Measures in generation, demand and trade to reduce the impact and cost of an increasing share of intermittent RES in the electricity generation

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Response Options Aimed at Increasing the Contribution of Variable Energy Resources in the Electricity Supply

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Measures in generation, demand and trade to reduce the impact and cost of an increasing share of intermittent RES in the electricity generation

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Contents

- Impacts and major categories of response options
- Generation and demand response options
- Wind impact on spot prices and possible mitigation from demand response, illustative example
- Actual example from DK price movements
- Which options could mitigate the price variations and the price reduction in different situations?
- Reduction of variation in intermittent generation and possible price impacts
- Are the illustrated impacts relevant in a broader EU perspective? – EU RES targets and the timing

Problems and Impacts
Focus on markets

- **Variability of intermittent sources - markets**
  - Price variation high
  - Lower prices at times of high wind output
  - Lower revenues for both intermittent generators and other generators
- **Unpredictability of intermittent sources**
  - High balancing costs
  - High and inflexible reserve requirements
  - Low capacity values for intermittent generators

Different categories of options to mitigate the problem of price variations

Two major alternatives

- **Reduce the output variations**
  - Interconnection capacity
  - Flexible generation technologies in mix
  - Mix of intermittent generation technologies
  - Dispersed location of intermittent technologies

- **Demand options that adjust to output variations**
  - Increase price flexibility – demand response (regulation, technology)
  - Storage of electricity or heat
  - New demand technologies (heat pumps, hybrid electric cars)

Generation technologies and variability

- **Flexible generation technologies wanted**
  - **Low stop and start costs as well as fast regulation properties**
  - **Reasonable part load characteristics – efficiency, emissions**

Combination of resources: intermittent and others

- **PV and wind power combination reduce variation**
  - **Somewhat uncorrelated production but dominated by cost differential**
- **Wind power and CHP can work**
  - **CHP can only be flexible with heat storage and correct subsidy scheme for CHP**
- **PV or Wind and Hydro**
  - **Excellent combination with sufficient hydro storage**

Demand options

- **Demand response reduce the variation in load and thereby reduce the impact of;**
  - **Low intermittent generation at times of high load**
  - **High intermittent generation at times of low load**

- **Wholesale prices will with unchanged total demand be reduced and their volatility also reduced**
- **New demand technologies made available might benefit from low prices and average prices even increase because total demand increase**
- **Different options exists:**
  - **time of use tariffs, day ahead pricing, peak pricing and real time pricing etc.**

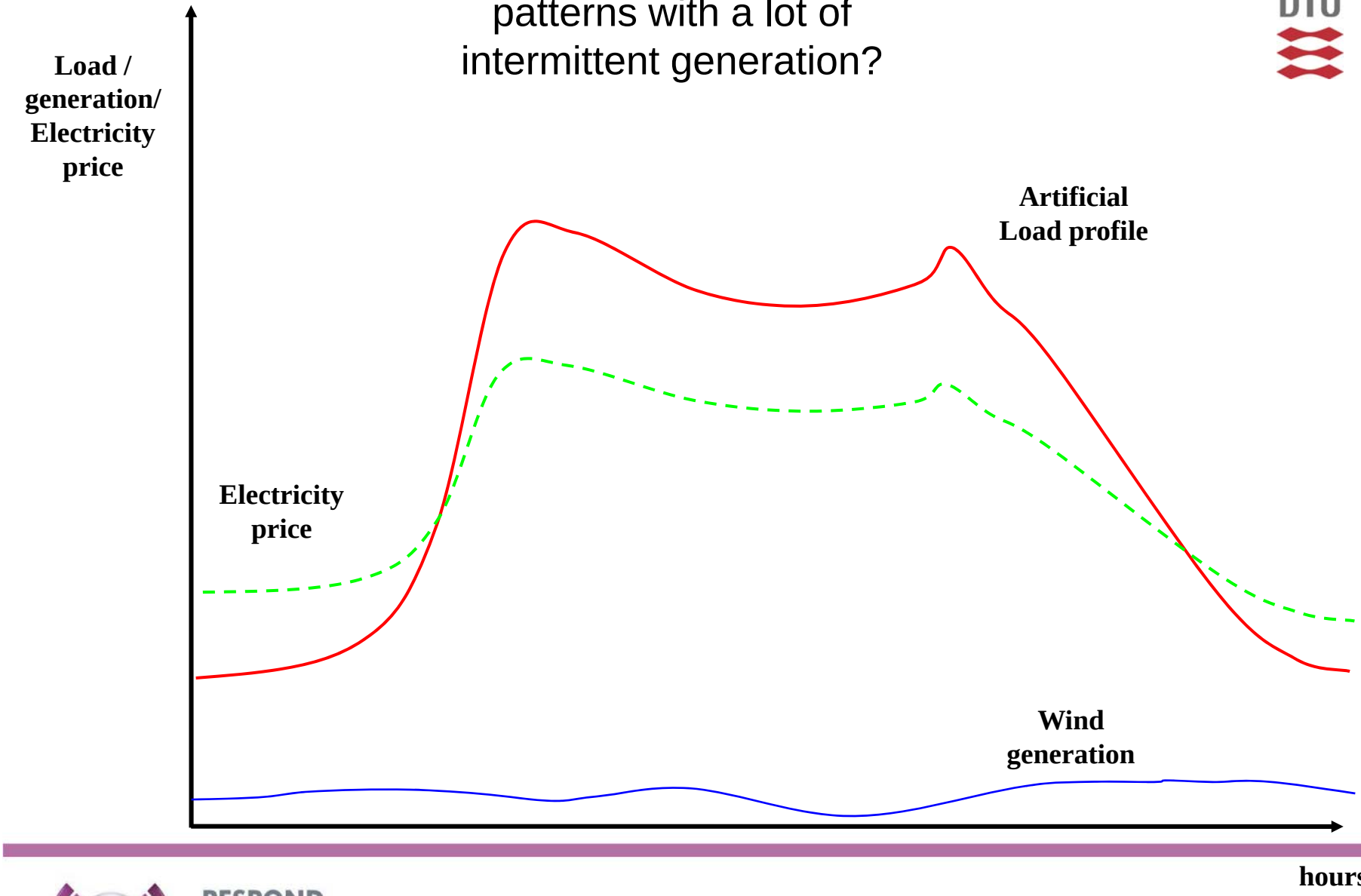
Demand response implementation

Demand response increase require the availability of

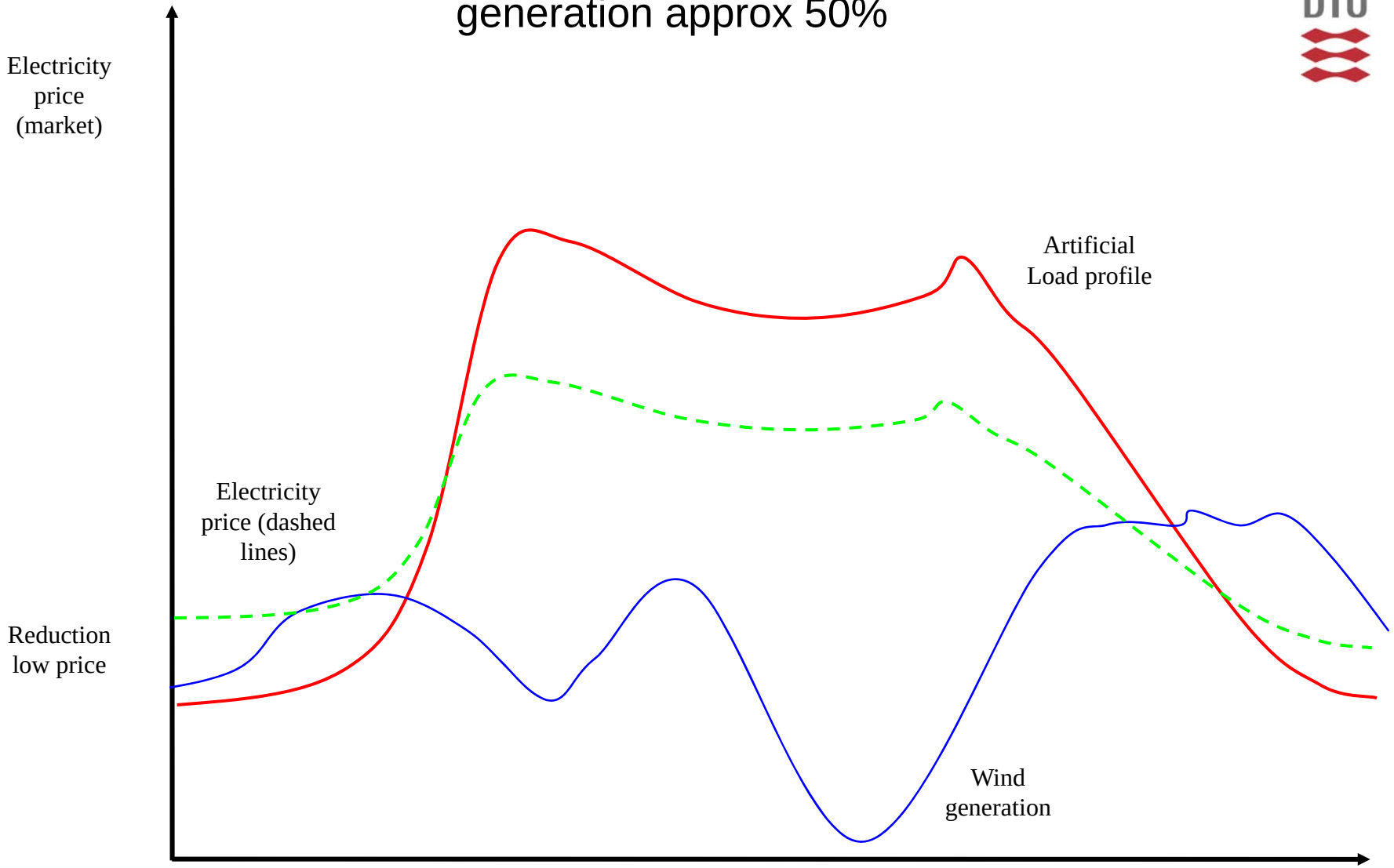
- **Metering (but not necessarily for all)**
  - **and billing that transfer the price signals to final consumers**
- **Tariff restructuring (especially for costumers with high taxation)**
  - **increase fluctuations that consider variations in environmental tax elements – including the PSO tariff that finance RES subsidies**
- **New demand technologies available (heat pumps, hybrid electric cars)**

- **Interacts with storage – storage increase demand response**

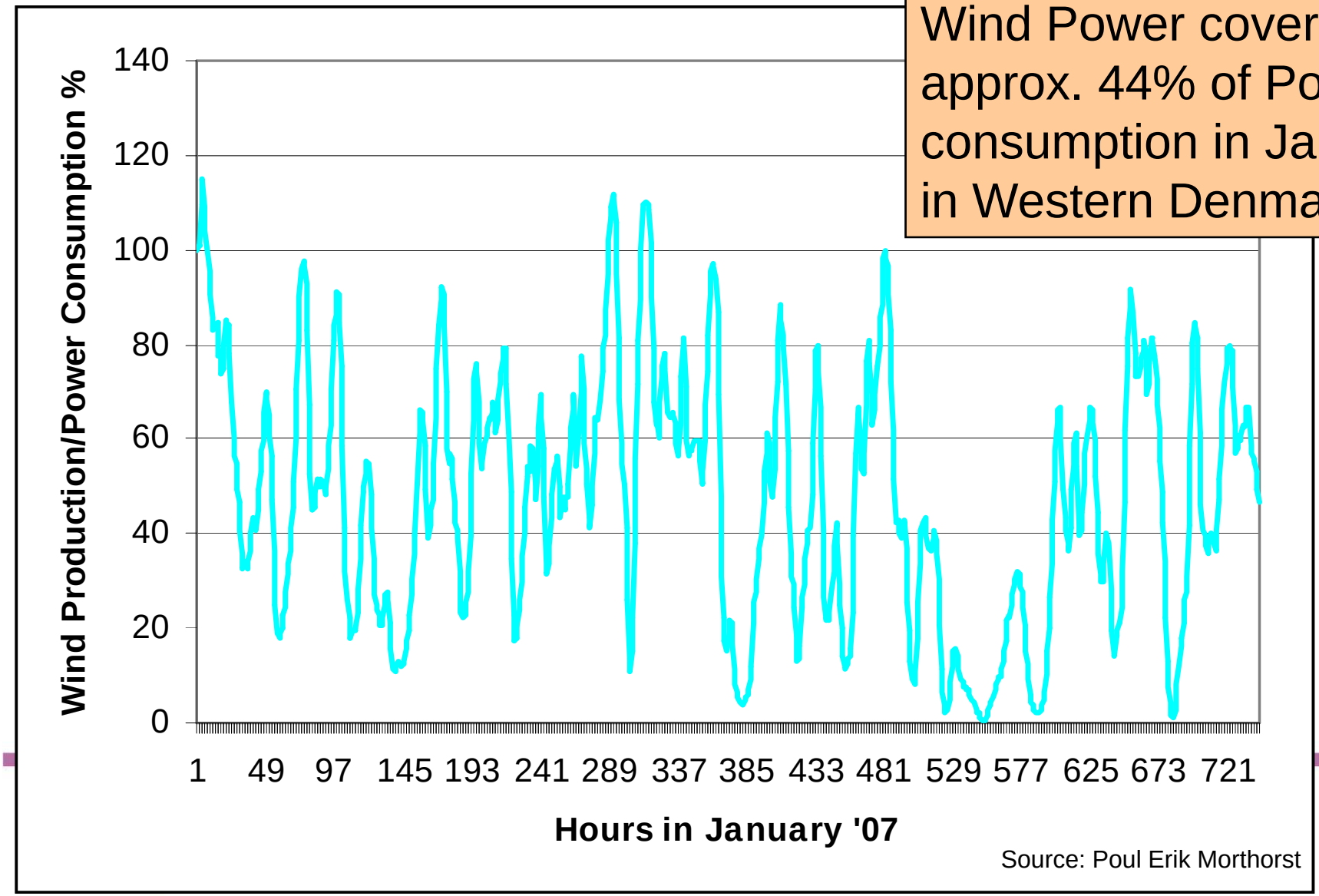
What happens to price patterns with a lot of intermittent generation?



Upscaled wind generation approx 50%



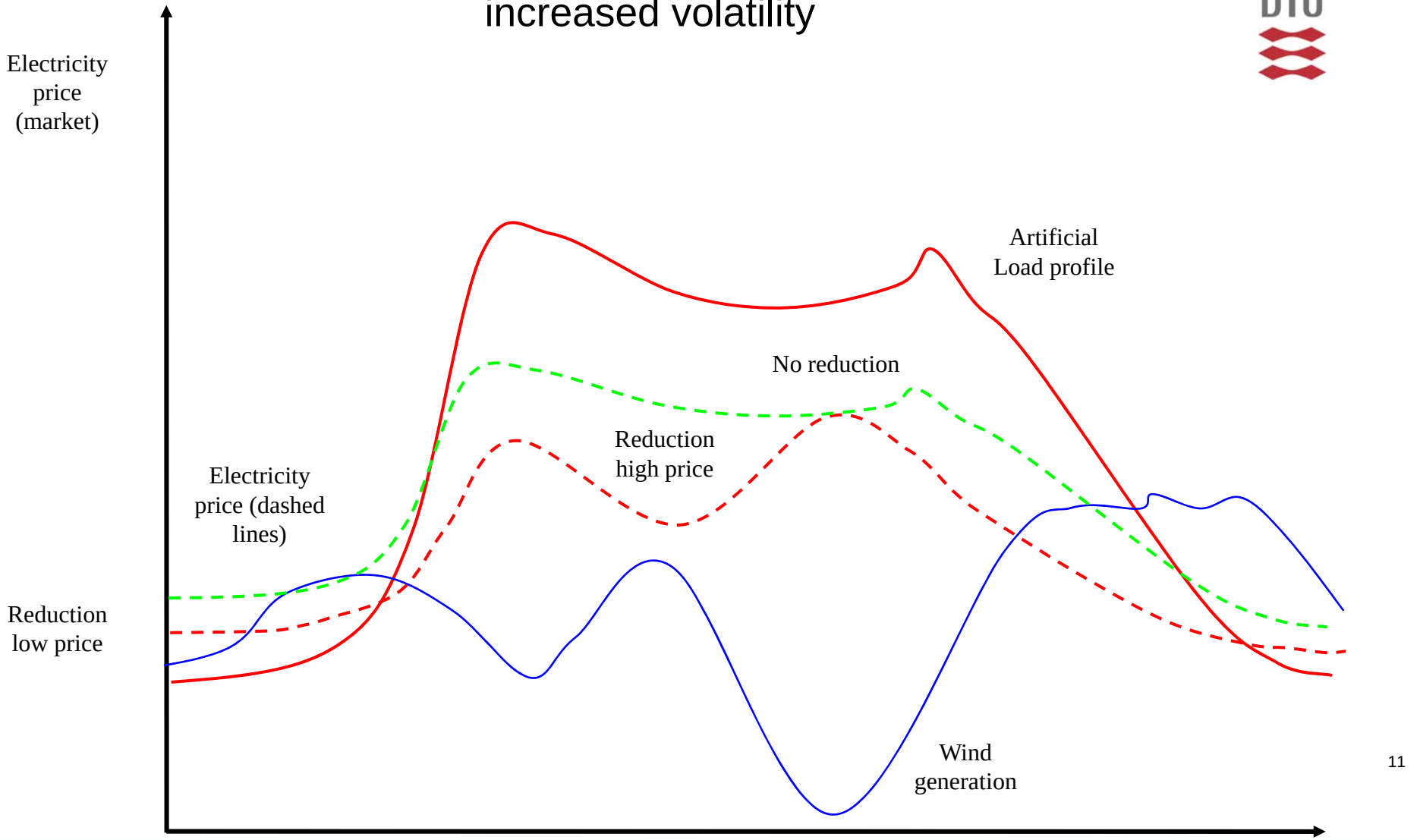
Wind power in Western Denmark



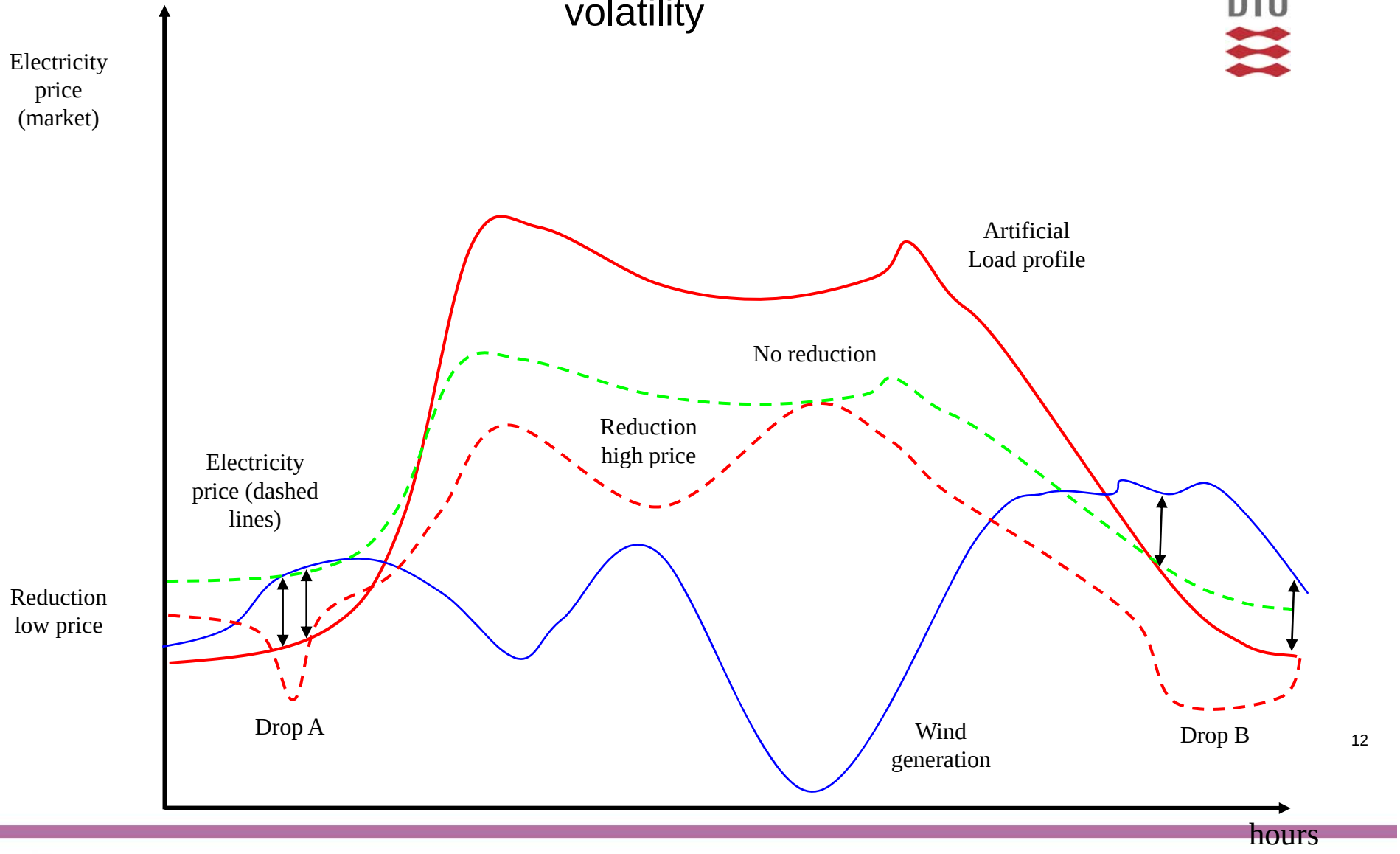
Wind Power covered approx. 44% of Power consumption in January in Western Denmark

Source: Poul Erik Morthorst

Lower price and increased volatility



Price drops also increase volatility

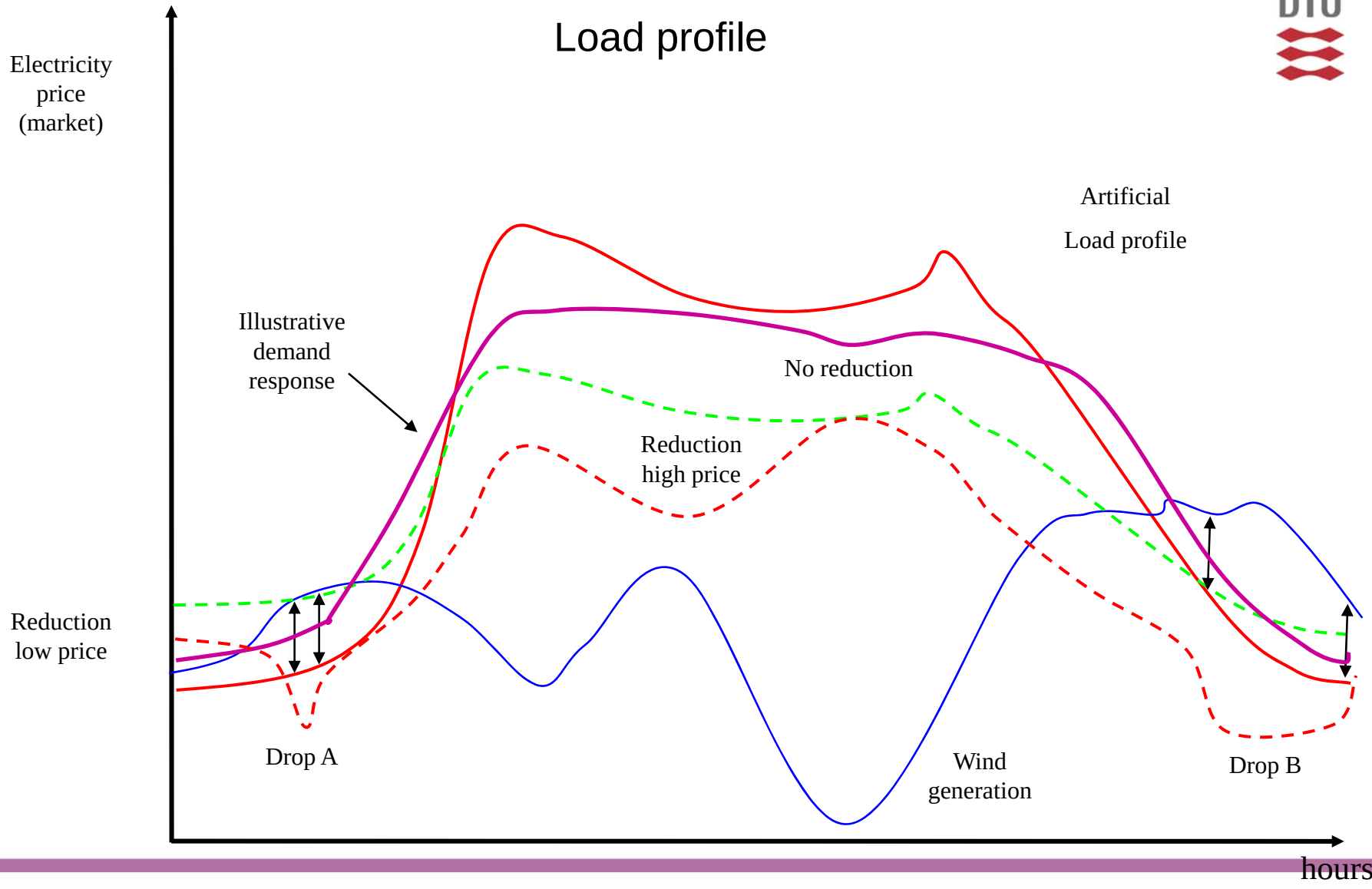


Demand response – effect on load and prices

- How would the demand response affect the situations where intermittent generation has an impact on prices?
- Load shifting (hours)
- Low prices increase demand (technologies)
- Excess generation and restricted export (interconnection capacities) – reduce the value of interconnection (substitute)

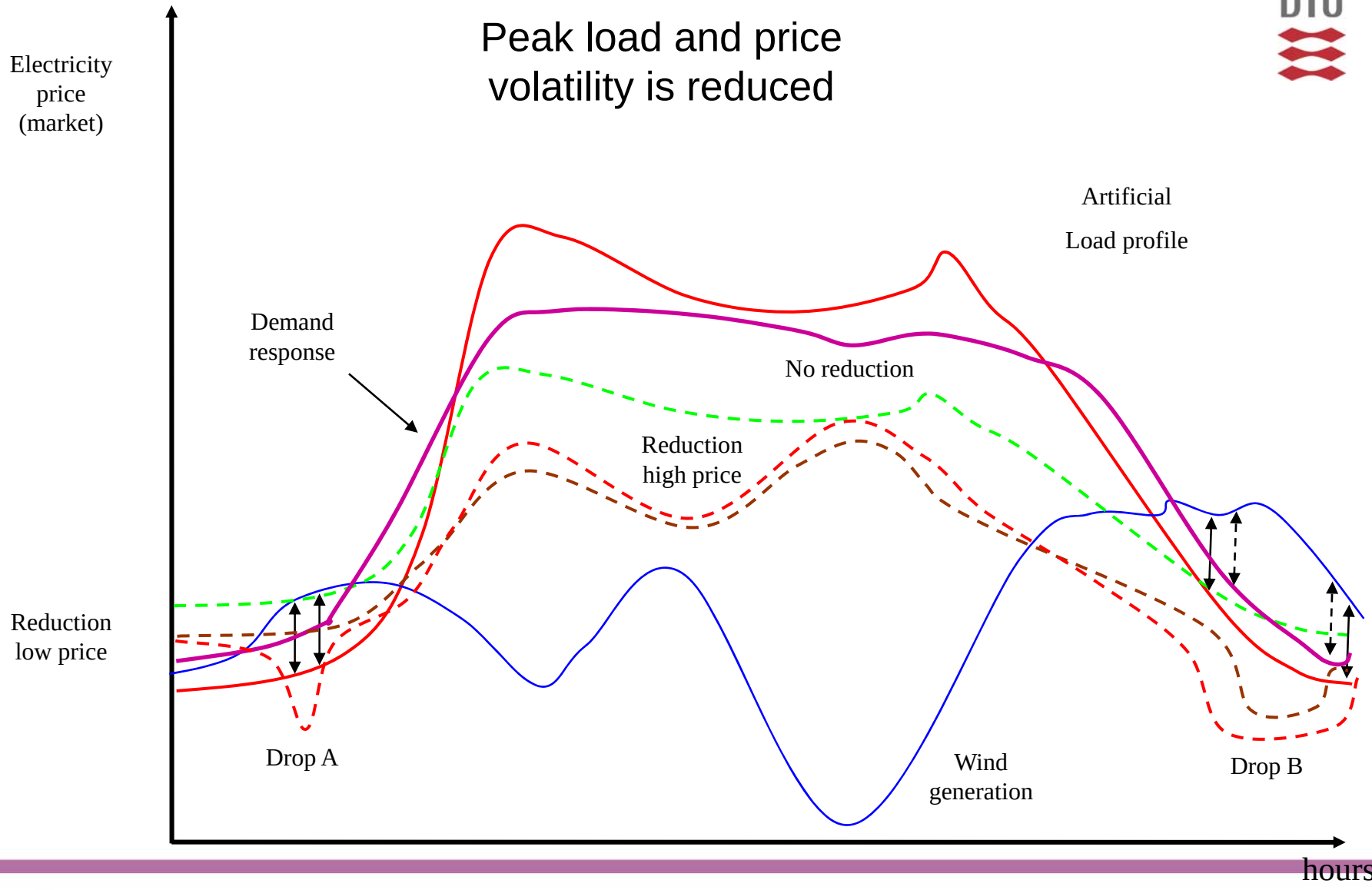
Demand response

Load profile



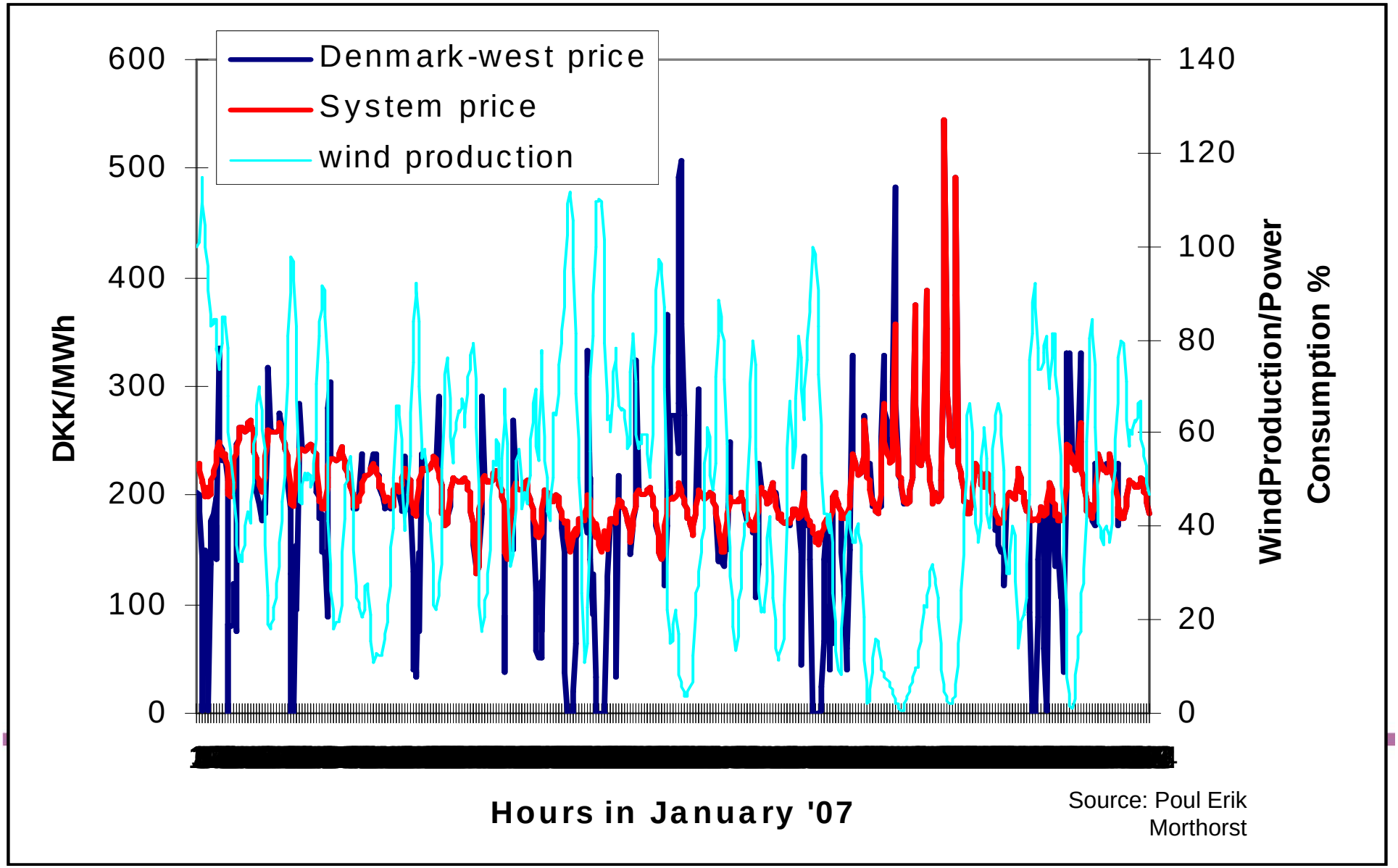
Demand response

Peak load and price volatility is reduced



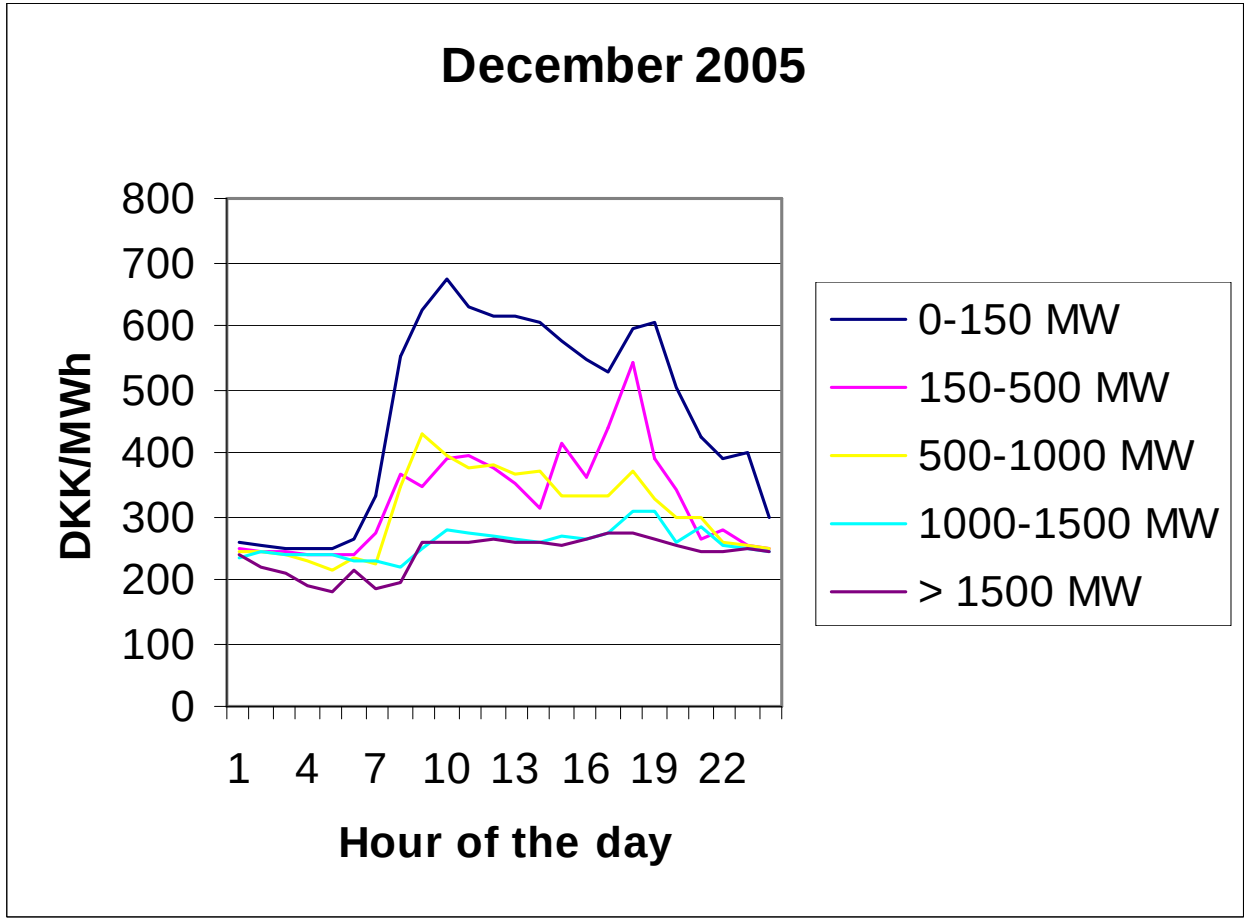
RESPOND
Renewable Electricity Supply interactions with conventional POwer generation, Networks and Demand

Impact on Spot Price: DK example



Source: Poul Erik Morthorst

Impact at the Western-Denmark power market



Source: Poul Erik Morthorst

Interconnections, storage and demand response

- Interconnection capacity
  - Reduce the impact of variability on prices
  - Reduce the reserve requirement

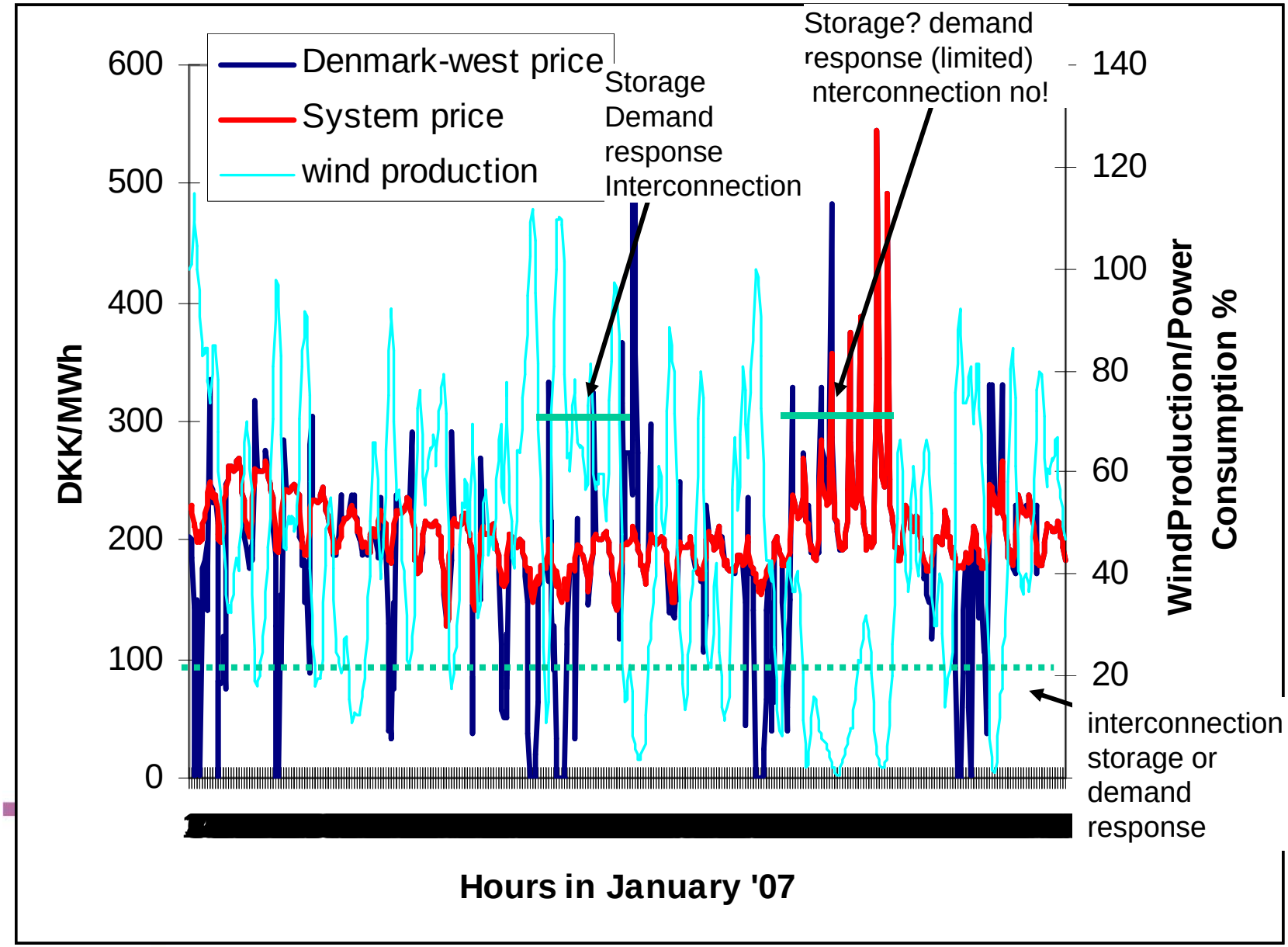
- Storage technologies
  - Use the variability of prices to store electricity or heat related to CHP – mainly short term (hours)
  - Hydro storage – both in short term and for longer term storage

- Demand response
  - Reduce variation of prices – flattened duration curve
  - Regulatory part – requires price pass through
  - Technological part - investments

Example of price impact reduction in a system with high intermittent shares and interconnection constraints

- Why is the low prices a problem?
- In a system with high intermittent shares there are unattractive low prices – from the generators view
- There is a lot of short term price variation – adjustment cost
- There might be longer periods of high prices
- Lower spot market price is reducing the incentive to invest for all generation (main revenue from spot market)
- Especially wind generators will experience low prices reducing the incentive to invest (share of revenue from market)

Demand response, storage or interconnection



Are the impacts and the options illustrated relevant?

- RES intermittent generation shares are only high in a few countries?
- But already at low shares networks will experience the impacts
- If EU targets are becoming reality the illustrated example might become the average rather than just a Danish extreme
- Therefore identifying a mix of options to mitigate the intermittent effects is vital to have a smooth implementation of the RES targets

Timing and options

- First we cannot wait to implement options to 2020 as interim targets are binding
- Different response options are relevant at different time horizons
- Targets are gradually increased up to 2020 – so we must make sure that options implemented in 2015 don't interferes with options planned to be in effect later on.
  - if we build interconnection
  - low prices during night-time to be exploited by hybrid (electric) vehicles will not be available (DK case)

Concluding remarks

- **New EU Directive including RES targets will increase the impacts that must be addressed due to high targets**
- **Market price effects of intermittent energy will become larger**
- **A larger share of RES generation will be market based**
- **Variability in intermittent generation could be matched by flexible units in generation mix and cheap storage technologies**
- **Interconnection and demand response are important options – but they must be evaluated taking account of each other**

Prioritised options

- Interconnection should always be considered – with the highest benefits for areas that differ in generation structure and demand pattern
- Demand response is an alternative that could contribute to reduce intermittency problems
- Dispersion of intermittent generation across countries or regions will also be beneficial (transmission constraints)
- Cheap storage technologies where available is also a substitute to interconnection and increase demand response (hydro, heat)
- Flexible generation mix

Finally all options must be evaluated taking account of each other and optimal mix is not identical for all areas/countries