Fontenay aux Roses Work Shop:
« Wind Power and Market design »

Contribution:
Well-functioning balancing markets as a prerequisite for wind power integration

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Well-functioning balancing markets as a prerequisite for wind power integration

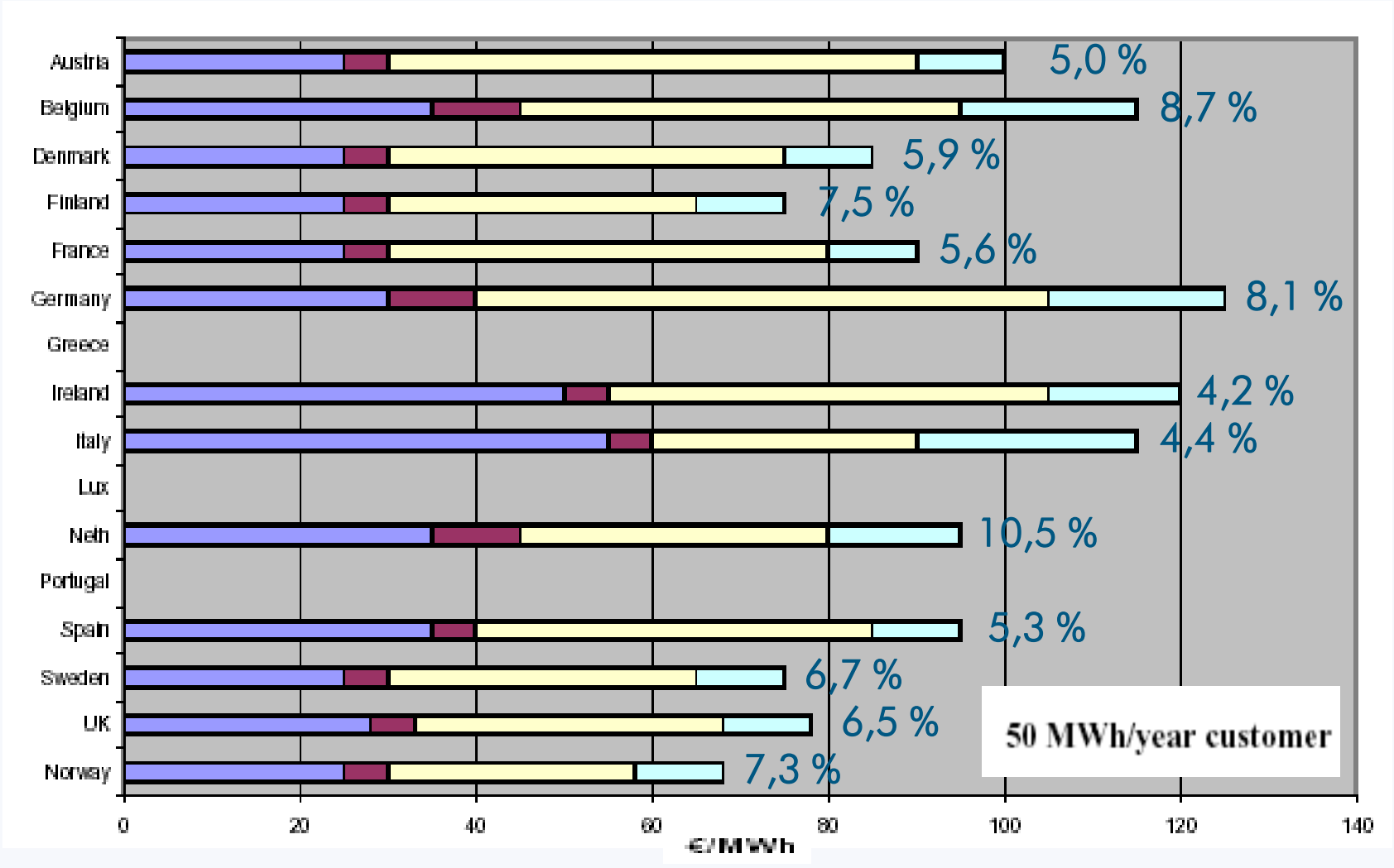
- **Are well-functioning balancing markets a prerequisite for wind power integration?**
- What are well-functioning balancing markets?
- What do well-functioning balancing markets imply for integration of wind?

Capacity payments

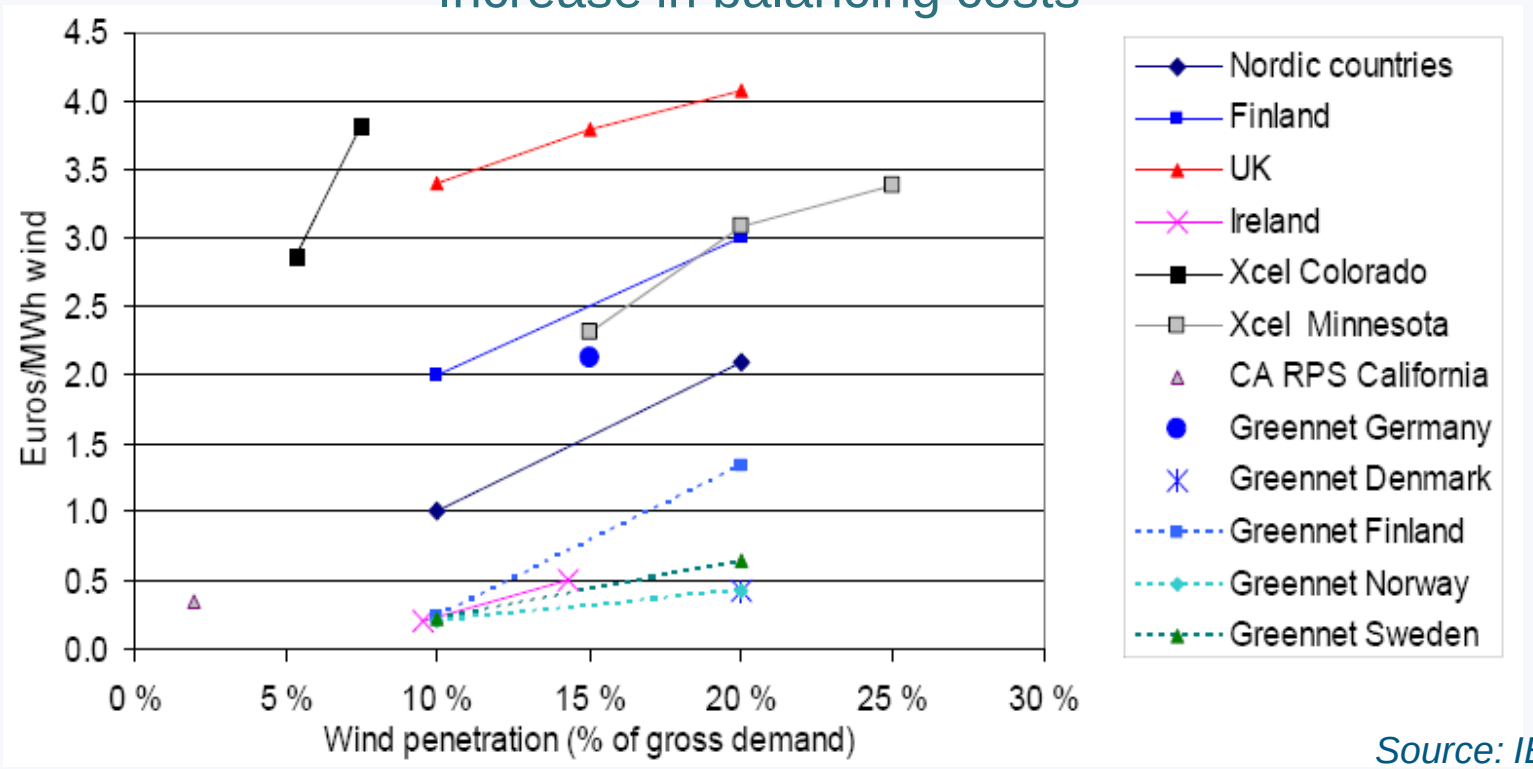
Production | Balancing costs\Capacity payments | Network Charge | Retail Supply Margin

DG TREN 3rd Benchmarking report: Estimated Breakdown of expected Electricity Prices 2004

LV



Additional balancing costs
Overview of existing studies



→ Direct comparison between studies not possible

- Different time scales
- Allocation of investment and/or operational costs for new reserves
- Power exchange possibilities to neighbouring countries
- Methods for cost calculation based on assumptions of thermal power

Additional balancing costs
Overview of existing studies

- Nordic countries - Finland
  - Holttinen, H. 2004. The impact of large scale wind power production on the Nordic electricity system. VTT Publications 554. Espoo, VTT Processes. 82 p. + app. 111 p., http://www.vtt.fi/inf/pdf/publications/2004/P554.pdf
  - Holttinen, H. 2005. Impact of hourly wind power variations on the system operation in the Nordic countries. Wind Energy, Vol. 8, No. 2, pp. 197.218
- UK
  - Ilex Energy, Strbac, G., 2002. Quantifying the system costs of additional renewables in 2020. DTI, 2002. http://www.dti.gov.uk/energy/developep/080scar_report_v2_0.pdf
  - Strbac, G., Shakoor, A., Black, M., Pudjianto, D. & Bopp, T. 2007. Impact of wind generation on the operation and development of the UK electricity systems. Electrical Power Systems Research, Vol. 77, Issue 9, pp. 1143.1238
- Ireland
  - Ilex, UMIST, UCD and QUB, 2004. Operating reserve requirements as wind power penetration increases in the Irish electricity system. Sustainable Energy Ireland
- Xcel Colorado
  - Zavadil, R. 2006. Wind Integration Study for Public Service Company of Colorado. May 22, 2006. Available at http://www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-1_1875_15056_15473-13518-2_171_258-0,00.html
- Xcel Minnesota 2006
  - EnerNex/Windlogics, 2004. Xcel North study (Minnesota Department of Commerce). Available at: http://www.state.mn.us/cgi-bin/portal/mn/jsp/content.do?contentid=536904447&contenttype=EDITORIAL&hpage=true&agency=Commerce
- CA RPS California
  - Shiu, H., Milligan, M., Kirby & B. Jackson, K. 2006. California Renewables Portfolio Standard Renewable Generation Integration Cost Analysis. California Energy Commission, PIER Public Interest Energy Research Programme. Available at: http://www.energy.ca.gov/pier/final_project_reports/CEC-500-2006-064.html
- Greennet Germany – Denmark – Finland – Norway – Sweden
  - Meibom, P., Weber, C., Barth, R. & Brand, H. 2006. Operational costs induced by fluctuating wind power production in Germany and Scandinavia. In: Swider, D. & Voss, A. (Eds.) Deliverable D5b . Disaggregated system operation cost and grid extension cost caused by intermittent RES-E grid integration. GreenNet-EU27. Pp. 133.154. http://greennet.i-generation.at/

Well-functioning balancing markets as a prerequisite for wind power integration

- Are well-functioning balancing markets a prerequisite for wind power integration?
- **What are well-functioning balancing markets?**
  - **Market based**
  - Cross-border
- What do well-functioning balancing markets imply for integration of wind

What does “market-based” mean?

- Real-time energy price fully reflect the costs of delivering energy in real time
- Cost allocation challenge
  - Alleviate congestion >< balance the system
  - Socialize >< imbalanced BRP
  - Reservation of capacity by doing capacity/availability payments
  - TSO generation capacity ownership

Common practice
Two price system with asymmetries

- **Containing other components**

→ **≠ market-based**

Example: France

Imbalance BRP	System imbalance: NEGATIVE (short) • ∑injections < ∑off-takes • TSO asks more production • NRV > 0	System imbalance: POSITIVE (long) • ∑injections > ∑off-takes • TSO asks less production • NRV < 0
NEGATIVE (short) Injections < off-takes	+ AP_u*(1 + k) (and ≥ Powernext price)	+ Powernext price
POSITIVE (long) Injections > off-takes	- Powernext price	- AP_d/(1 + k) (and ≤ Powernext price)

Common practice
One price system

- **Recovery of capacity/availability payments reserves only via socialisation among grid users or BRPs**

→ ≠ market-based

Example: Germany

		System imbalance	
		NEGATIVE (short) • ∑injections < ∑off-takes • TSO asks more production • NRV > 0	**POSITIVE (long)** • ∑injections > ∑off-takes • TSO asks less production • NRV < 0
Imbalance BRP	**NEGATIVE (short)** Injections < off-takes	+ MP_u	+ MP_d
	POSITIVE (long) Injections > off-takes	- MP_u	- MP_d

Our market-based proposal
Mix between one & two price system

- $MP_{u/d}$
  - ≅ One price system
- Uplift/Additive $Component_{cap}$
  - ≅ To recover capacity payments

		System imbalance	
		NEGATIVE (short) • ∑injections < ∑off-takes • TSO asks more production • NRV > 0	**POSITIVE (long)** • ∑injections > ∑off-takes • TSO asks less production • NRV < 0
Imbalance BRP	**NEGATIVE (short)** Injections < off-takes	MP_u + $component_{cap}$	MP_d + $component_{cap}$
	POSITIVE (long) Injections > off-takes	- (MP_u - $component_{cap}$)	- (MP_d - $component_{cap}$)

Restrictions on use of capacity payments

- Cost allocation via uplift/additive component only 2nd best
  - Limited accuracy of additive component
  - Impact on new entrants rather than incumbents

→ Restrictions on use of capacity payments needed
  - To ensure $component_{cap} << MP_{u/d}$

  → Capacity payments should not exceed “reservation price”

- Excessive reserves finally result in disappearance real-time market!

Categorisation
Reserves & balancing services

	SECURITY INSURANCE	REAL-TIME ENERGY
Settlement	Socialisation of costs among grid users	Allocation of costs among BRPs via real-time energy price
Procurement	Capacity payments	Preferably *only* energy payments Capacity payments justified in case of high price volatility & to compensate for non-convexities
Use	Very small E(real-time energy delivery)	Very small E(real-time energy delivery)

E.g. use or activated reserves and balancing services in Belgium in 2006:

	Primary reserves *symmetric regulation*	**Secondary reserves**	**Tertiary reserves**	**Other tertiary control services** *not reserved*
↑	± 19,3 GWh	± 216 GWh	± 0,5 GWh	± 12,9 GWh
↓	± -19,3 GWh	± -258,1 GWh	0 GWh	± -2,8 GWh

What does “market-based” imply?

- An imbalance settlement based on other components such as power exchange prices is not market- based

  BUT an additive component is necessary to settle capacity payments for reserves

- A cap should be imposed on the amount of reserves so that their share in real-time energy delivered is marginal

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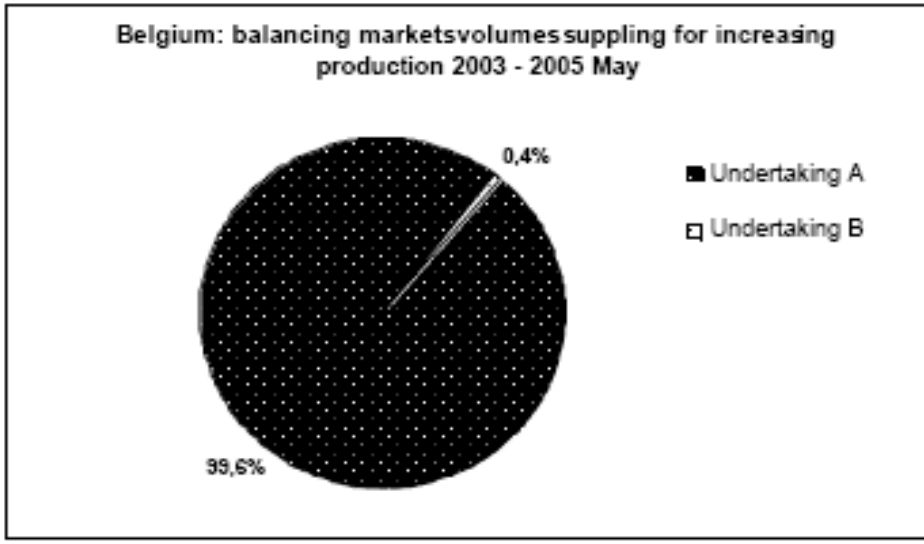
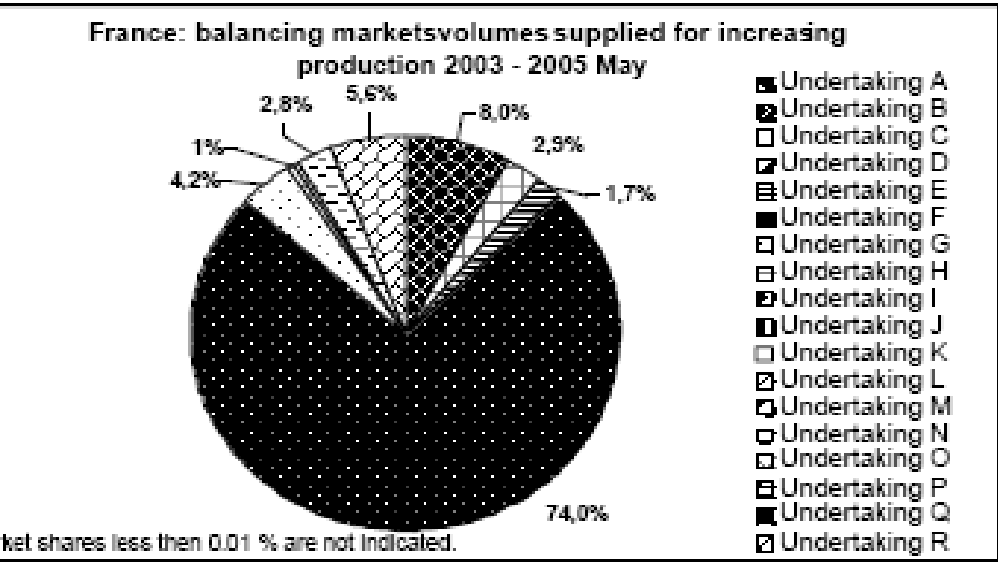
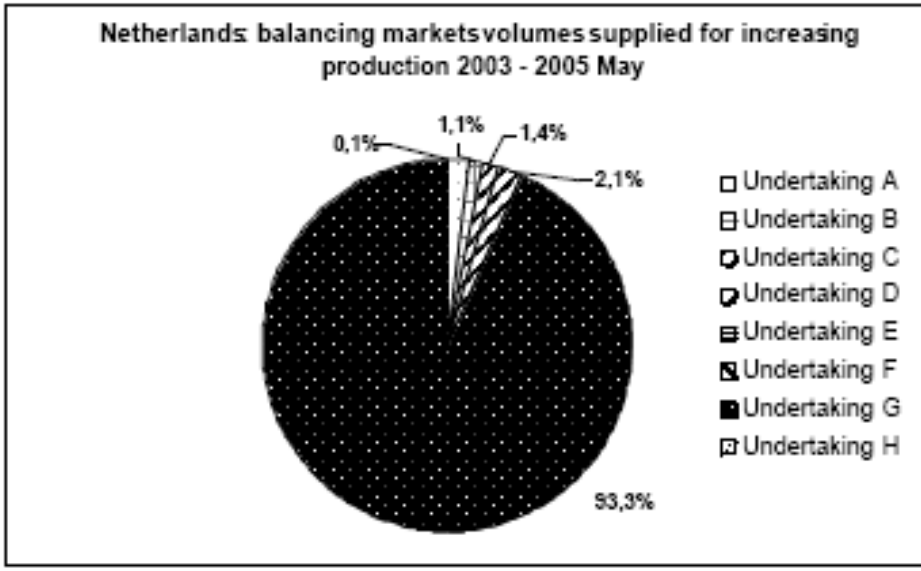
The Sector Inquiry about balancing
Conclusions

- Findings:
  - Balancing markets are highly concentrated
  - Mostly national in scope







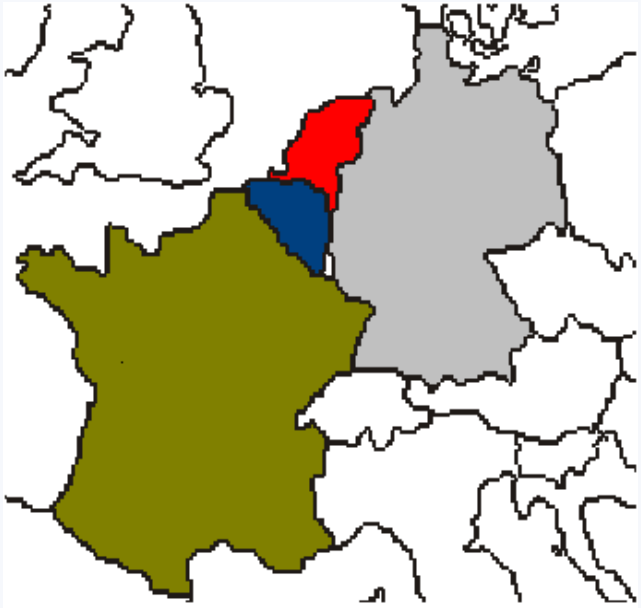
Non-harmonised imbalance settlement
The Central-West Region

Belgium

- Two price system
- With power exchange prices & penalty

Netherlands

- One(/two) price system



Germany

- One price system

France

- Two price system
- With power exchange prices & penalty

Cross-border balancing implementation

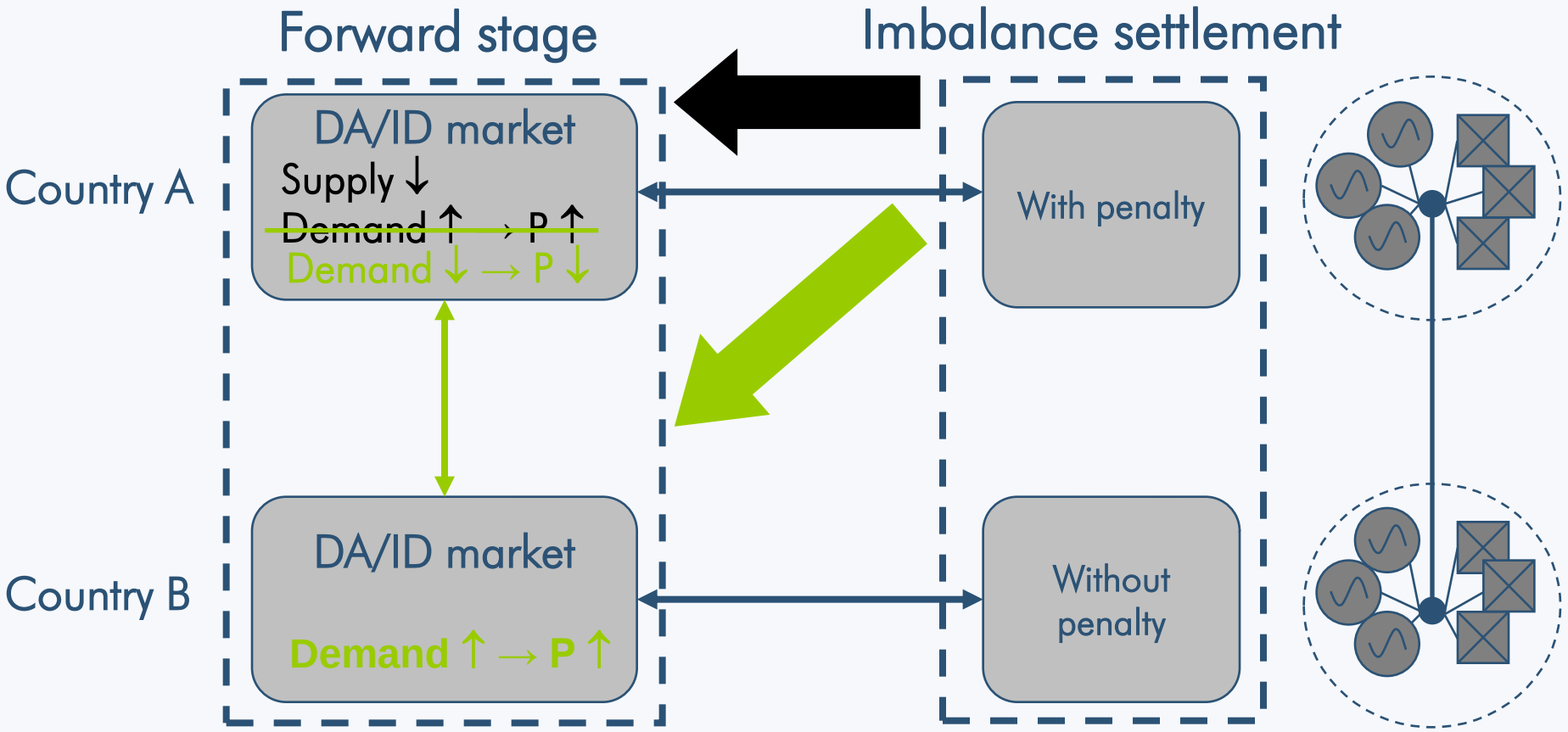
→ Cross-border initiatives proven to trigger harmonisation & centralisation rather than requiring it

- E.g. TLC & Nordic cross-border balancing initiative

→ Lack of harmonisation & centralisation already creates distortions & security issues

- E.g. due to fact that wholesale trade is increasingly across borders

Possible distortions
Non-harmonised imbalance settlement



BRPs of A increase DA/ID purchases to hedge against short position

BRPs of A partly transfer DA/ID purchases to B

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Our market-based proposal
Impact on wind power

+ Avoidance of other components such as penalties
  → Likely reductive effect on overall real-time energy prices
- Additive component
  → Cf. Ramsey-Boiteux pricing: recovery of fixed costs from price-inelastic consumers
  → Wind generators – rather inelastic – likely to bear significant part of capacity payments
+ Cap on the amount of reserves

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