Regulating wind farms in meshed offshore grids

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Technical University of Denmark

Regulating wind farms in meshed offshore grids

Market and regulatory framework conditions

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Energy Systems Analysis

NSON workshop Strathclyde
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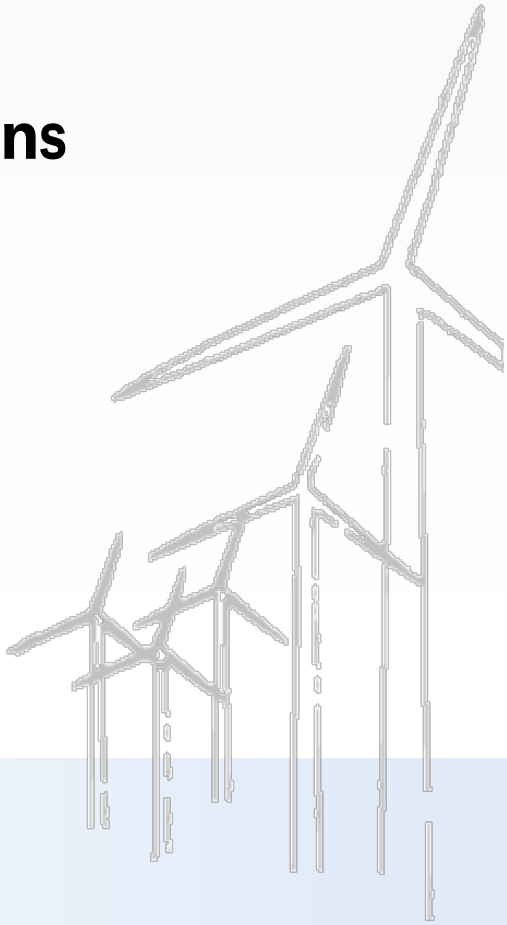

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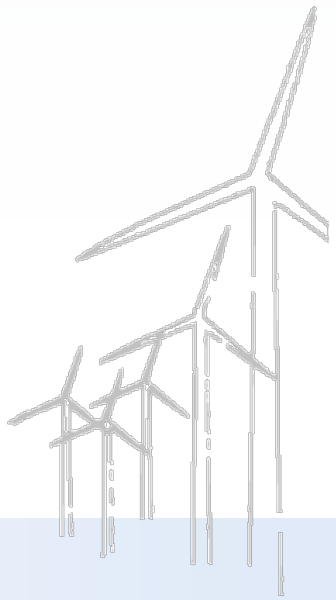
Department of Management Engineering

Agenda Regulatory framework challenges

- Wind farms at meshed offshore grids
  - EU legislation, bidding zones, congestion and residual transmission capacity
  - Pricing rules?
- Market Design:
  - From passive to active dynamic generation / market actors
- Main future challenges?



Regulating future offshore grids

- Currently, offshore wind parks in Europe are single-country approaches
- Future meshed offshore grids will interconnect wind parks and countries
- Current research mostly from a macroscopic perspective

Research Question

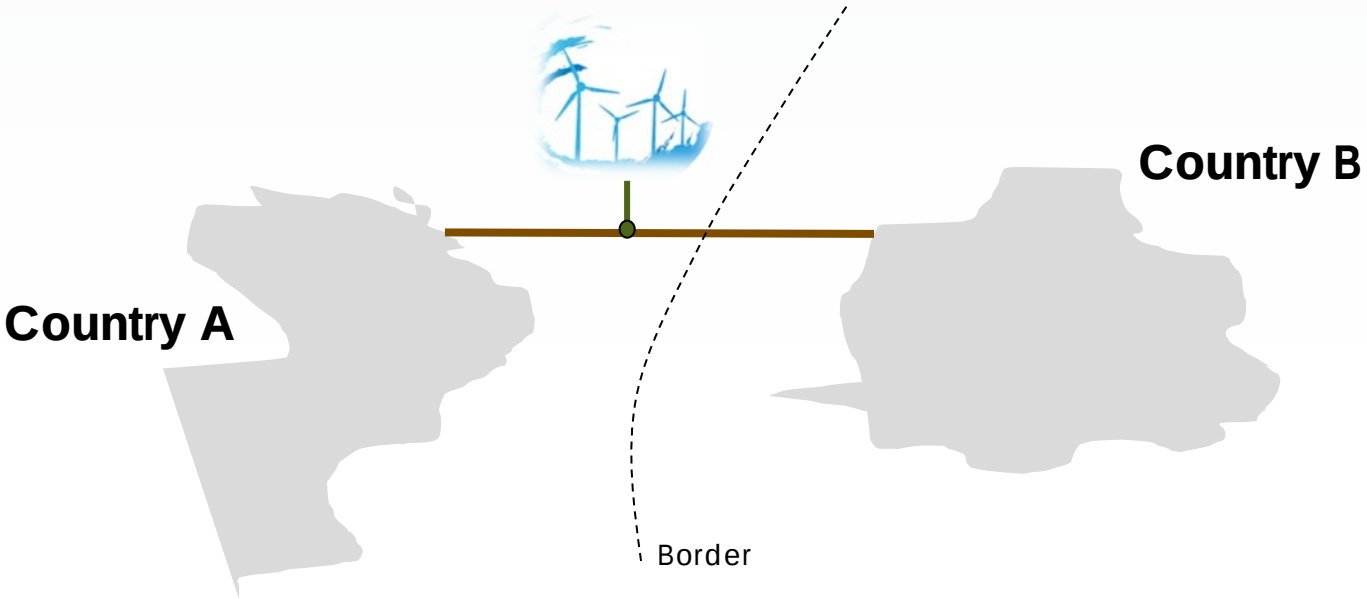
How should production in offshore grids be regulated in terms of

- Market access
- Pricing rules
- Support scheme for RES

EU legislation

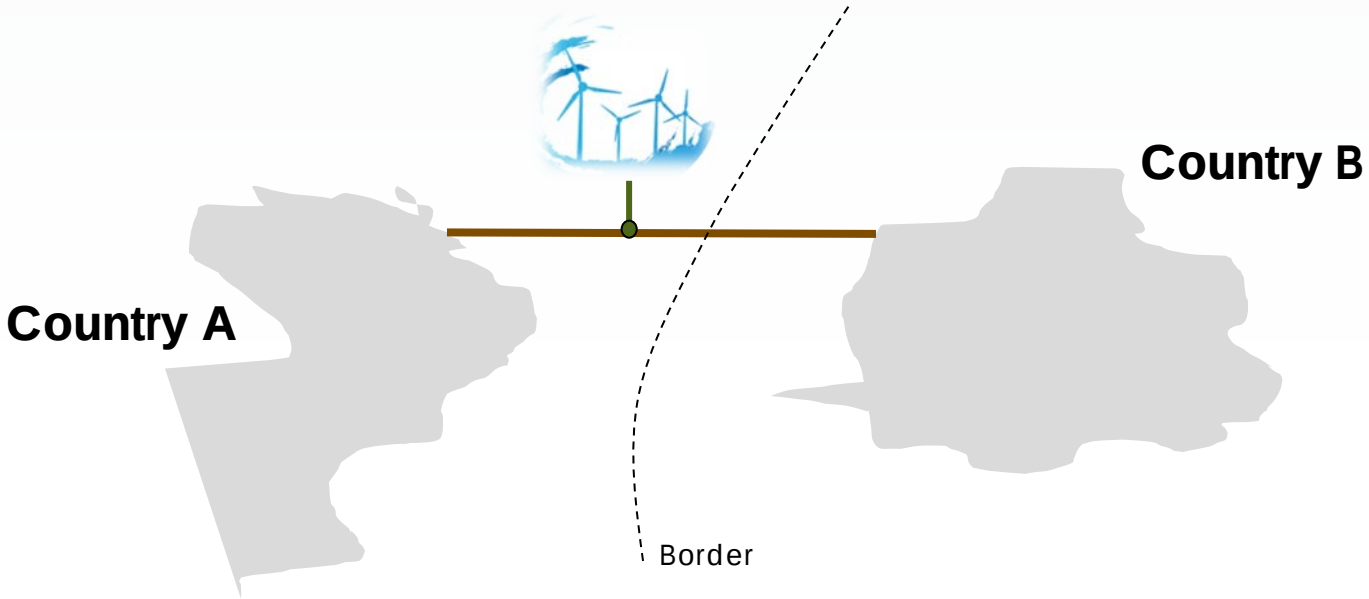
- **Priority Access** and **Priority Dispatch** for RES-E as per RES Directive (Directive 2009/28/E)

- **Congestion Management Guidelines** and **EU Target Model** as per the 3th Energy Package legislation
  - electricity should flow between price or bidding zones according to price differences.
  - cross-border flows should not be reduced to solve a country's internal congestion



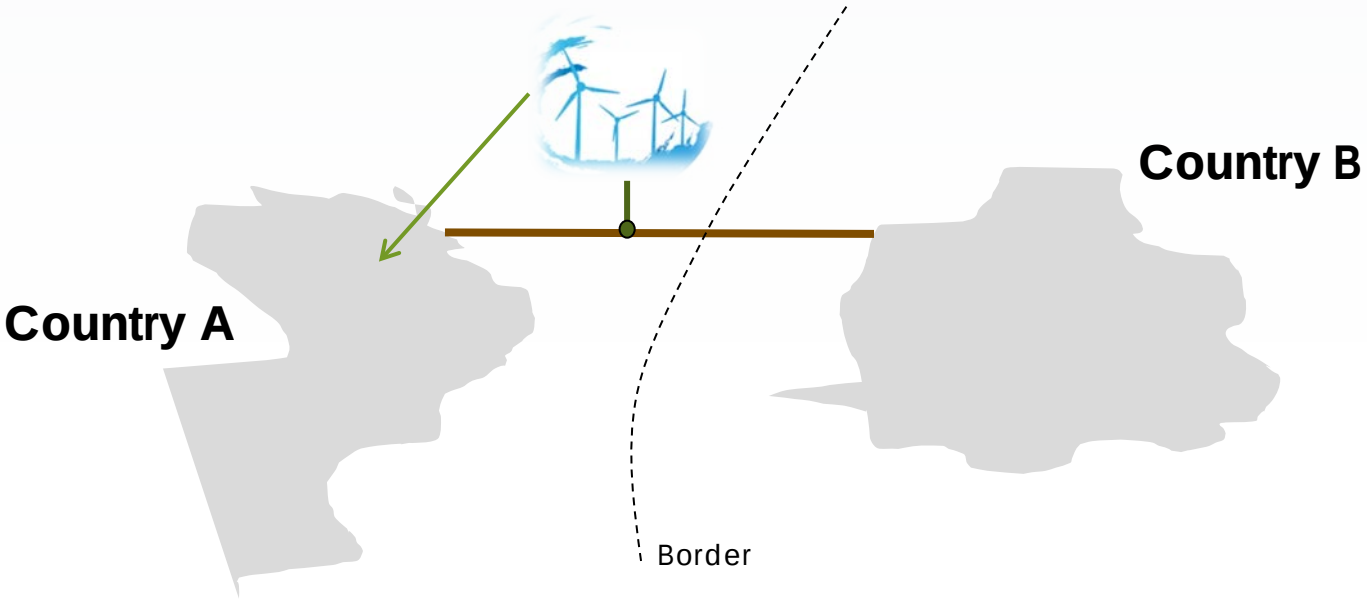
Bidding zones

- **Home country / Fixed bidding zone**: Wind farm treated as any other trader in zone A
- **Primary access / Floating bidding zone**: May choose its bidding zone
- **Offshore hub / Own bidding zone**: Bidding zone separated from zone A and B



Home country / Fixed bidding zone

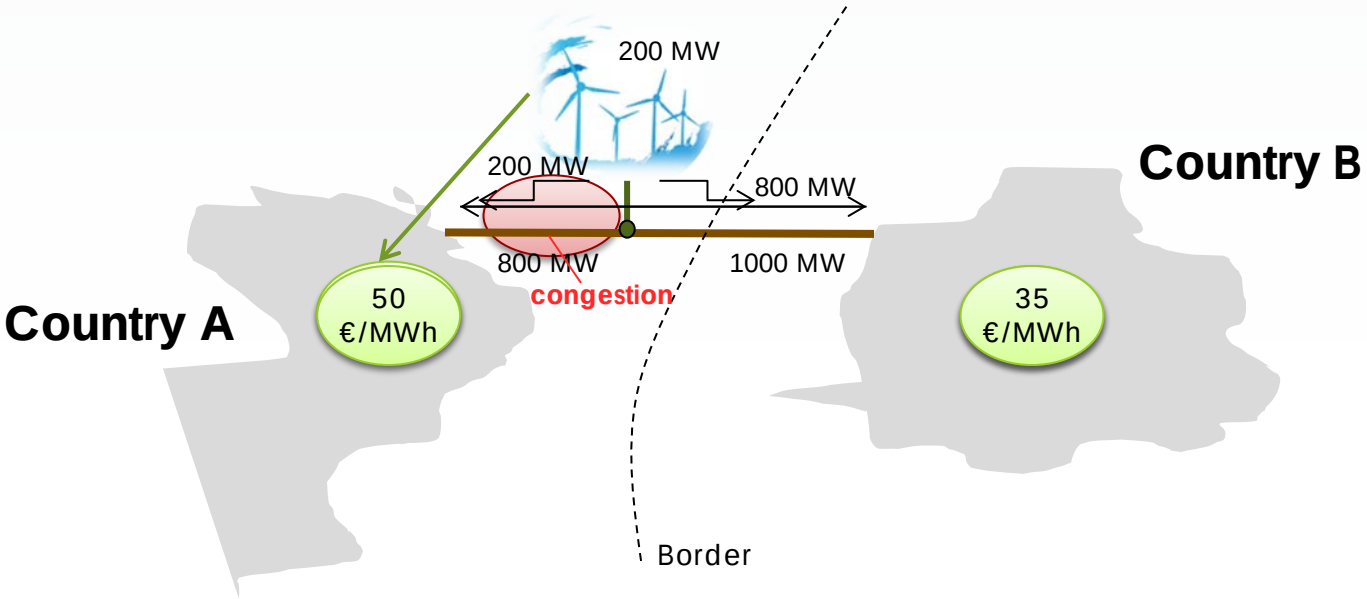
- "Domiciled" in bidding zone A - Treated as any other trader in zone A
- RES support only in home country
- Limited cross-country cooperation
- Residual inter-connector capacities dispatched by TSO



Fixed bidding zone and congestion

- **Flow from A to B**
- **Flow from B to A** ? → **Congestion**

Priority leads to reduction in day-ahead interconnection capacity = **residual capacity** = 800 MW

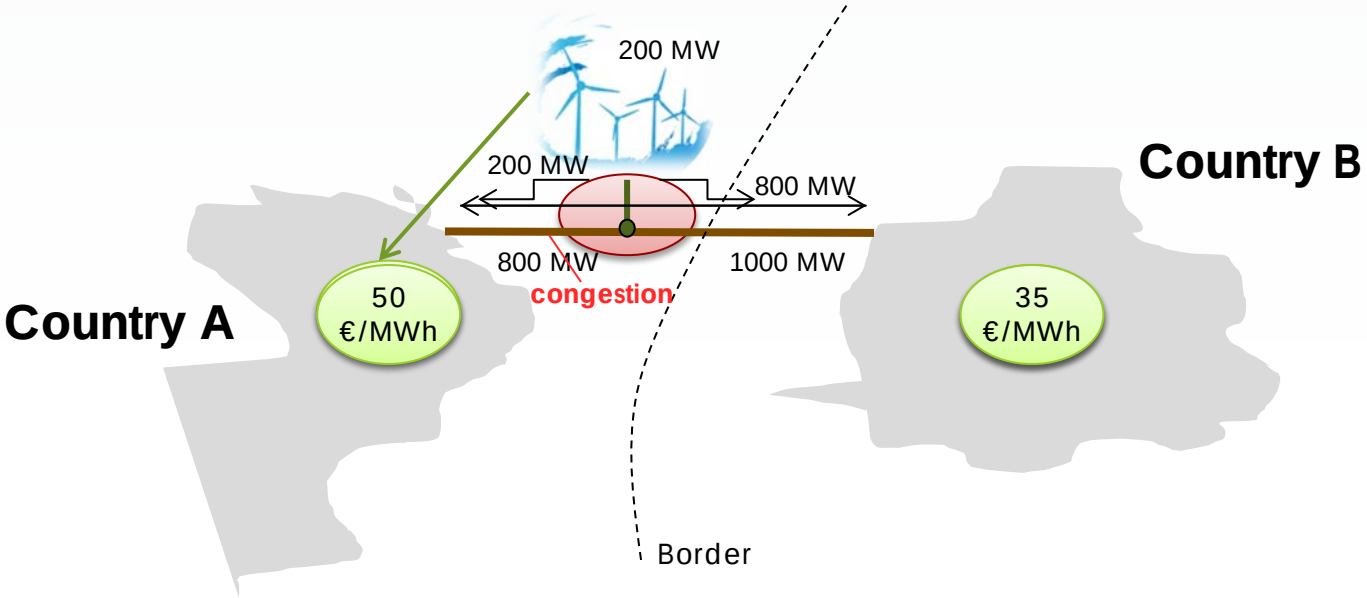


Pricing rules and congestion compensation

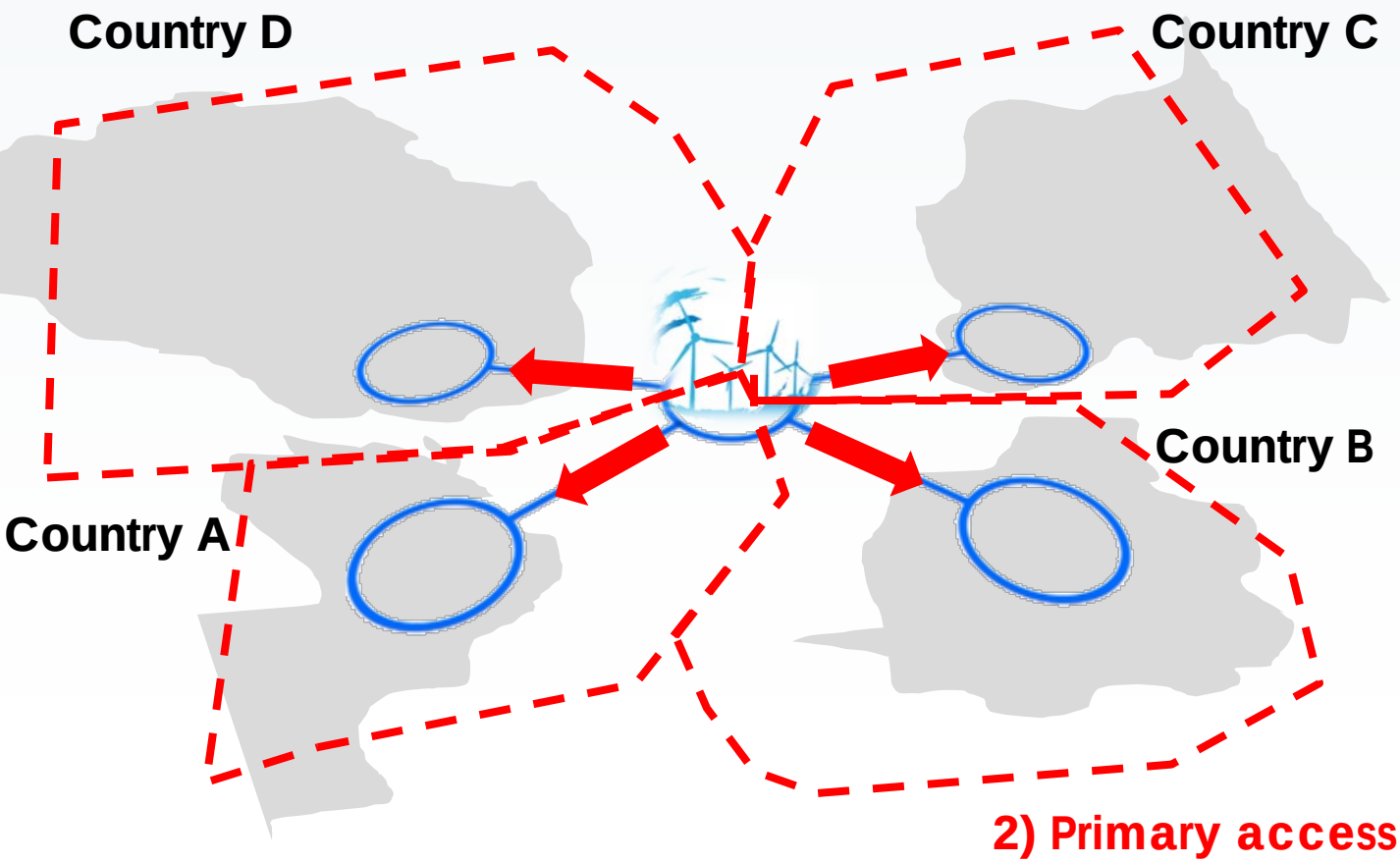
✓ Lower price in high price zone (+/÷) Higher price in low price zone

- Only residual transmission capacity is dispatched
  - Compensation to low price country? Of 200 MW or ???
  - Always the lower price? The high price zone buys ***all*** capacity from low price zone?

- Who should pay? Subsidy to wind in order to displace conventional emitting power - not to increase export



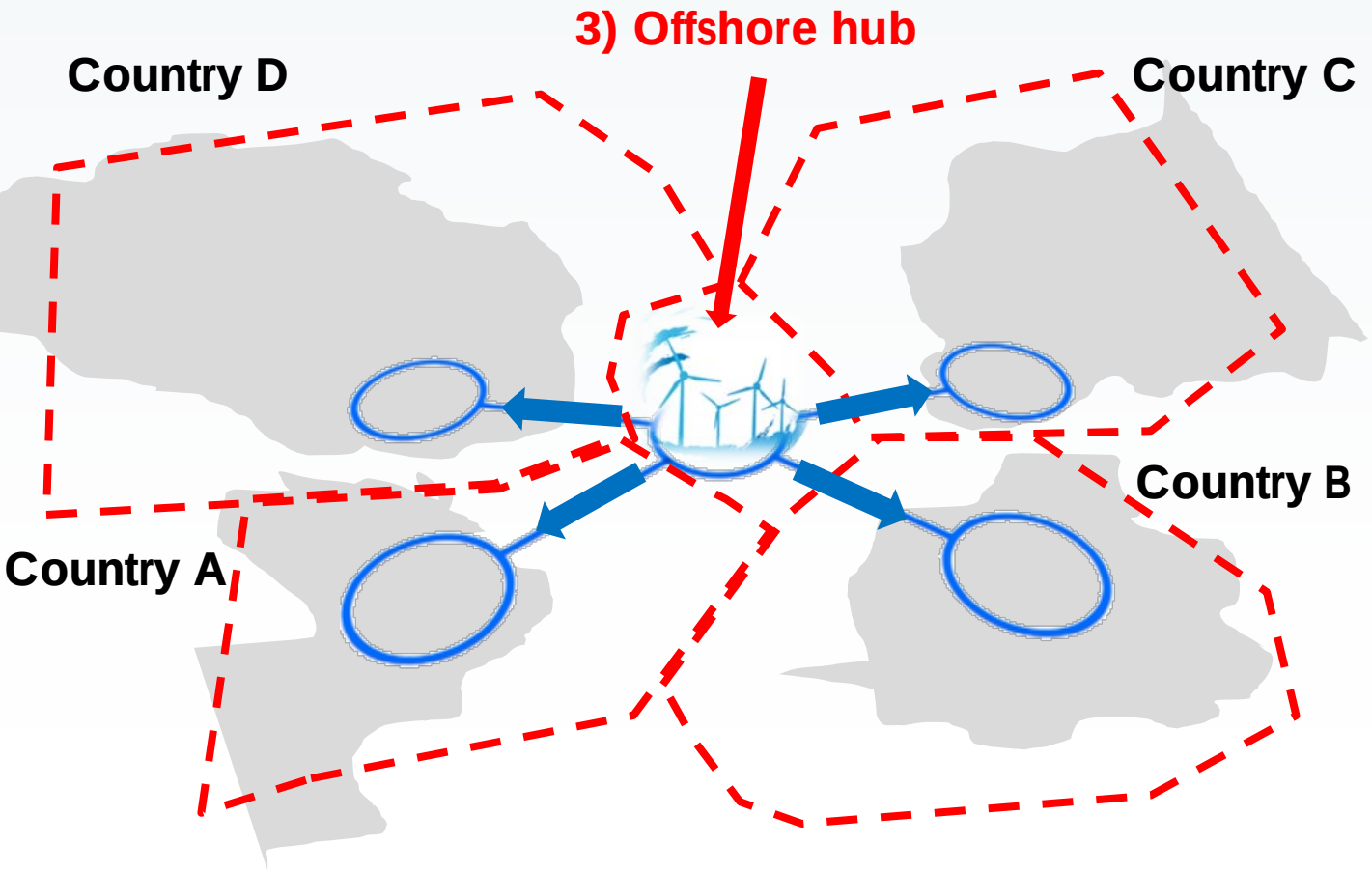
Market access & Pricing rules: Option 2



2) Primary access

- Floating bidding zone
- Wind park can choose its bidding zone
- Production is integrated into the most attractive of the neighbouring countries
- RES support in all countries
- Residual inter-connector capacities dispatched by TSO

Market access & Pricing rules: Option 3



3) Offshore hub

- Production of wind park forms its own market area
- No market choice for the wind park
- Joint RES support for the new market area
- All interconnector capacities dispatched by TSO

Regulatory framework challenges

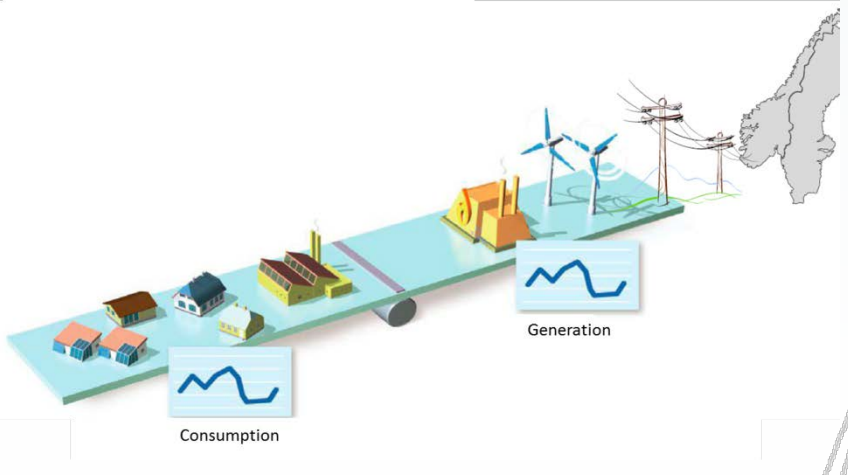
Market integration and flexibility

From passive to active dynamic generation / market actors

- Act to negative prices at the spot market (day-ahead)
  - Case: Change in market design from 2009: negative prices at NordPool
    - Close down of wind turbines in hours with neg prices = saved costs
- Active at the balancing markets

  Close down of wind = down regulation

☺ **Case Denmark**: New wind turbines gets a Feed In Premium in certain full load hours (depending on size). When down-regulation, the not "used" full load hour with support can be used later.



☹ **Case Denmark**: Some existing off-shore tenders have no incitements for WTs to be active in down-regulation.

☺ One (Anholt) doesn't receive FIT when negative prices.

Managing **Negative** Spot Prices

Case: Sund & Bælt wind farm – 16. March 2014

Elspot prices

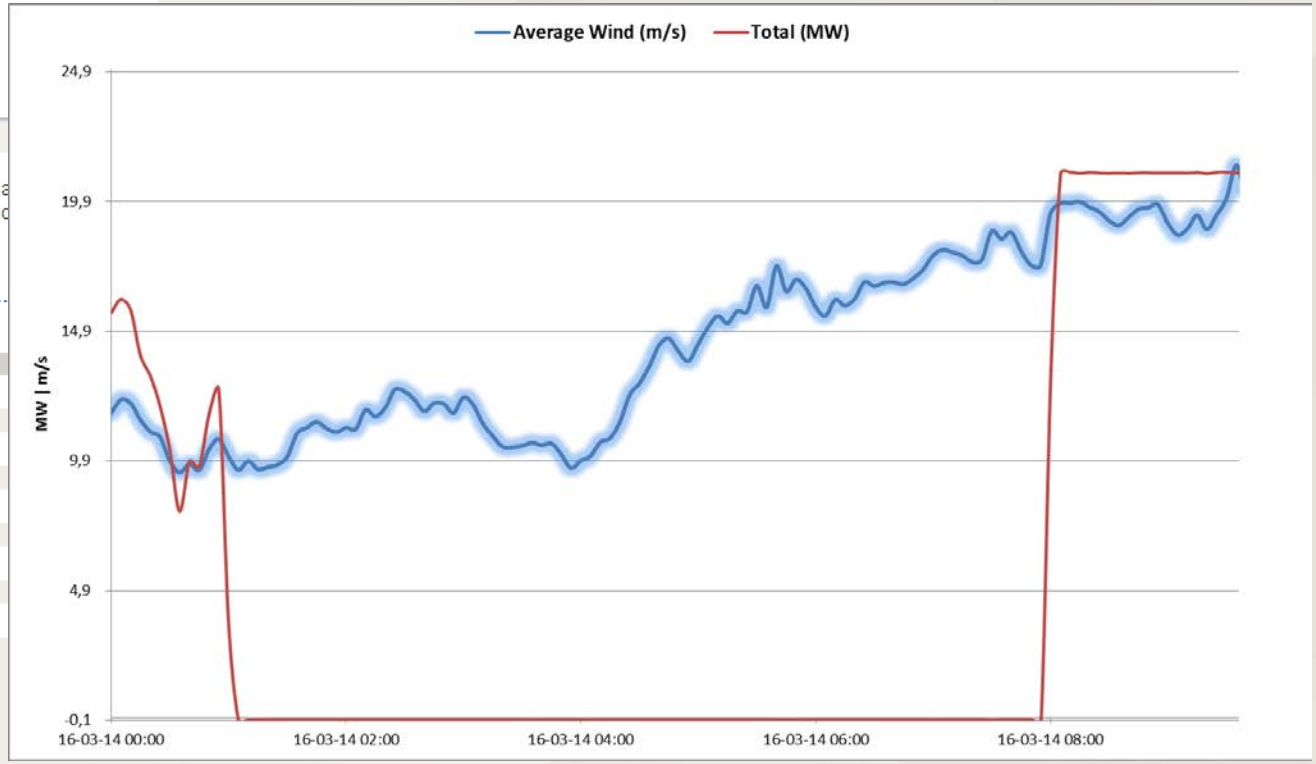
ALL SYS NO SE FI DK EE LT LV

- further details -

Please note that changes in the Norwegia
comparison between present and historic
the area change log pdf.

EUR/MWh

	DK1
16-03-2014	
00 - 01	-0,02
01 - 02	-25,08
02 - 03	-25,06
03 - 04	-60,26
04 - 05	-50,65
05 - 06	-50,12
06 - 07	-25,08
07 - 08	-25,00
08 - 09	0,05
09 - 10	10.77



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Managing **Negative** balancing Prices

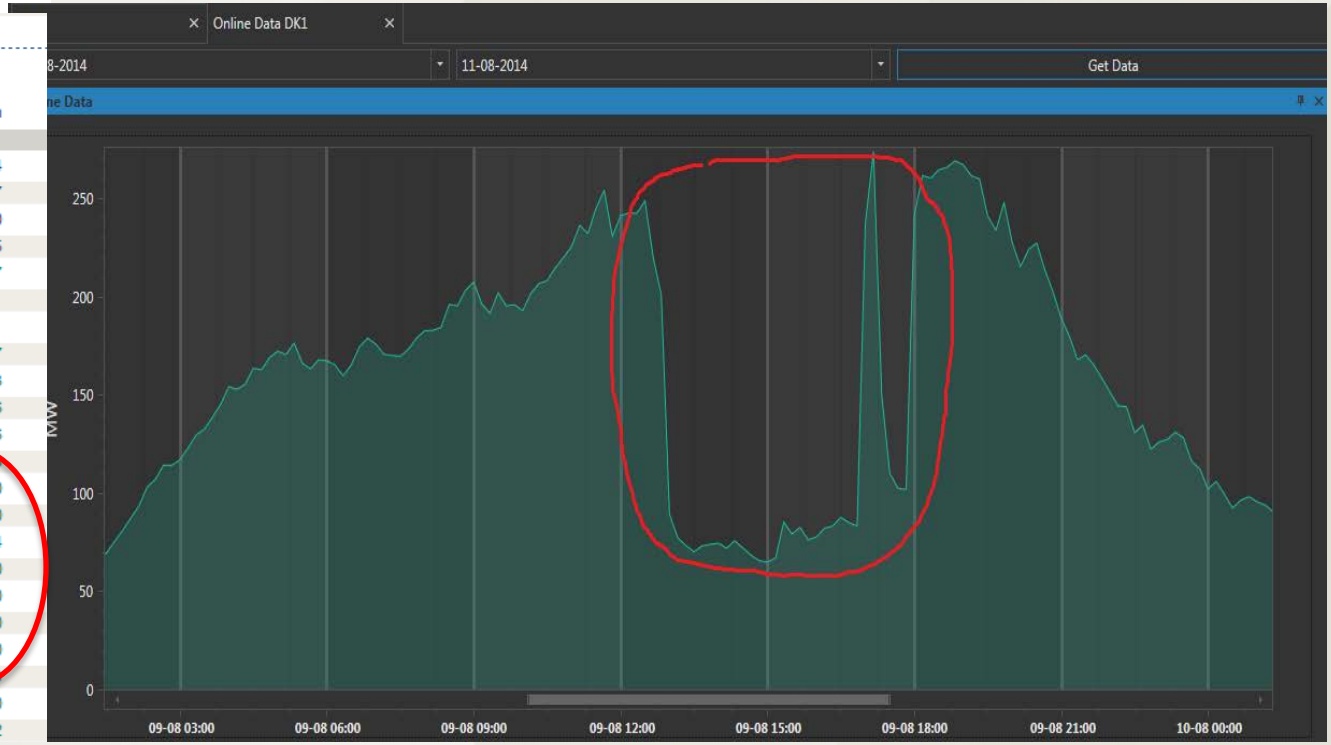
Case: Down ward regulation – 9 August 2014

Regulating prices

ALL NO SE FI DK

DKK/MWh

	DK1	
	Up	Down
09-08-2014		
00 - 01	248,34	247,34
01 - 02	213,27	213,27
02 - 03	200,90	200,90
03 - 04	196,95	196,95
04 - 05	188,60	138,07
05 - 06	183,38	124,71
06 - 07	179,65	124,71
07 - 08	194,04	138,07
08 - 09	200,15	151,43
09 - 10	204,25	178,16
10 - 11	207,91	178,16
11 - 12	207,31	178,16
12 - 13	200,68	-90,00
13 - 14	189,05	-90,00
14 - 15	186,06	-541,94
15 - 16	200,75	-90,00
16 - 17	200,82	-90,00
17 - 18	191,88	-90,00
18 - 19	225,42	-50,00
19 - 20	240,26	155,82
20 - 21	246,22	182,70
21 - 22	249,20	193,82



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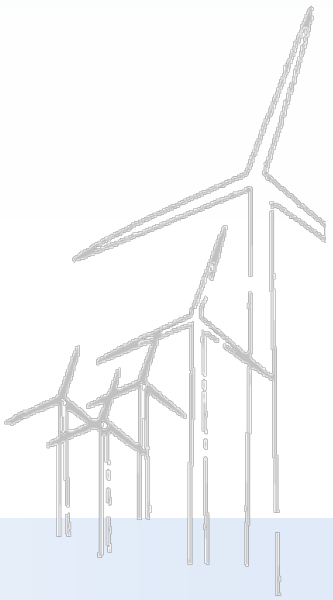
Discussion: future challenges

- Main future challenges?
  - Current challenges?
  - Research gaps?
  - Scope ?

Regulatory re-thinking

- Wind farms at meshed offshore grids
  - Bidding zones, congestion and residual transmission capacity
  - Pricing rules? Support and burden sharing
- Market Design:
  - From passive to active dynamic generation / market actors. Value of ancillary services



Thank you for your interest

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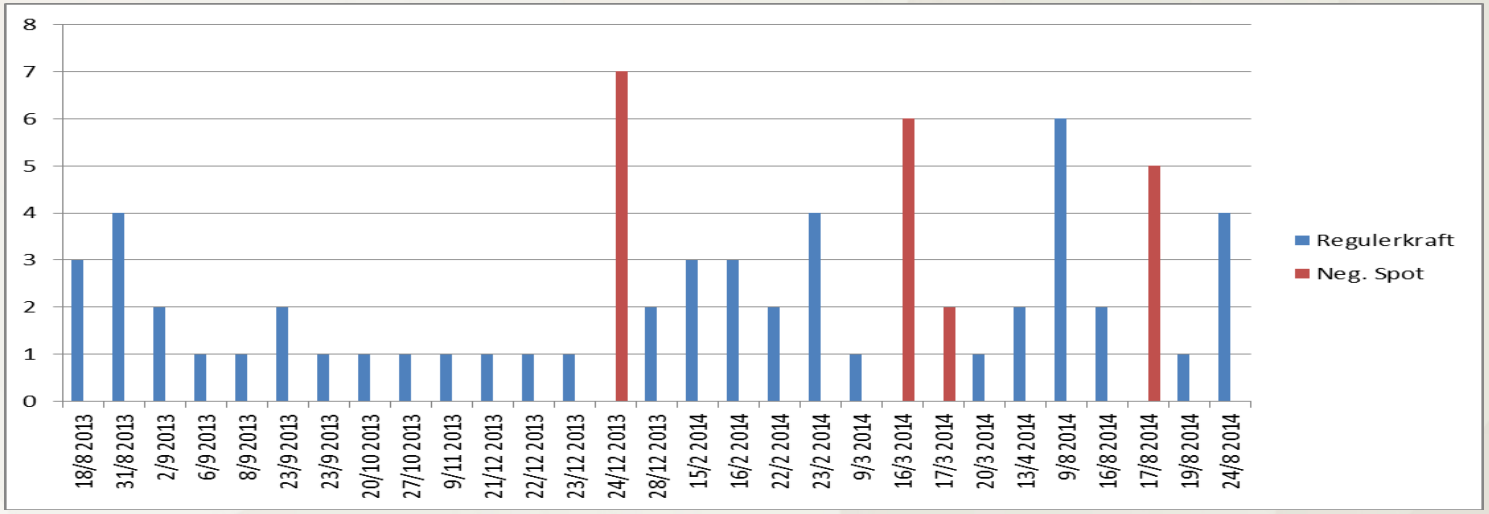
Questions ?

Last year with active participation of wind turbines in ancillary service



Activations where negative regulating prices are below -50 DKK/MWh.

- 25 times
- 51 hours

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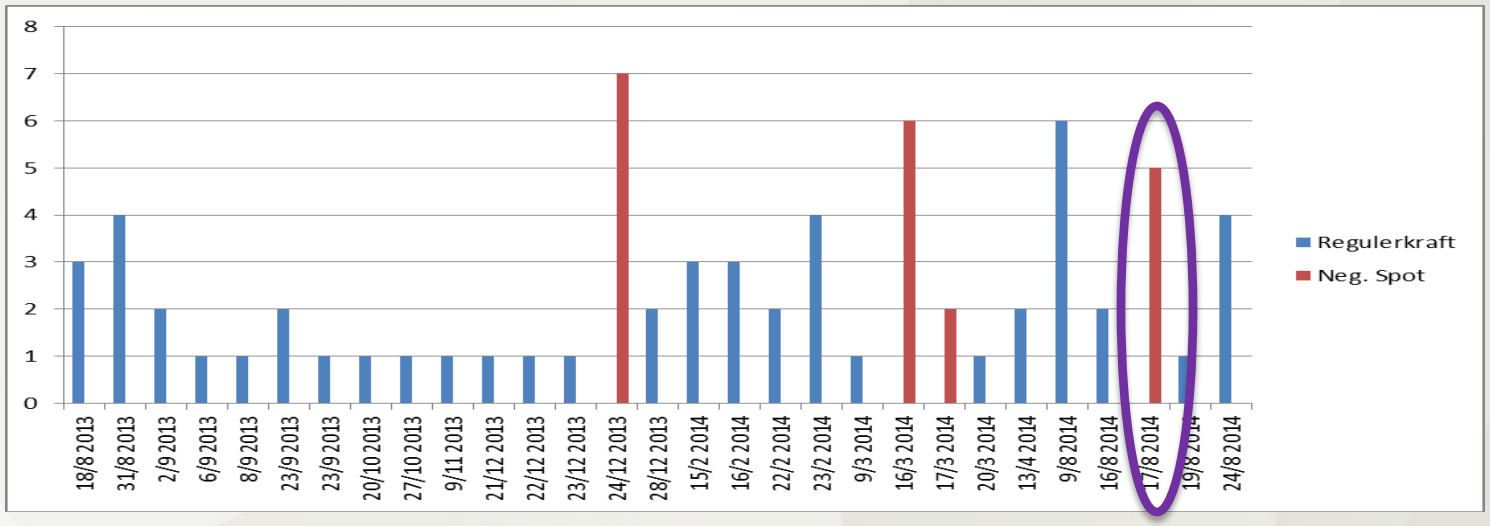
Last year with active participation of wind turbines in Day Ahead market.

Hours



Protection against negative spot prices 17. august 2014.

- Day Ahead trading resulted in negative spot prices
  - Wind production was expected at high level
  - Wind production considerable lower than expected
  - Wind turbines were used actively and did not stop at all.