-I? FR-ES-PO?
- Cross-border intraday allocation progresses
- Considerable support from NRAs, TSOs

***But Switzerland not part of EU/ERI***

# Cross-border Electricity Exchange in EU





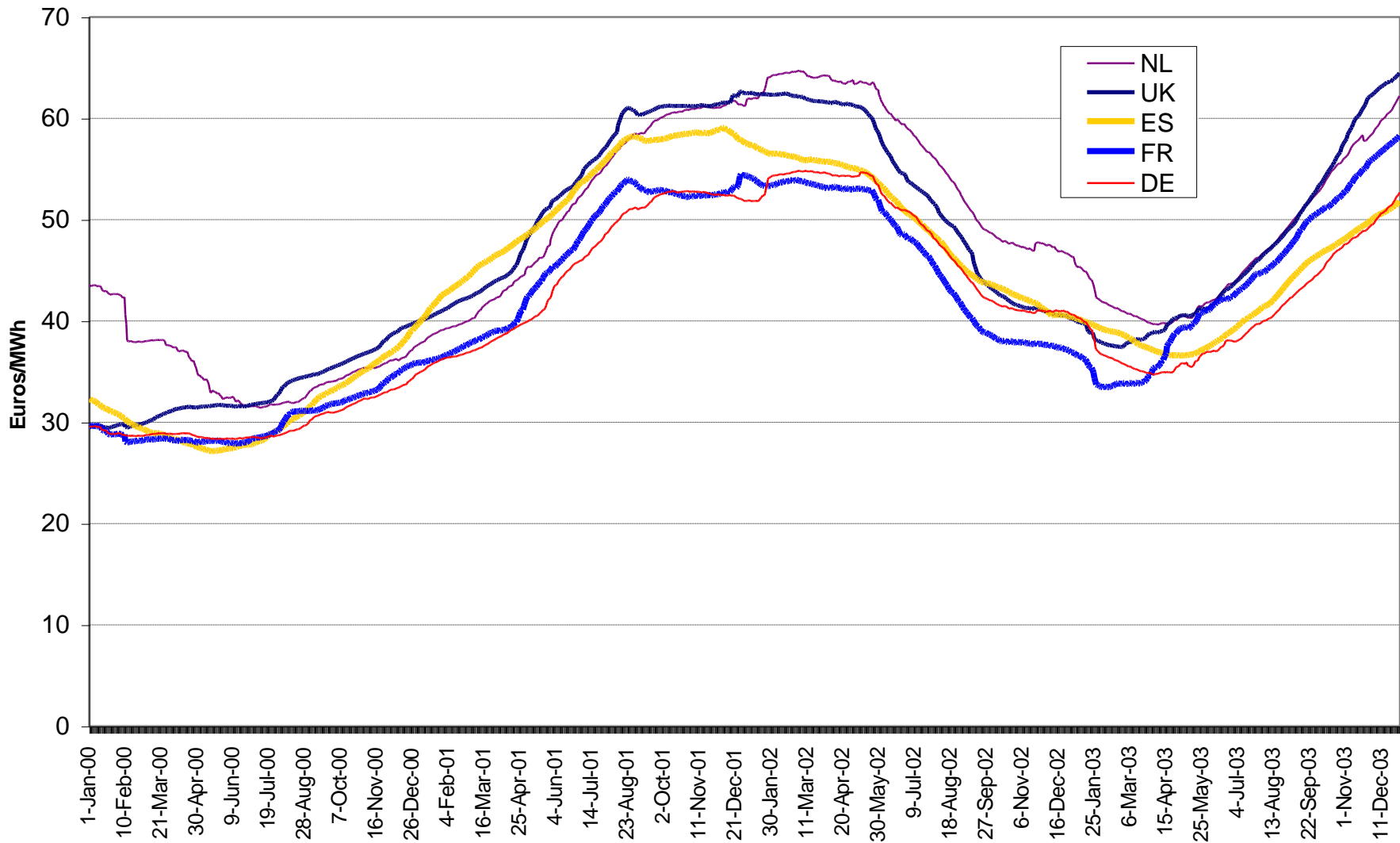
# Challenges for managing EU networks

- 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

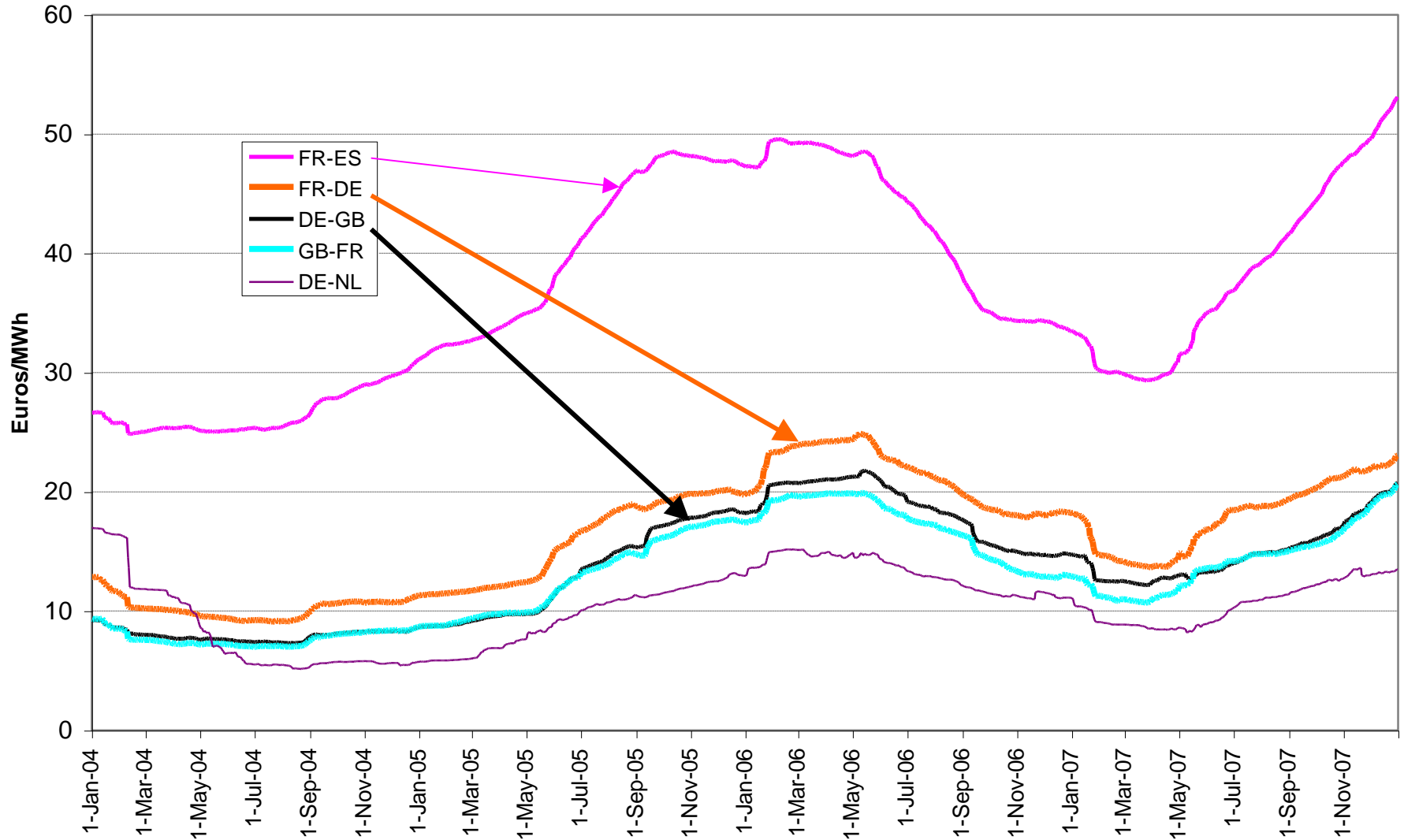
# Cross-border trade

- 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



# 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
  - 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

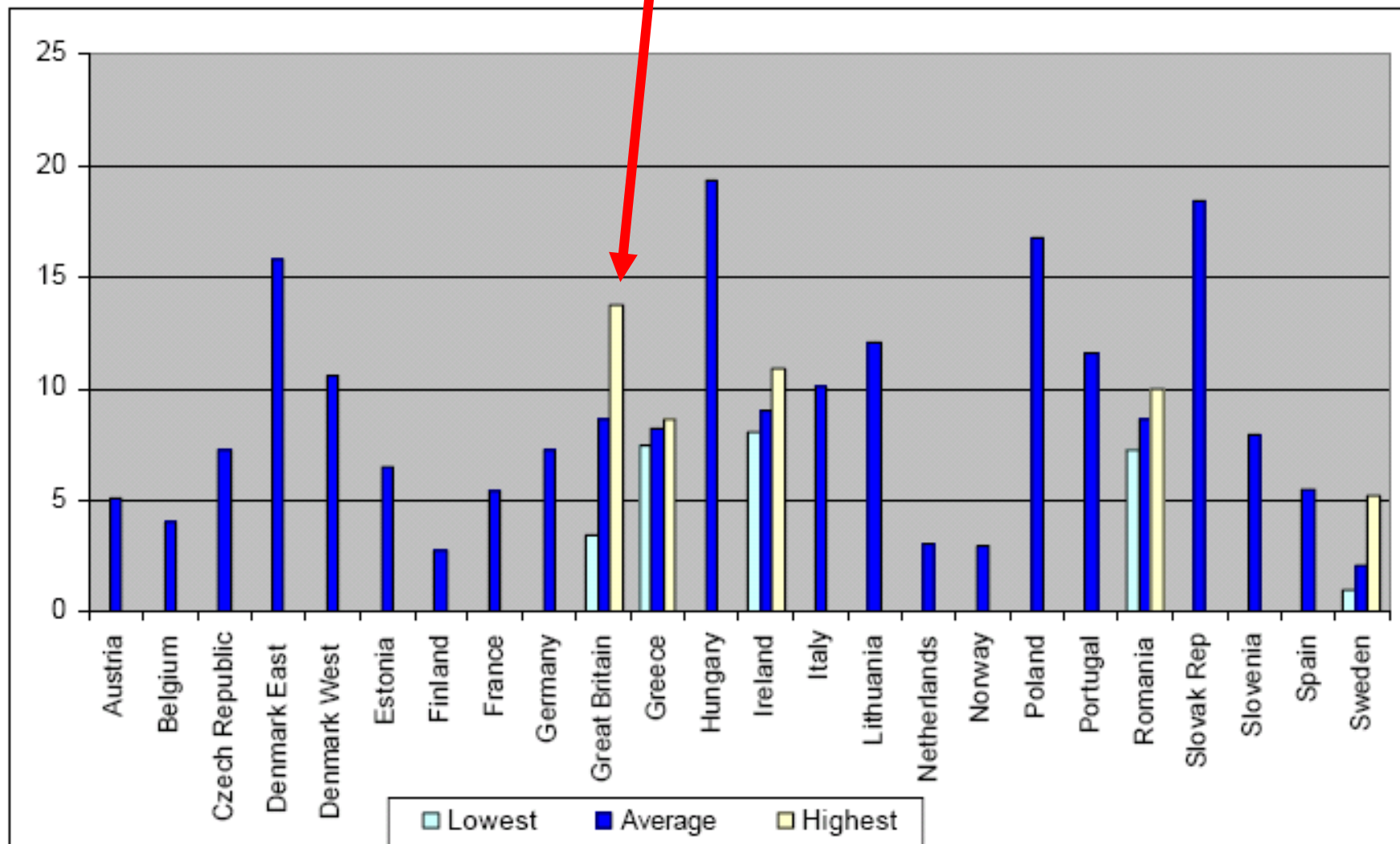
# Cross-border investment

- 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?)
  - 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

# The challenge of renewables

- 20% EU renewables target by 2020 agreed  
=15% renewable **ENERGY** for UK  
=30-40% renewable **ELECTRICITY**
  - likely to be largely wind
- => volatile supplies, prices, congestion, ....
- Strains current congestion management?
  - Risks inefficiency and higher emissions

*Will it precipitate move to more integration?*

# 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)

# Smart 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, pricing too low?
  - simplifies access of intermittent generation

# Conclusions

- ERI => improved congestion management  
=> Could it move to wide area nodal pricing?
- Increased interconnection
  - reduces market power, aids renewables
  - needs financial model, detach from CBT
  - needs central planning/finance? and local support

***Wind => volatility => increases gains from wide-area smart market design***



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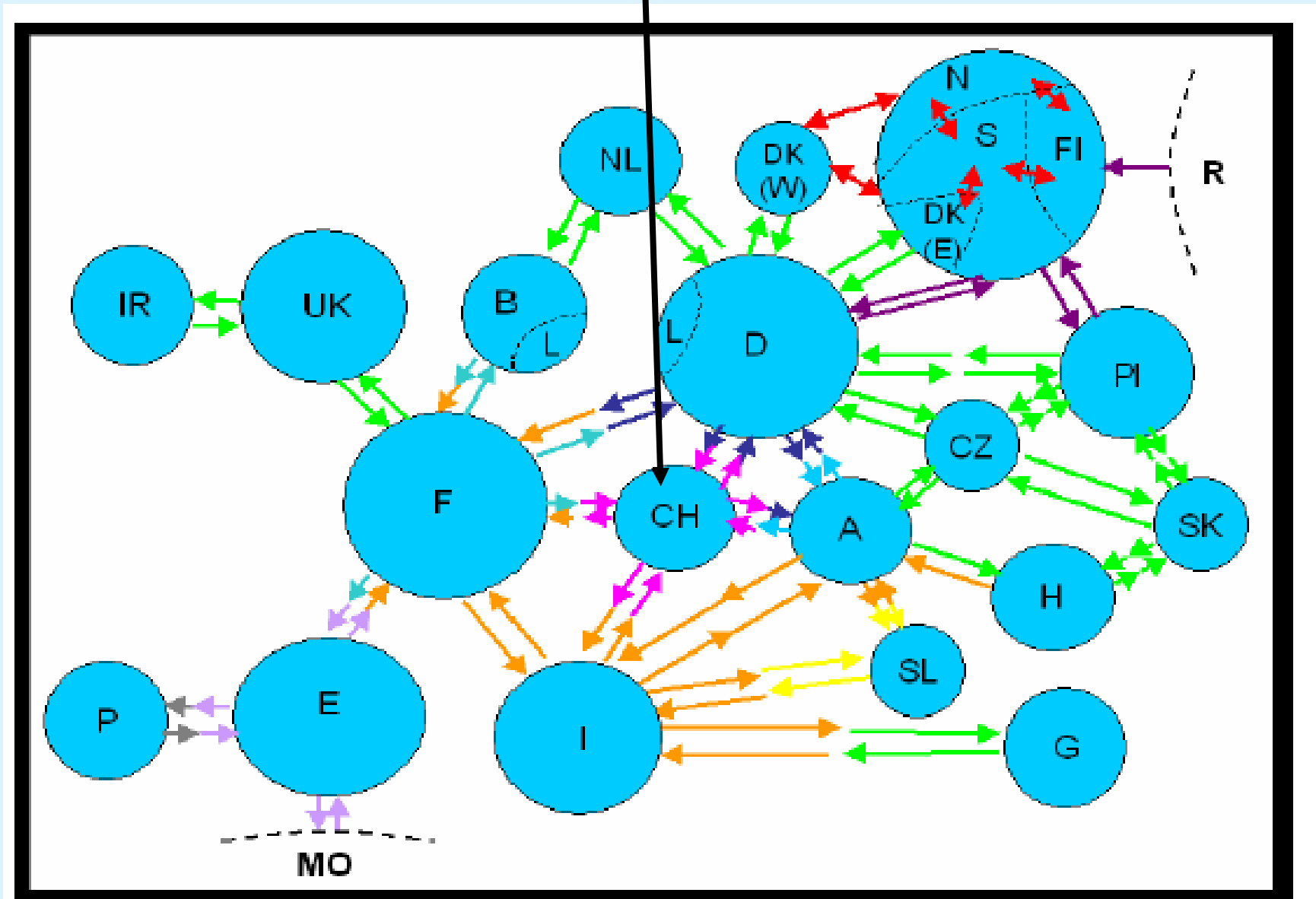
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# IIT study for 2002 for DGTren

- 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  |

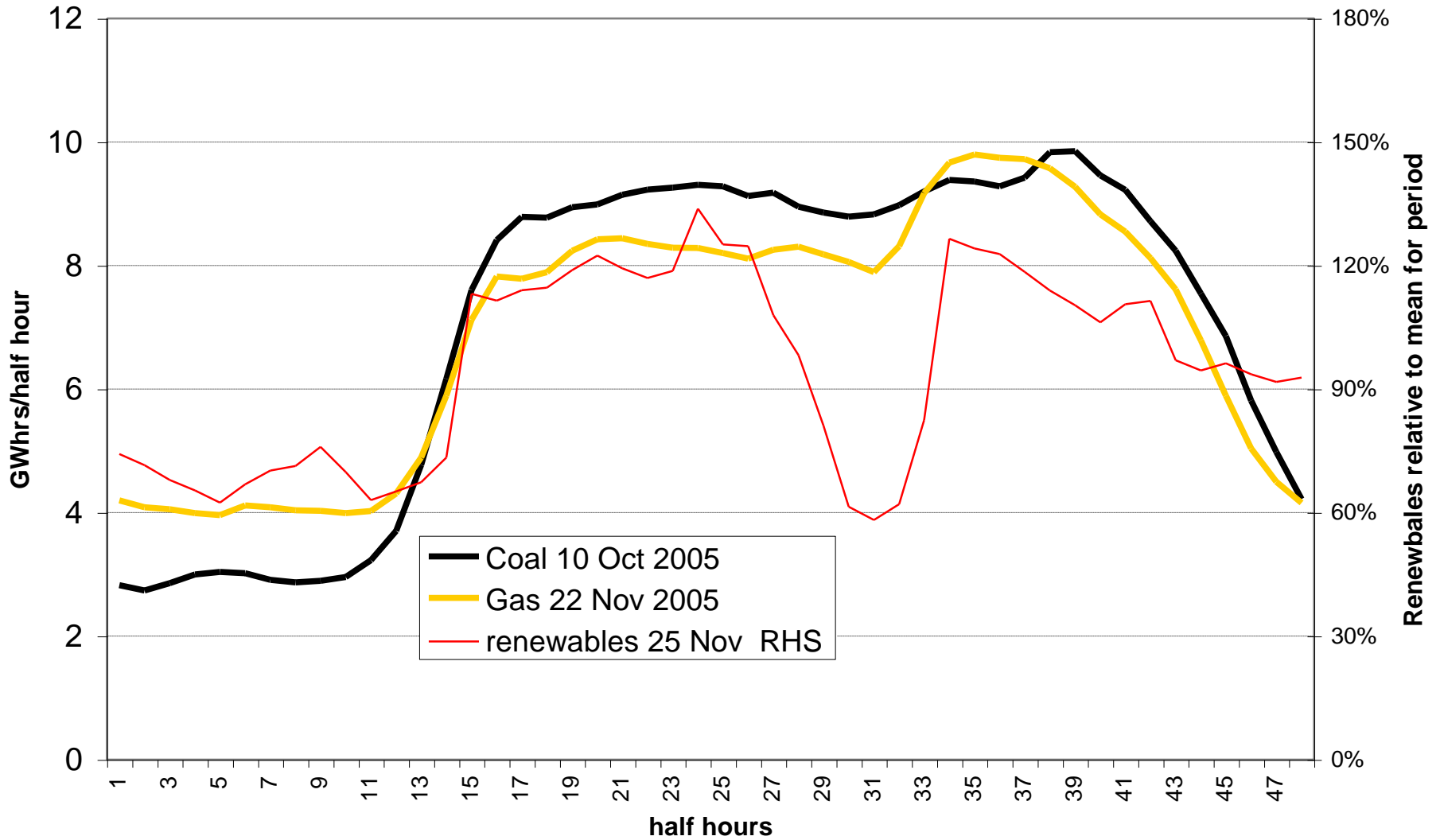
CH's network used 162.5, uses others 105.2,  
receives 57.2

# 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

# Ability to vary thermal output



# GB simulation – more volatility

