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Møller Andersen, Frits; Grohnheit, Poul Erik

*Publication date:*  
2009

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*Citation (APA):*

Møller Andersen, F., & Grohnheit, P. E. (2009). Increasing integration of variable RES-E: Policy and regulatory measures for demand and trade [Sound/Visual production (digital)]. 4th RESPOND Project Workshop : Increasing the contribution of variable energy resources, such as wind, photovoltaic and micro-CHP in the energy supply system, Berlin (DE) 3. Feb., 01/01/2009

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## 4<sup>th</sup> RESPOND Project Workshop

Increasing the contribution of variable energy resources, such as wind, photovoltaic and micro-CHP in the energy supply system

Increasing integration of variable RES-E:  
Policy and regulatory measures for demand and trade

Frits Møller Andersen and Poul Erik Grohnheit  
Risø DTU, Technical University of Denmark



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Renewable Electricity Supply interactions with conventional  
POWER generation, Networks and Demand

## Overview

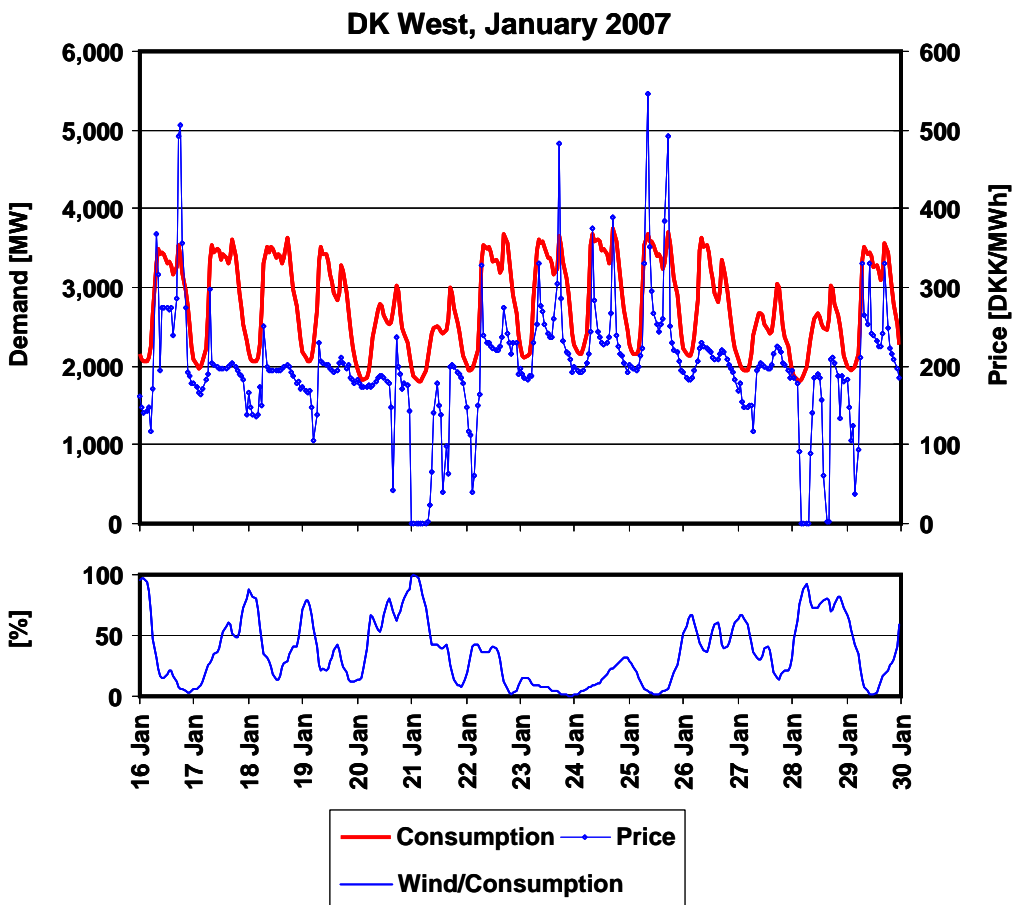
- Problems of intermittent generation – in practice wind
- Response by the electricity market
- Market organisation and development
- Response technologies
- Key recommendations on policy and regulatory measures



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# Wind power on the day-ahead market



Hourly Nord Pool prices, consumption, and wind power production in West Denmark in the second half of January 2007.

Observations:

- a systematic daily and weekly variation in demand and the price of electricity
- peak prices that are unsystematic in time and often related to limited wind power production
- low or even zero prices that are unsystematic in time and often related to a large production from wind power

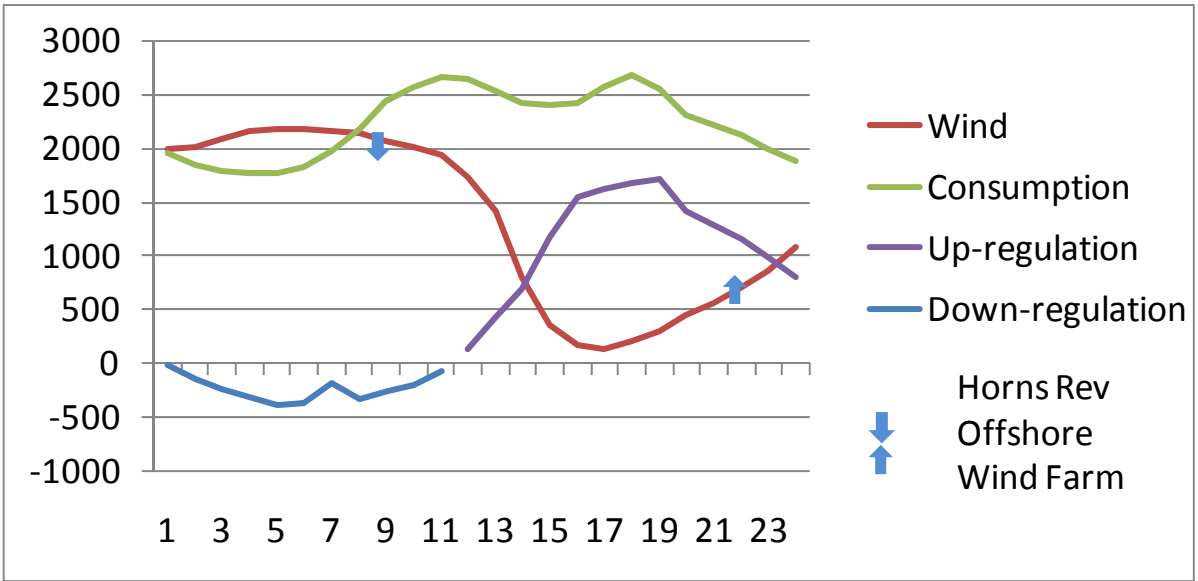
Observations reveal problems with different barriers requiring different technical solutions and different design of incentives



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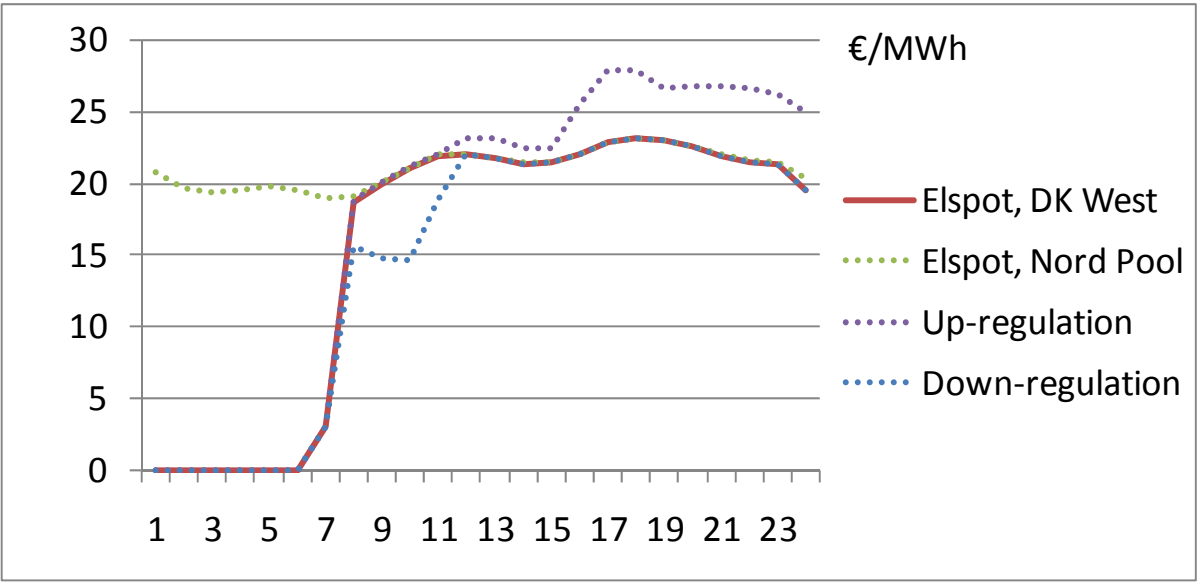
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# Wind production during storm



*Western Denmark, Saturday 8 January 2005*

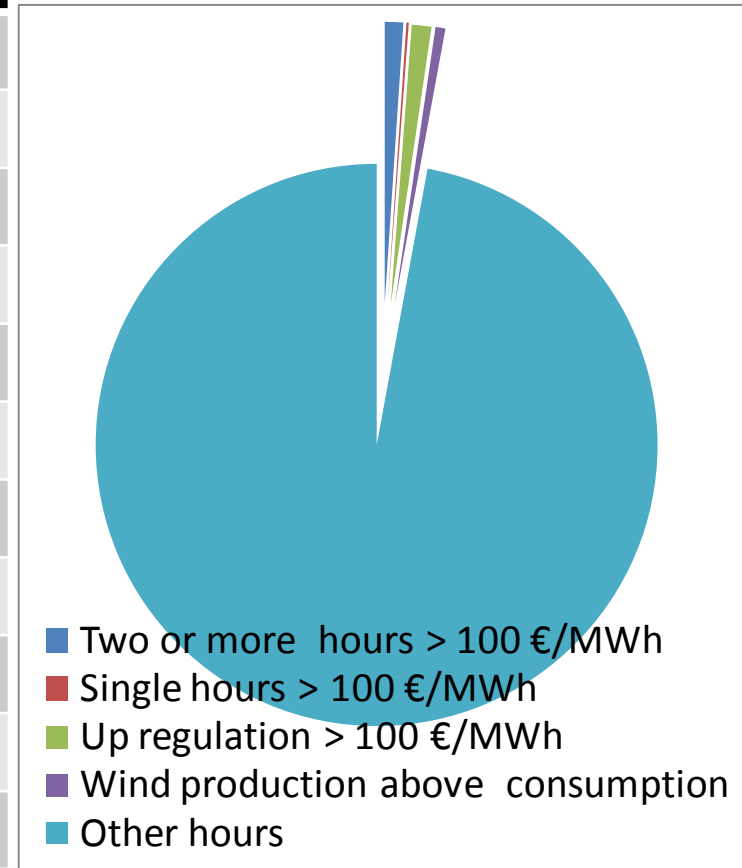
During the worst storm in recent years some 2000 MW wind turbines stopped due to wind speeds more than 25 m/s of mean wind. The TSO had to buy large amounts of regulation power. During the night the area spot and regulation prices had been zero, but prices were not abnormal during the outage of the wind capacity.



# Electricity flows and capacities in the Nord Pool price area Western Denmark

	2006	2007	2008
Consumption, TWh	21.4	21.6	21.6
Wind production, TWh	4.6	5.6	5.2
Net Import, North, TWh	-2.4	3.5	5.6
Net Import, South, TWh	-2.1	-5.2	-6.6
<b>Share of wind</b>	<b>22 %</b>	<b>26 %</b>	<b>24 %</b>
Central thermal capacity, GW	3.40	3.40	
Decentral thermal capacity, GW	1.74	1.74	
Wind power capacity	2.39	2.39	
Max. Load, GW	3.75	3.77	3.75
Min. Load, GW	1.41	1.38	1.30
Max. Wind, GW	2.20	2.21	2.18

*Extreme hours 2007*



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# Market development – Nord Pool price area Western Denmark

- Nord Pool (Norway from 1993 expanded to other Nordic countries)
  - Western Denmark day-ahead market since July 1999
  - With auctions for reserves and regulation market
  - Balancing responsible parties (production and consumption)
  - Co-operation between TSO and market players on IT-development
  - Decentral CHP above 10 MW must take part in the market from 2005 (above 5 MW from 2007)
  - Block bids (minimum reduced from 4 to 3 consecutive hours from 2006)
  - Daily auctions for reserves from 2007
  - Elbas introduced from 2007
  - DSO development of 'smart grids'
- Market development driven by*
- Import, export and transit
  - Wind power
  - Large and small-scale CHP



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## Electricity spot markets – key elements

- Hourly prices - day-ahead and intraday markets
- Capacity reserve – annual, monthly or daily auctions
- Bidding by legal entities – identification of physical units
- TSO and balancing responsible parties
- Implicit and explicit auctions for transmission bottlenecks
- Participation by producers, consumers and traders
- Ongoing European co-operation on electricity markets

### Some recommendations

- Large consumers and small CHP must face hourly prices
- Wind turbines with regulation capability should bid for up and down regulation reserves
- Bids by legal entities with suitable portfolios of generating units
- Geographical price areas to reflect transmission bottlenecks – these day-ahead prices should be transferred to all consumers



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# Market organisation: Balance responsible parties in Western Denmark

## Production, Consumption and Trade

- DONG Energy (3 entities)
- Energi Danmark A/S
- Markedskraft Danmark A/S
- E.ON Energy Trading AG
- Nordjysk Elhandel A/S
- Vattenfall (2 entities)

## Production and Trade

- Stadtwerke Flensburg GmbH

## Consumption and Trade

- Danske Commodities A/S
- Energipartner AS
- Modstrøm (Aktant)
- Norsk Elkraft Danmark A/S

## Trade only

- Some 25 companies – including several major European electricity producers

“A Balance Responsible Party (BRP) is an entity which is committed to guaranteeing the financial settlement to the System Operator for all the imbalance charges subsequently recorded between injections and extractions within a defined Balance Group (BG).”

*(RED Electrica on access to the Spanish market)*

A BRP must register with the TSO and comply with a set of rules.

Market access by decentral CHP generators was prepared in co-operation with several production BRP and the TSO.



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# Response technologies and measures considered in RESPOND

- Flexible generators
- CHP with heat storage
- Aggregation of units
- Large-scale electric storages
- Interruptibility contracts for large consumers
- Automatic control of small consumers' appliances
- Electric boilers and heat pumps
- Large building heating and cooling
- Individual air conditioners
- Electric (storage) heating
- Electric vehicles
- Etc. ...

*Most of these measures may be integrated into the market organisation, e.g. by contracts with a balance responsible party.*

*However, sufficient economic incentives and active participants are needed.*



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# Key recommendations on demand and trade

- Day ahead prices in price areas to reflect energy system constraints, e.g. transmission bottlenecks
- These prices should be transferred to all consumers with hourly metering. Fixed price additives should be reduced
- Communication standards and procedure for handling hourly measurements should be developed. Preferably common communication standards for all meters
- For small customers prices are not a sufficient incentive for demand response. Additional incentives of automatic or centrally controlled response is needed
- Charge and discharge of electric car batteries should be controlled by market prices and electricity system organisation



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