

Impacts of Wind Power on Power Spot Prices

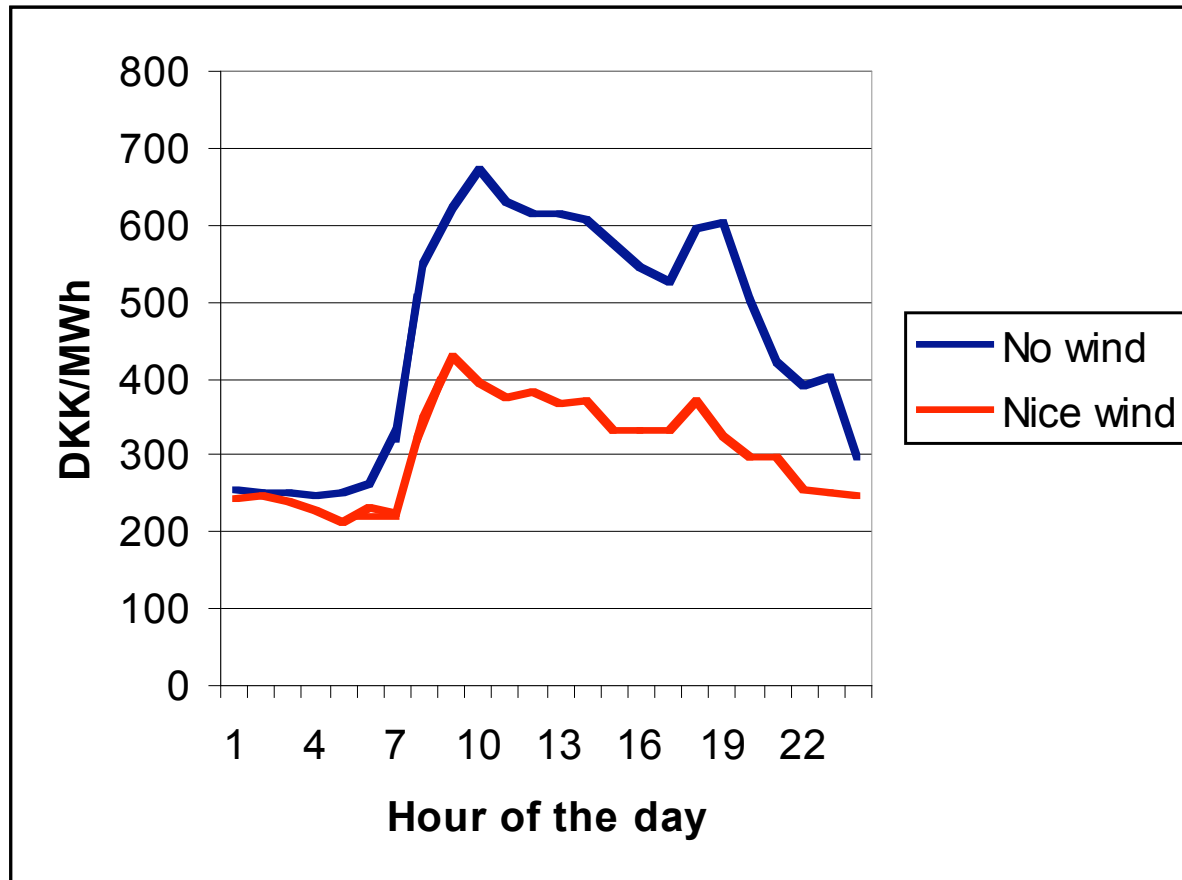


**Senior Research Specialist Poul Erik Morthorst
Risø National Laboratory
The Technical University of Denmark**

Wind Power and Spot Prices

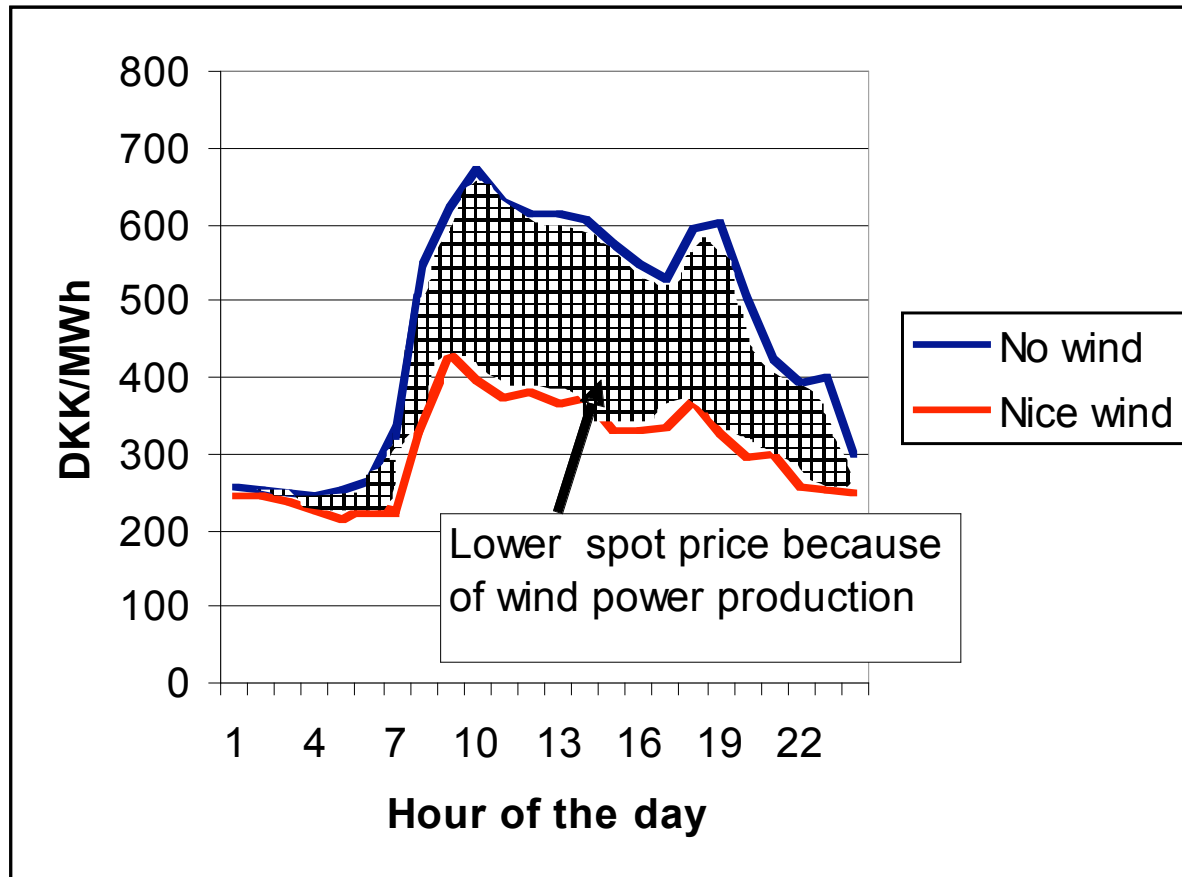
- We know that Wind Power does affect the Spot Price
- ...but how much?
- .. and can we somehow calculate the consequences?

Illustrative example



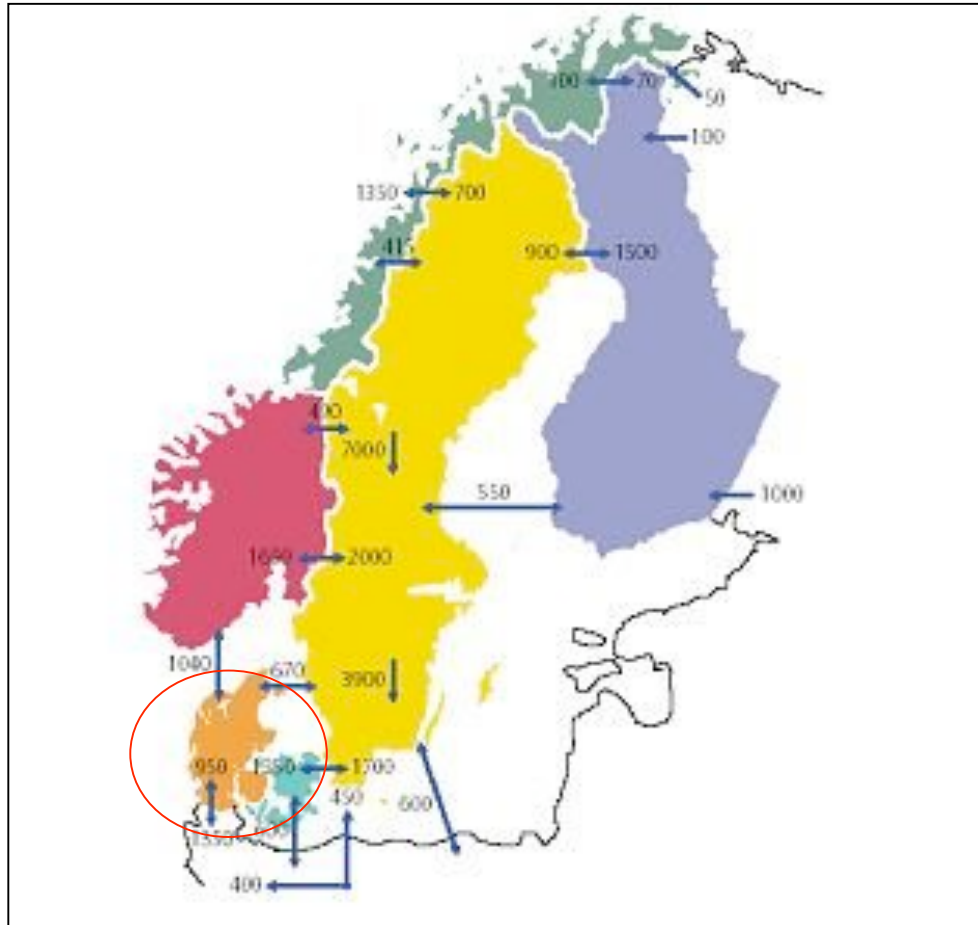
- At the power market we have power prices and wind power production 24 hours a day
- For each hour we divide prices into two categories: **No Wind** and **Nice Wind**
- We calculate the average

Illustrative example



- The difference between the two curves is caused by wind power production

Denmark is a small country.....



- **Nordic power market comprising Sweden, Norway, Finland and Denmark**
- **In Denmark we have 3200 MW wind power – app. 4500 turbines**
- **Wind power covers 18% of Danish electricity consumption**

Bottlenecks in transmission between countries



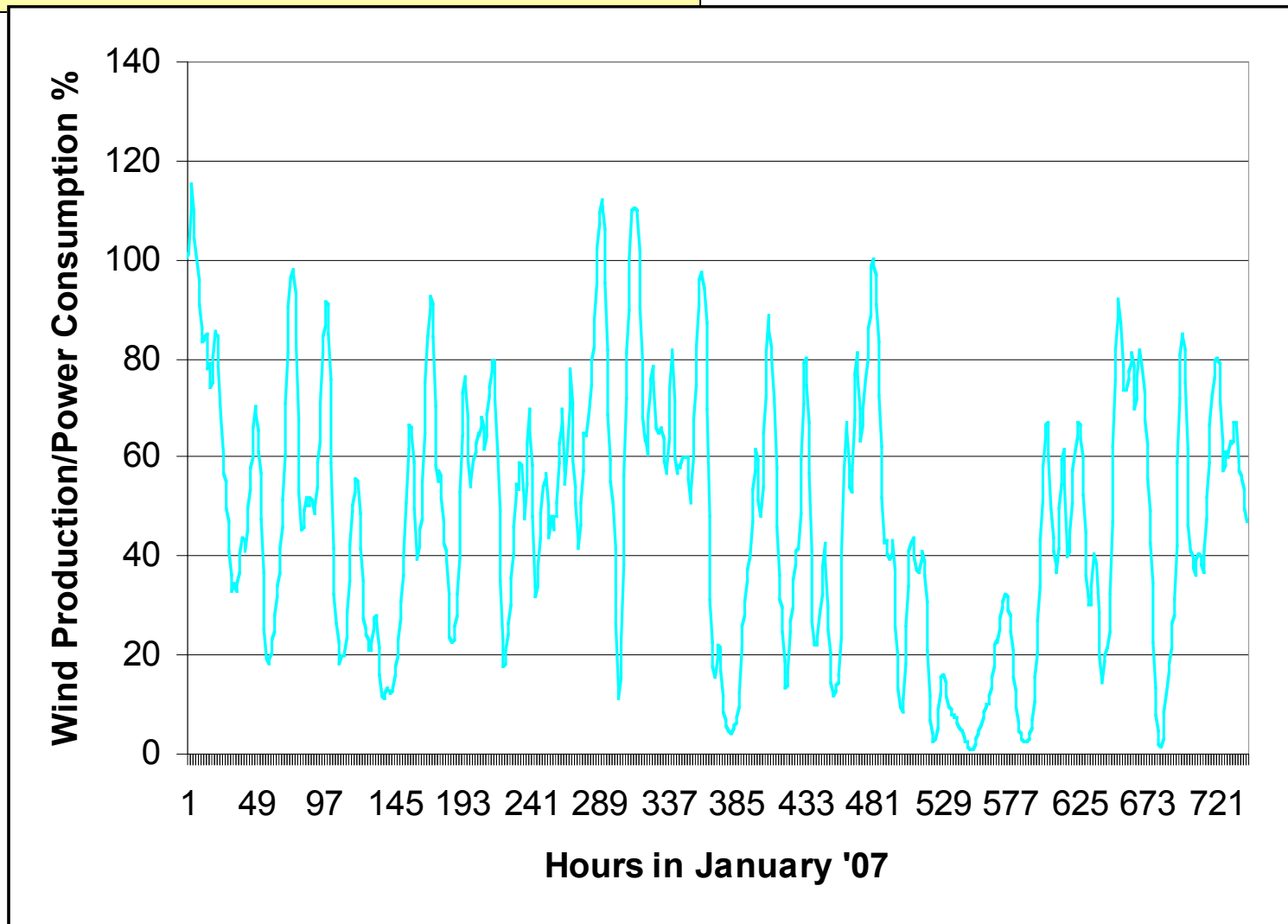
- **No bottlenecks in transmission**
- =
- **One spot price for the whole area**

Denmark is divided into two areas..

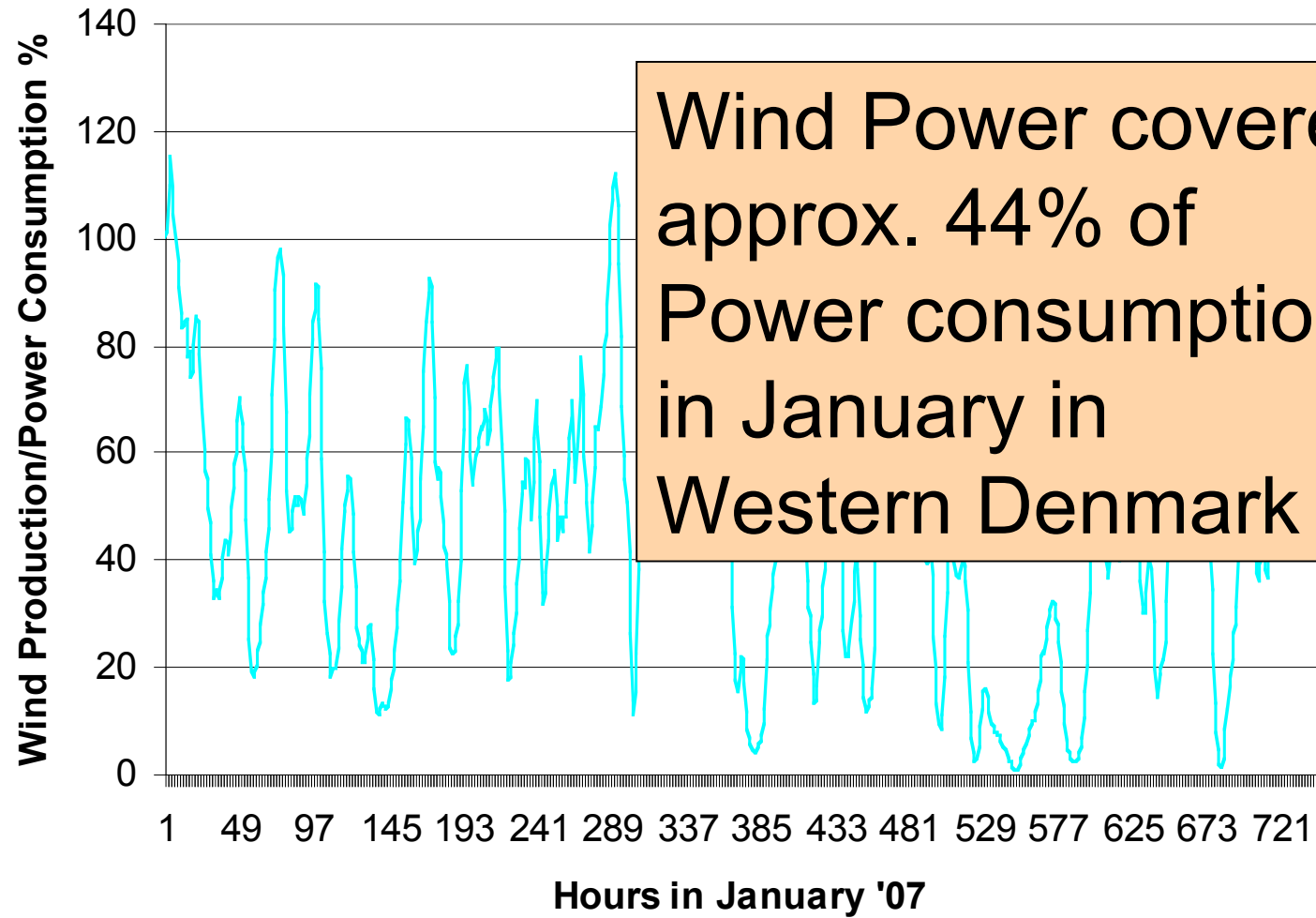


- **Eastern and Western Denmark are not electrical connected**
- **Western Denmark Has approx. 75% of wind power capacity**

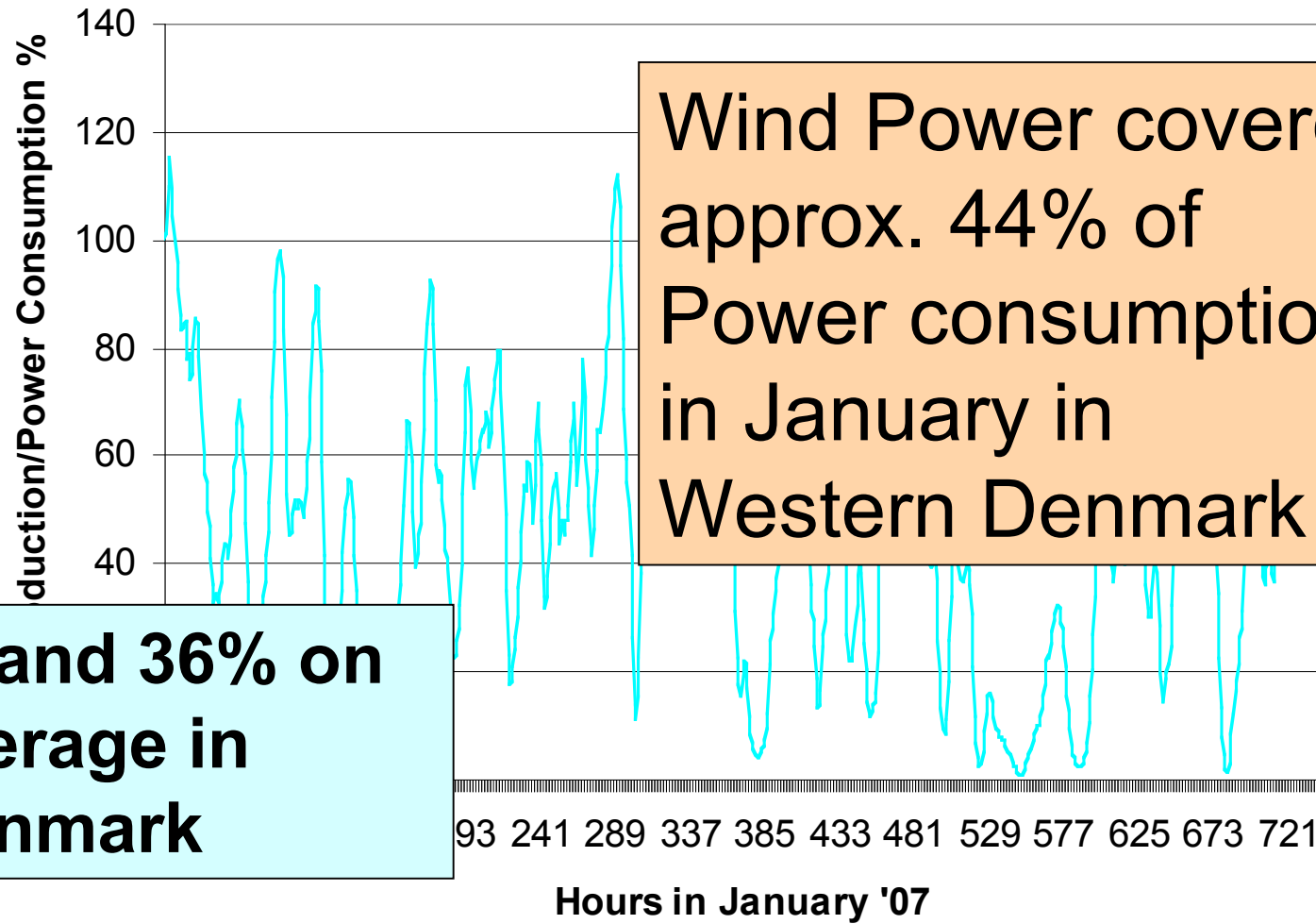
Wind power in Western Denmark



Wind power in Western Denmark



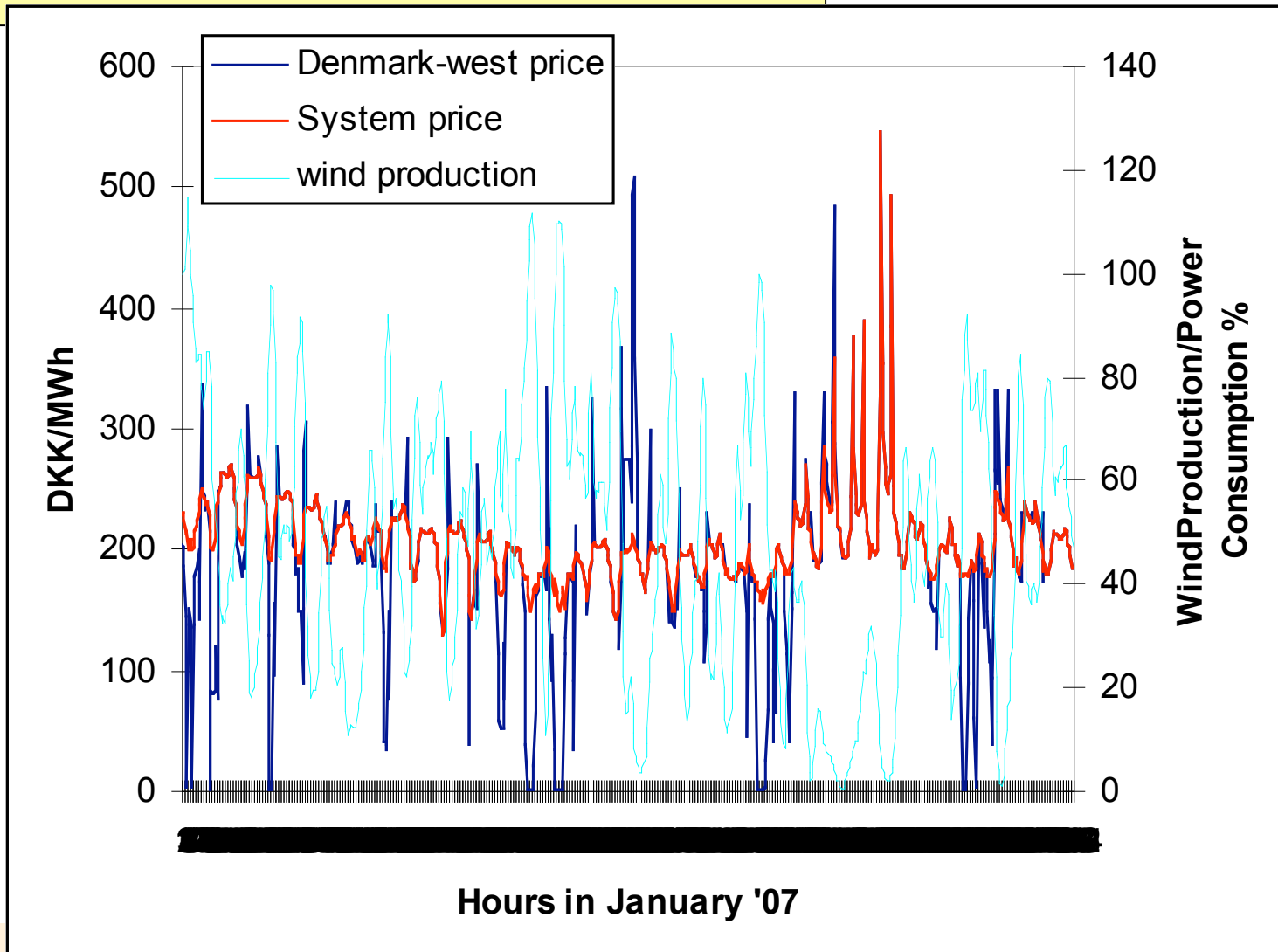
Wind power in Western Denmark



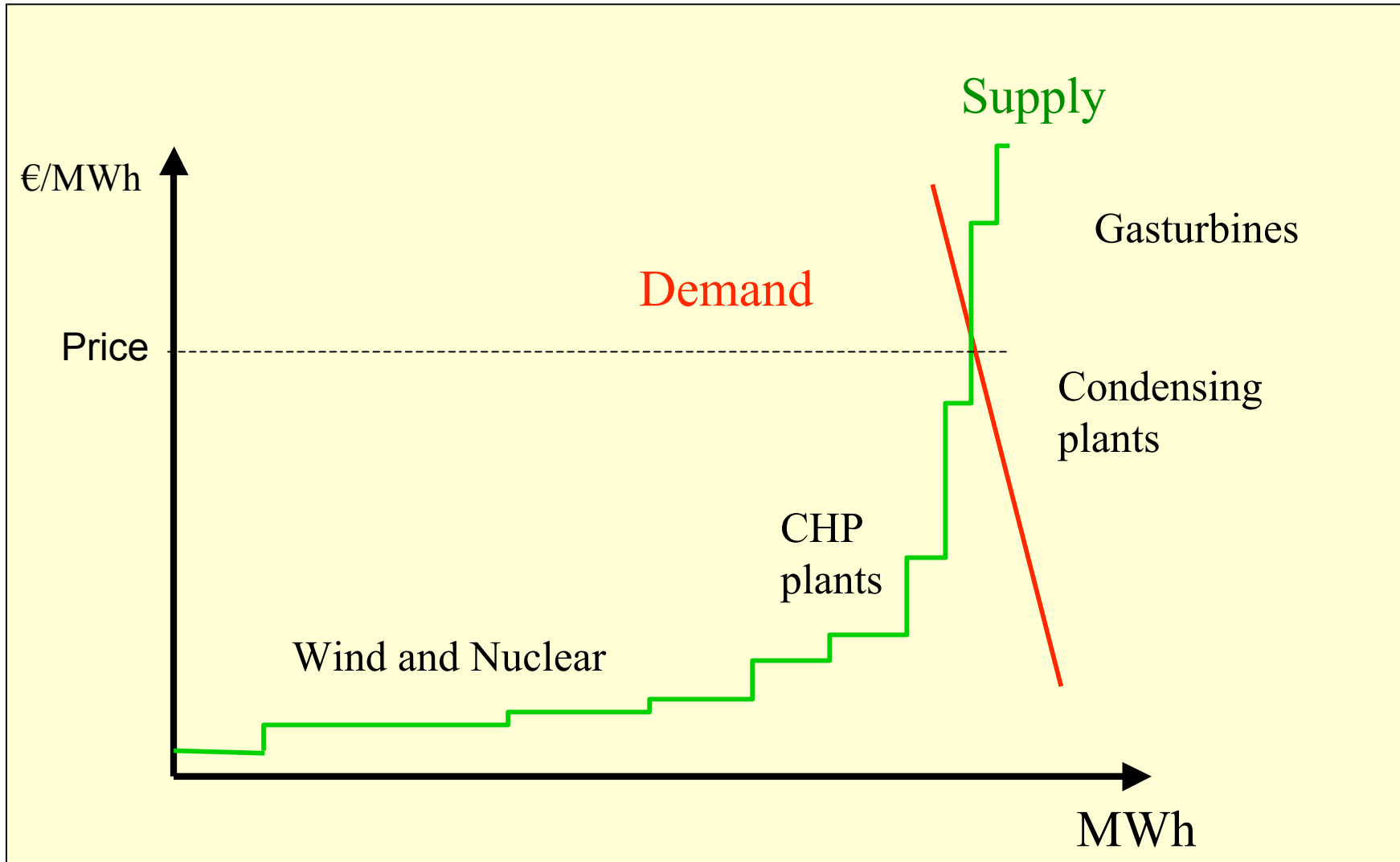
Wind Power covered approx. 44% of Power consumption in January in Western Denmark

... and 36% on average in Denmark

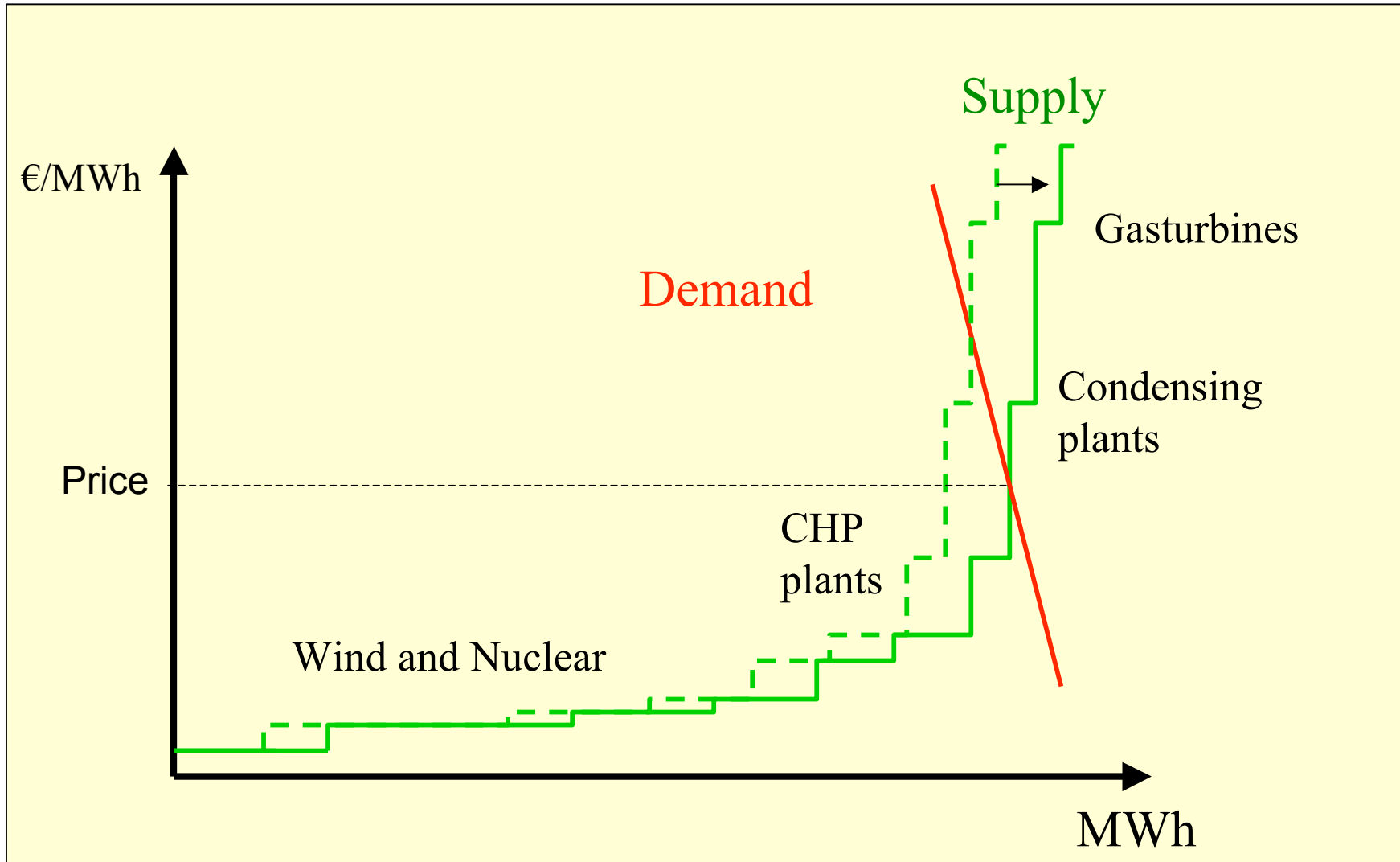
Impact on Spot Price



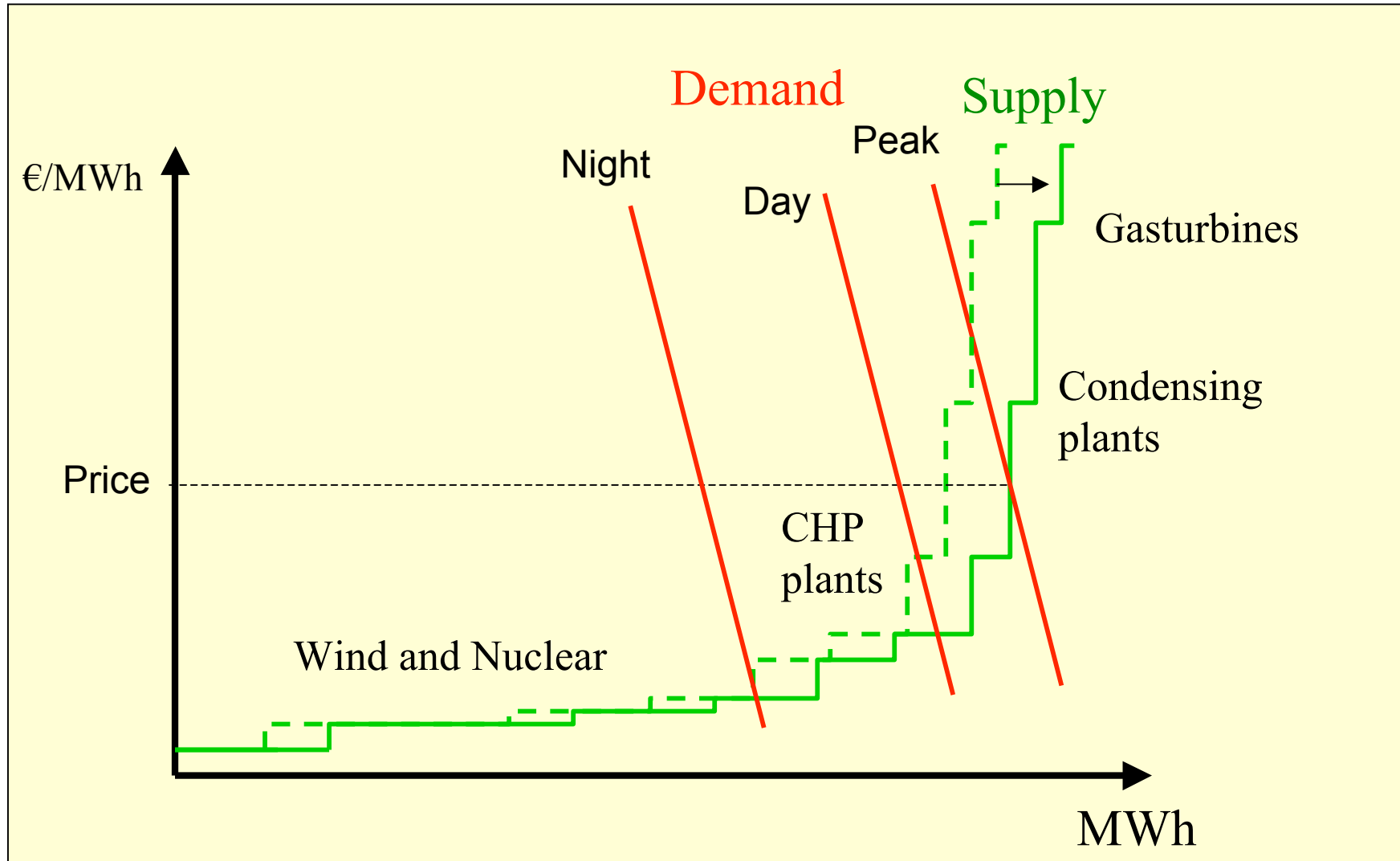
Small amounts of Wind Power



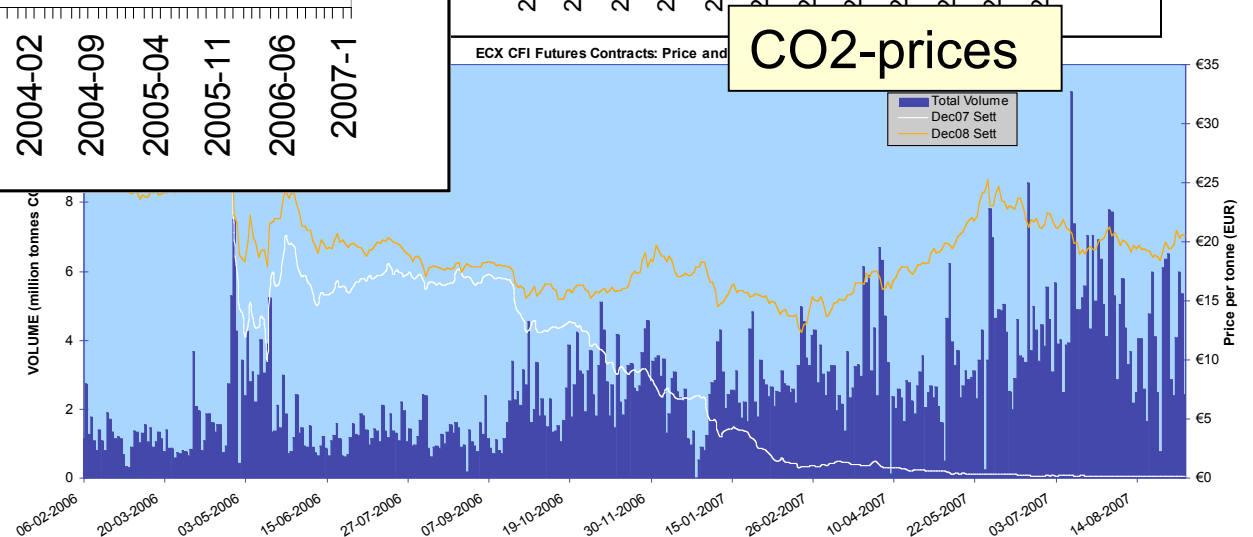
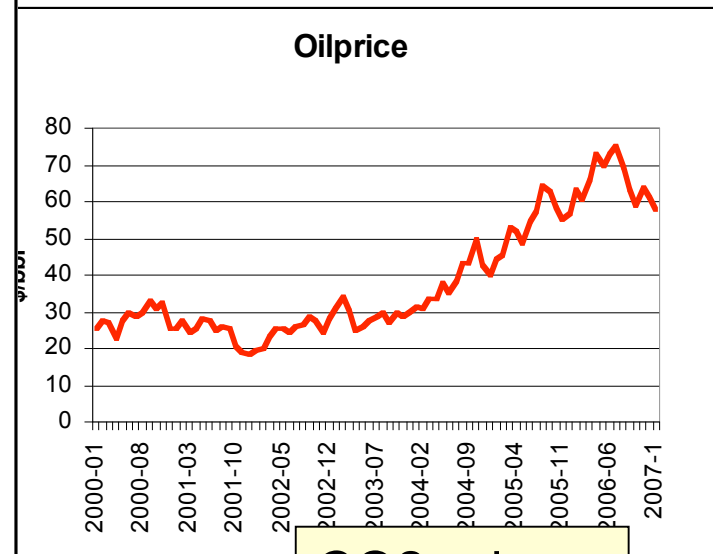
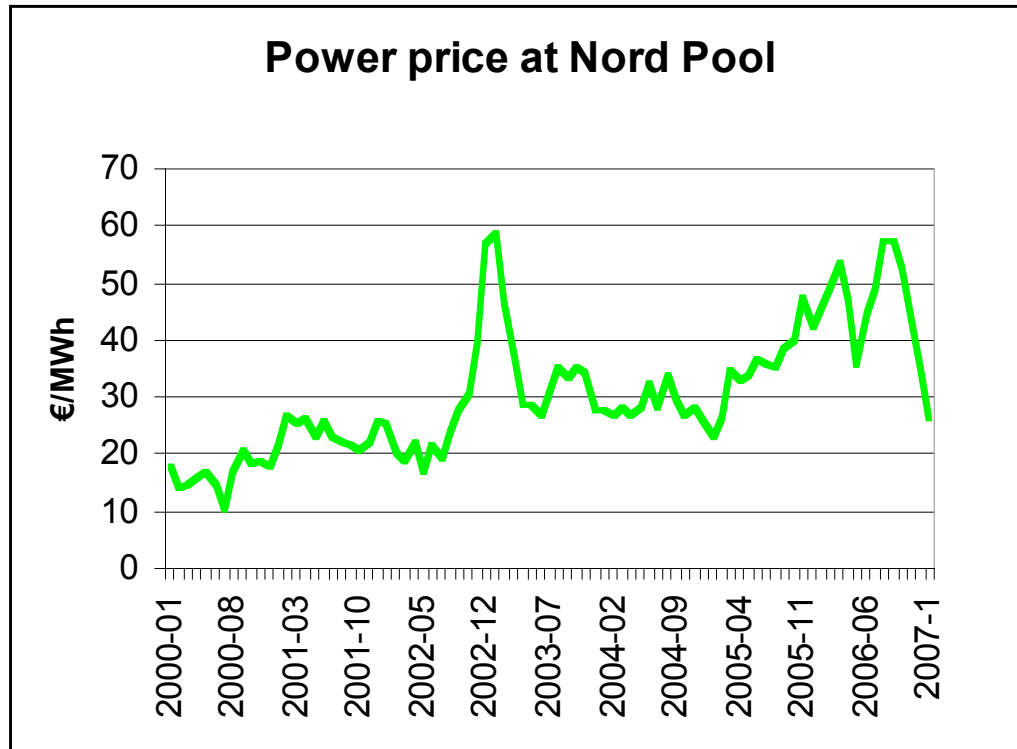
Large amounts of Wind Power



Time of day is important



Drivers for Power Prices



... many issues impact the spot price

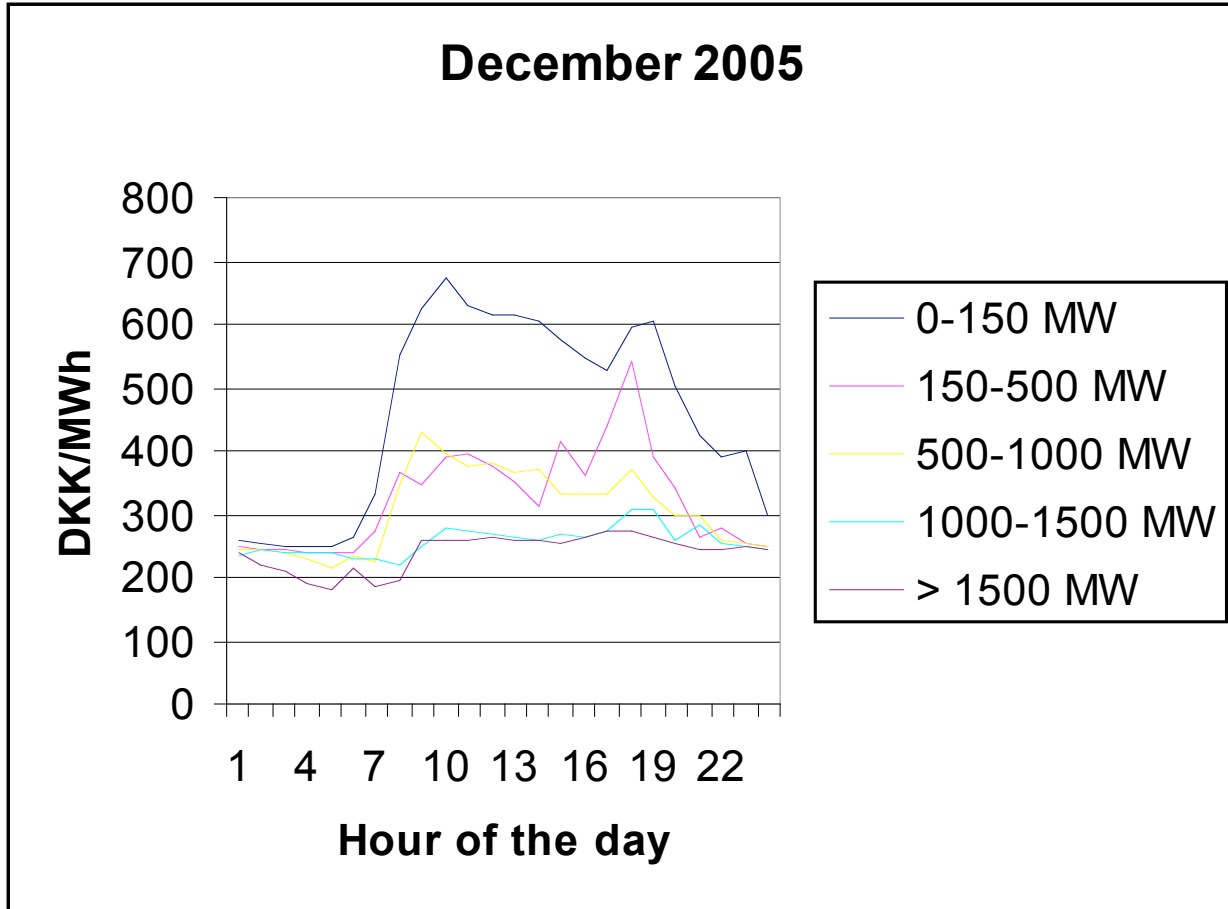
- Journal and seasonal variations in electricity consumption
- Precipitation – hydro power
- Cross-border trade
- Oil- , gas- and CO₂-prices
- Trends – less capacity
- Noise

Decomposing – structural analysis

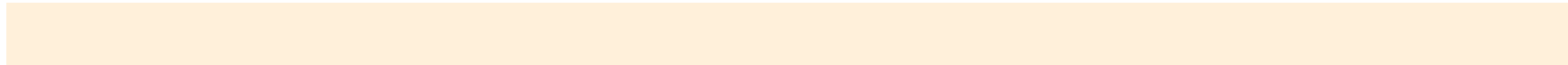
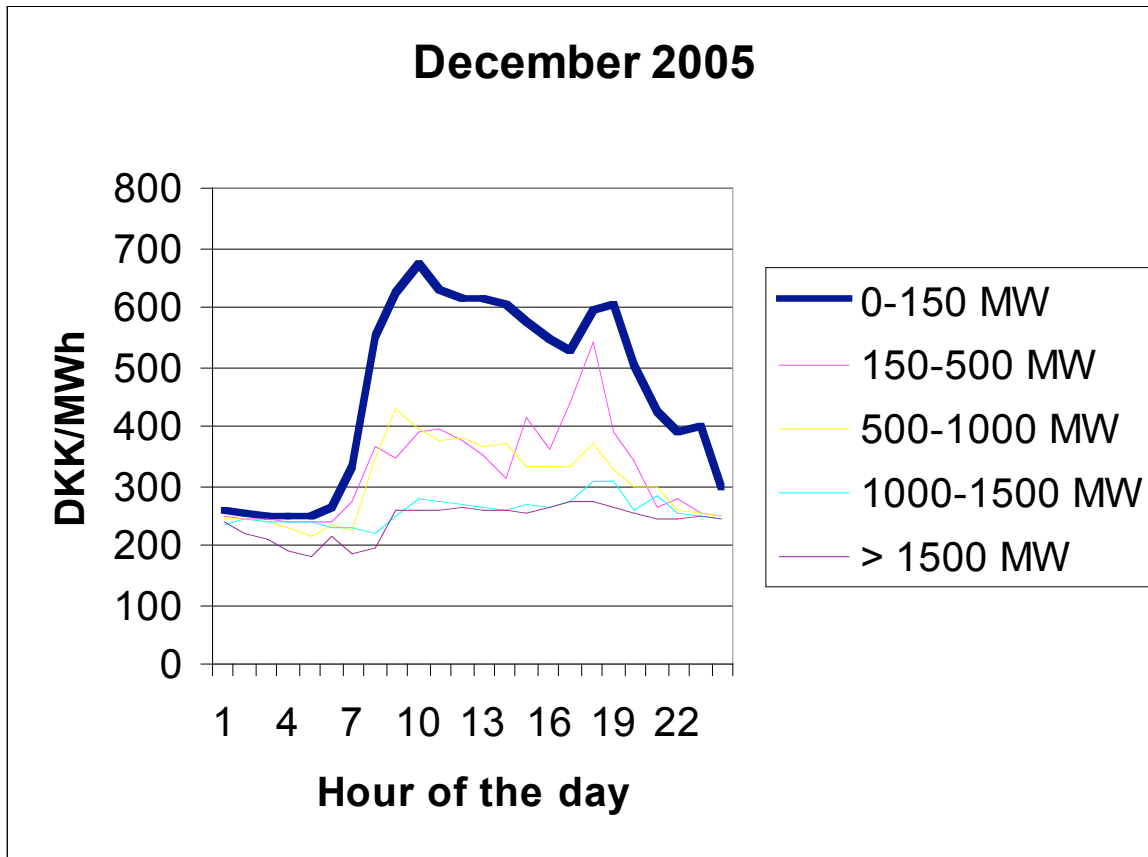
Calculations performed for

- Hour of the day (24 steps)
- Month of the year (max. 12 steps)
 - comparable month are merged
- Five categories of wind power
 - 0 – 150 MW equals "No wind" reference
 - four more categories from "low wind" to "storm", the last mentioned covers more than 1500 MW

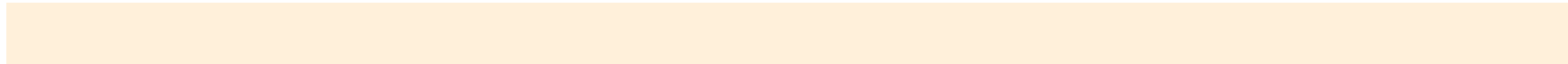
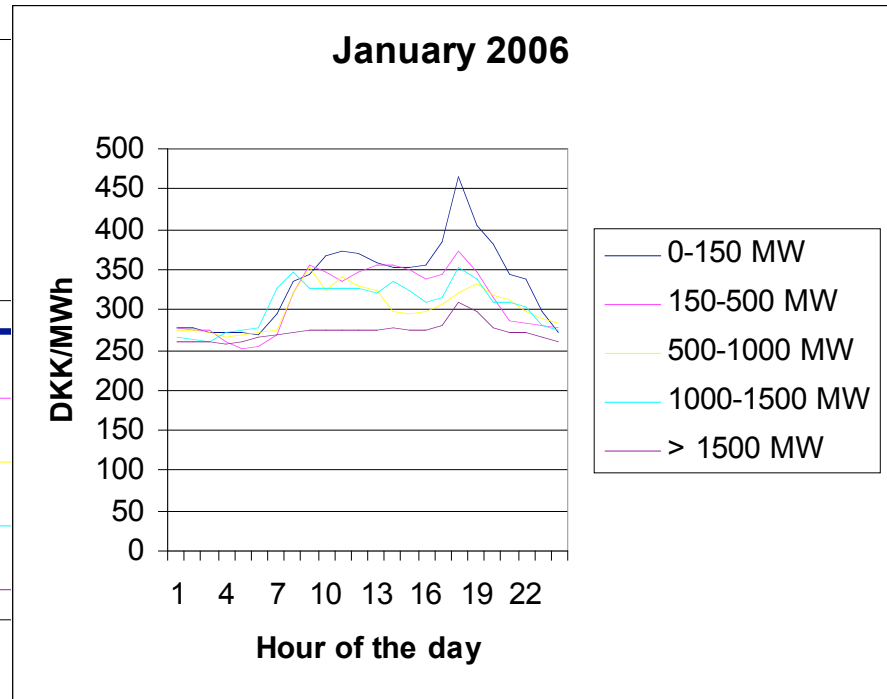
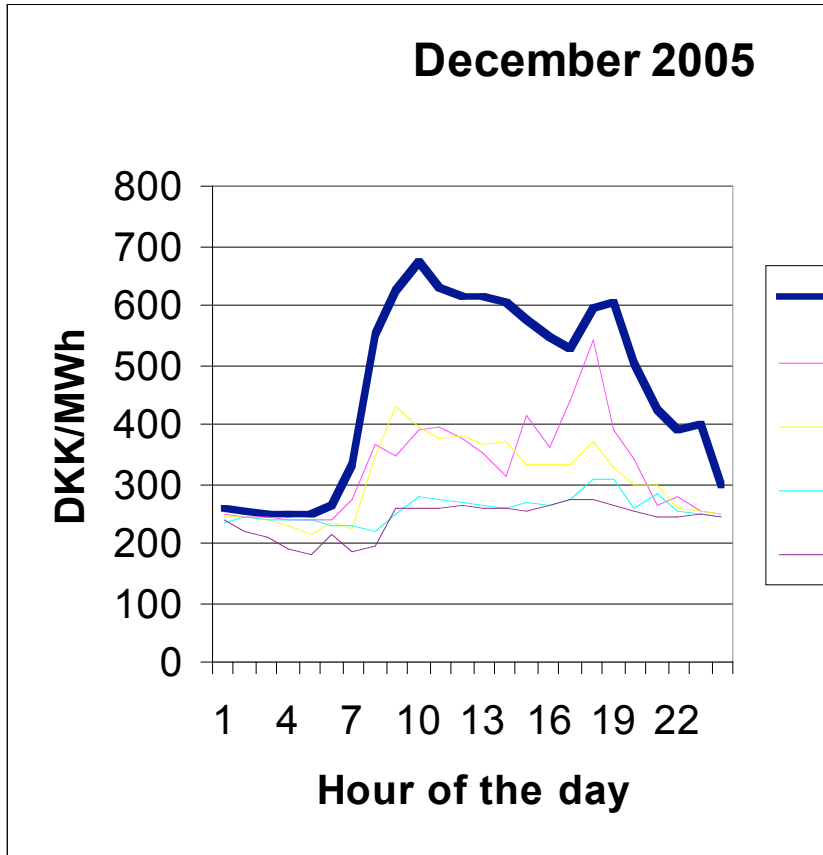
Impact at the Western-Denmark power market



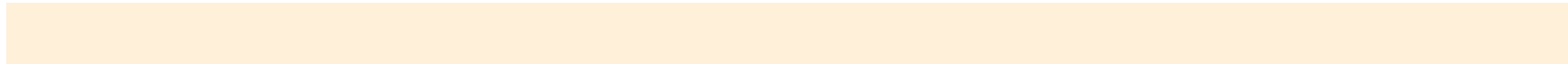
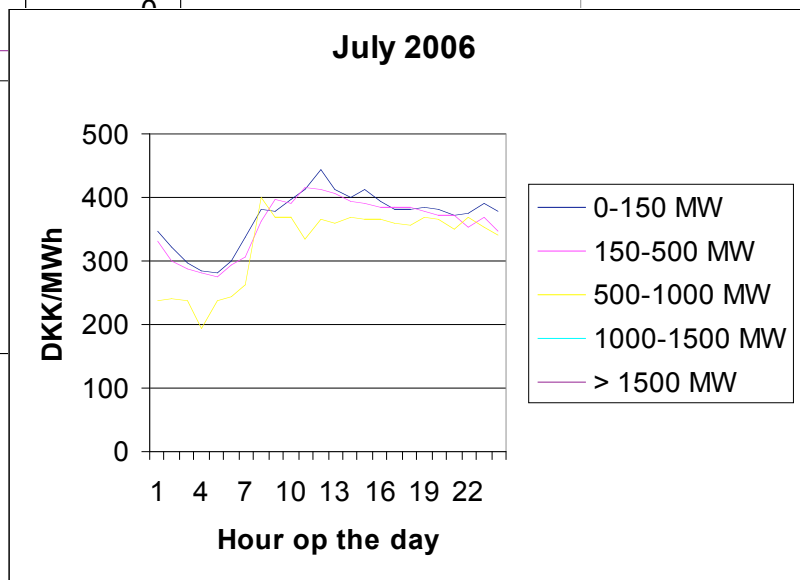
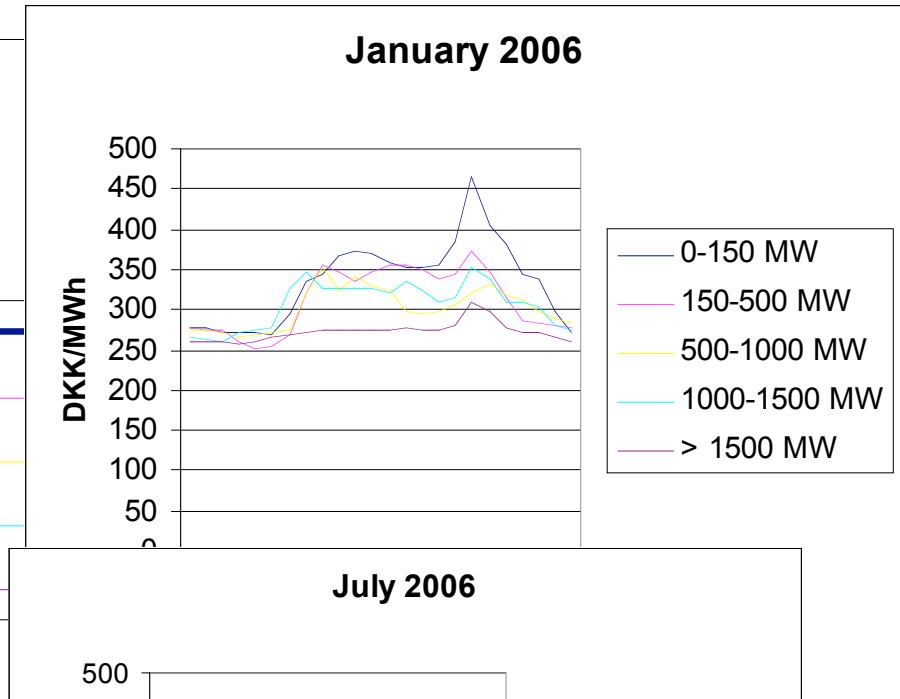
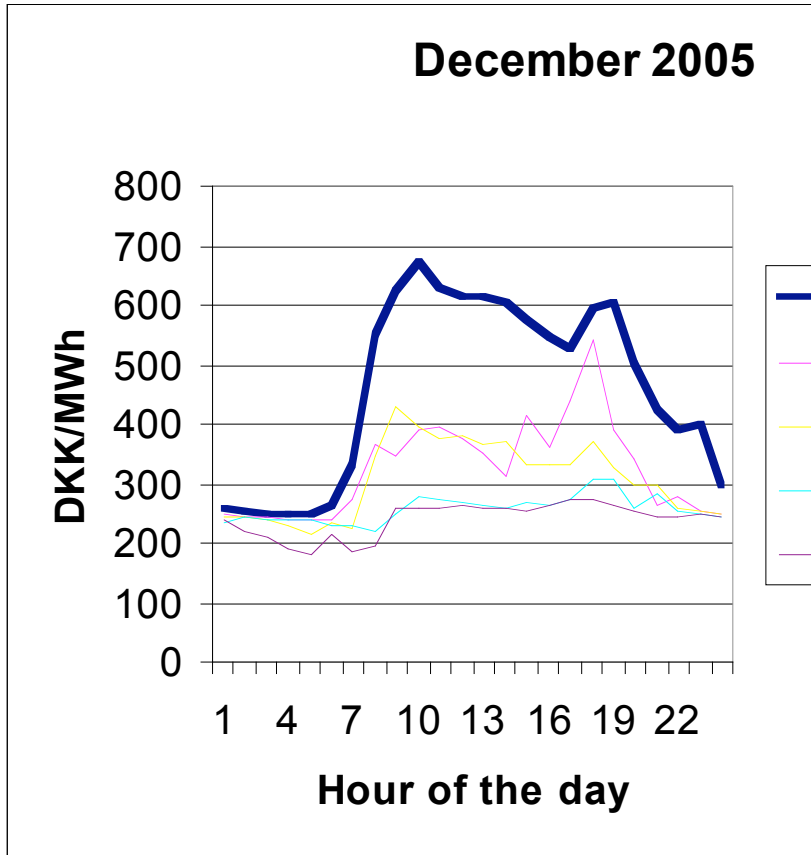
The reference...



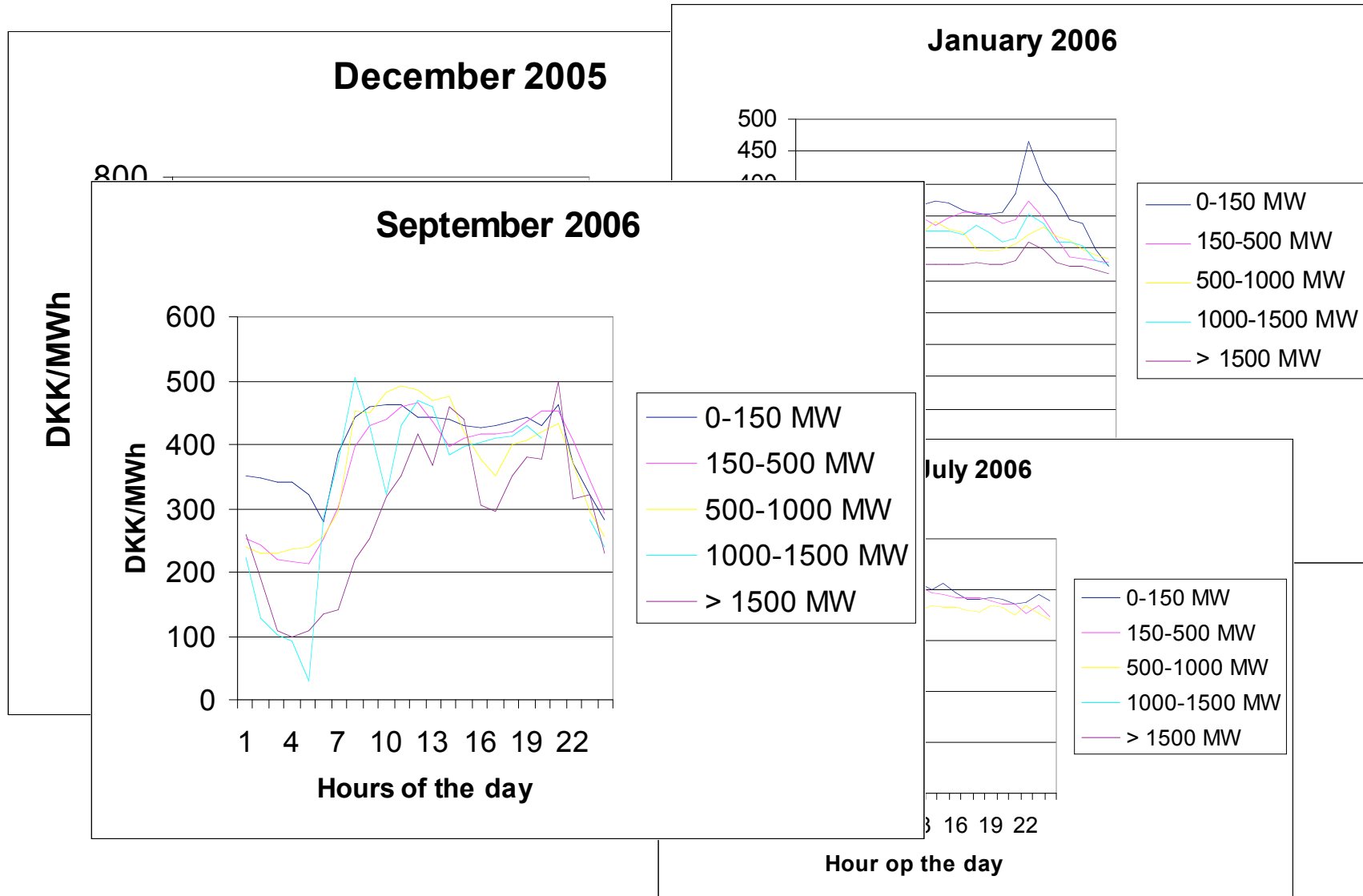
January is reasonable convincing too..



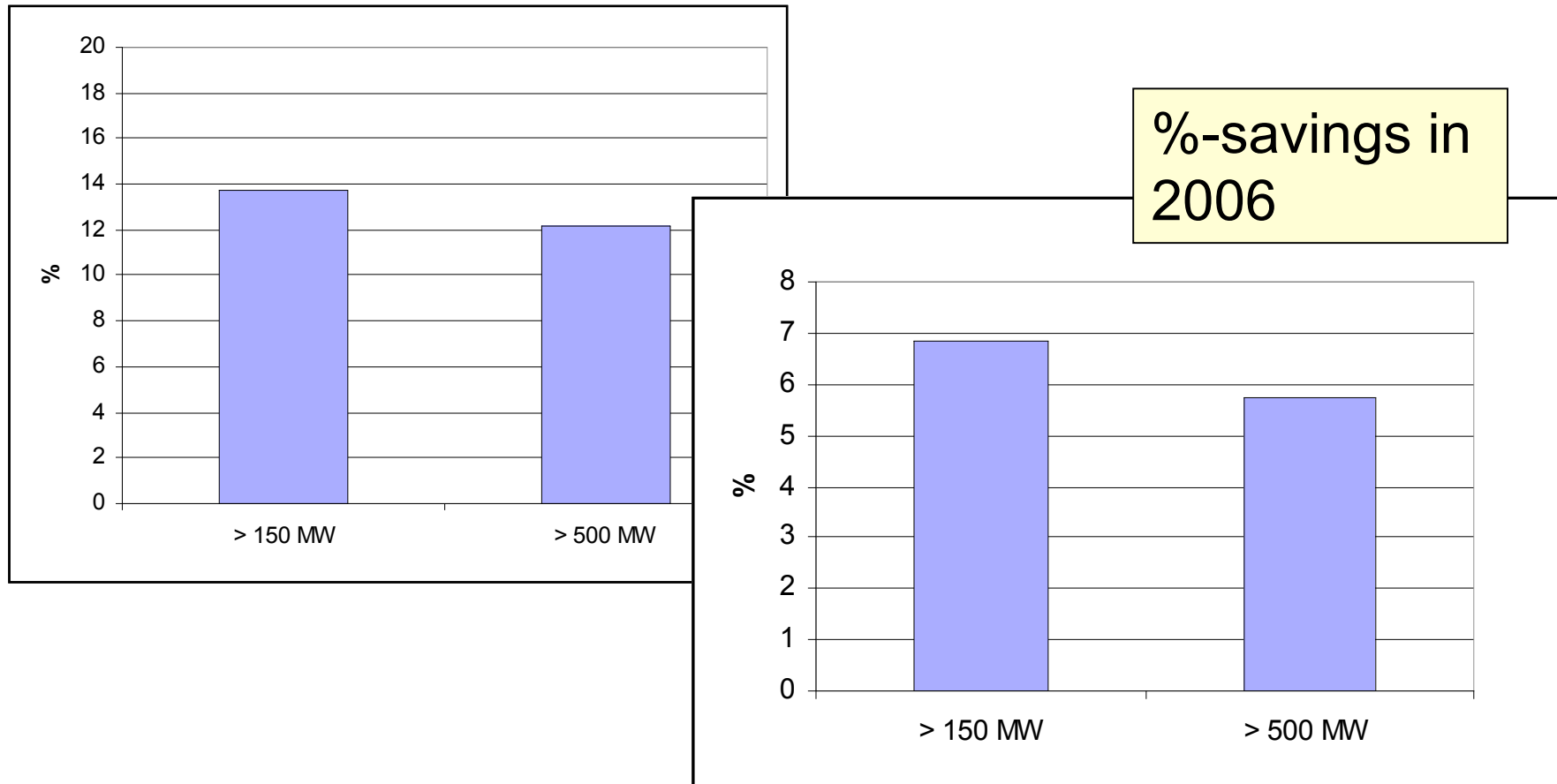
Not so much impact in Summertime....



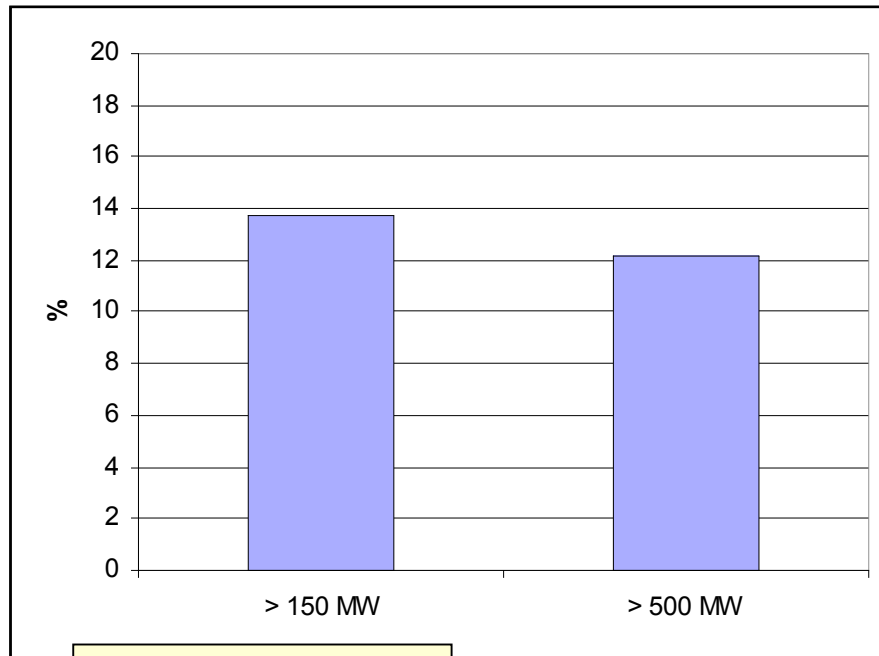
Not all month are equally pretty...



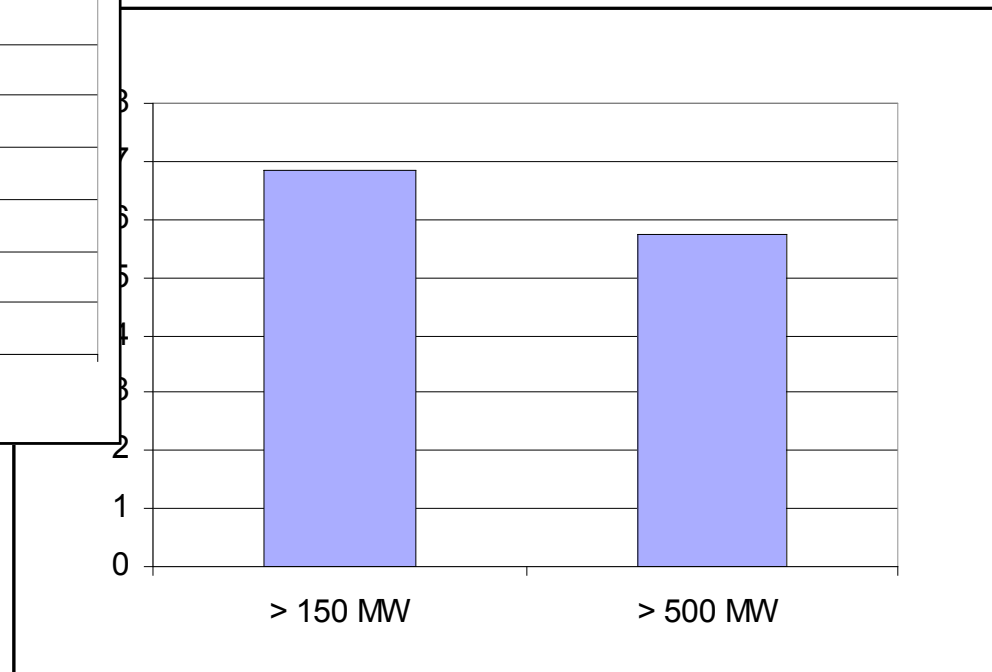
Consequences in 2005 and 2006 for power consumers in Western-Denmark



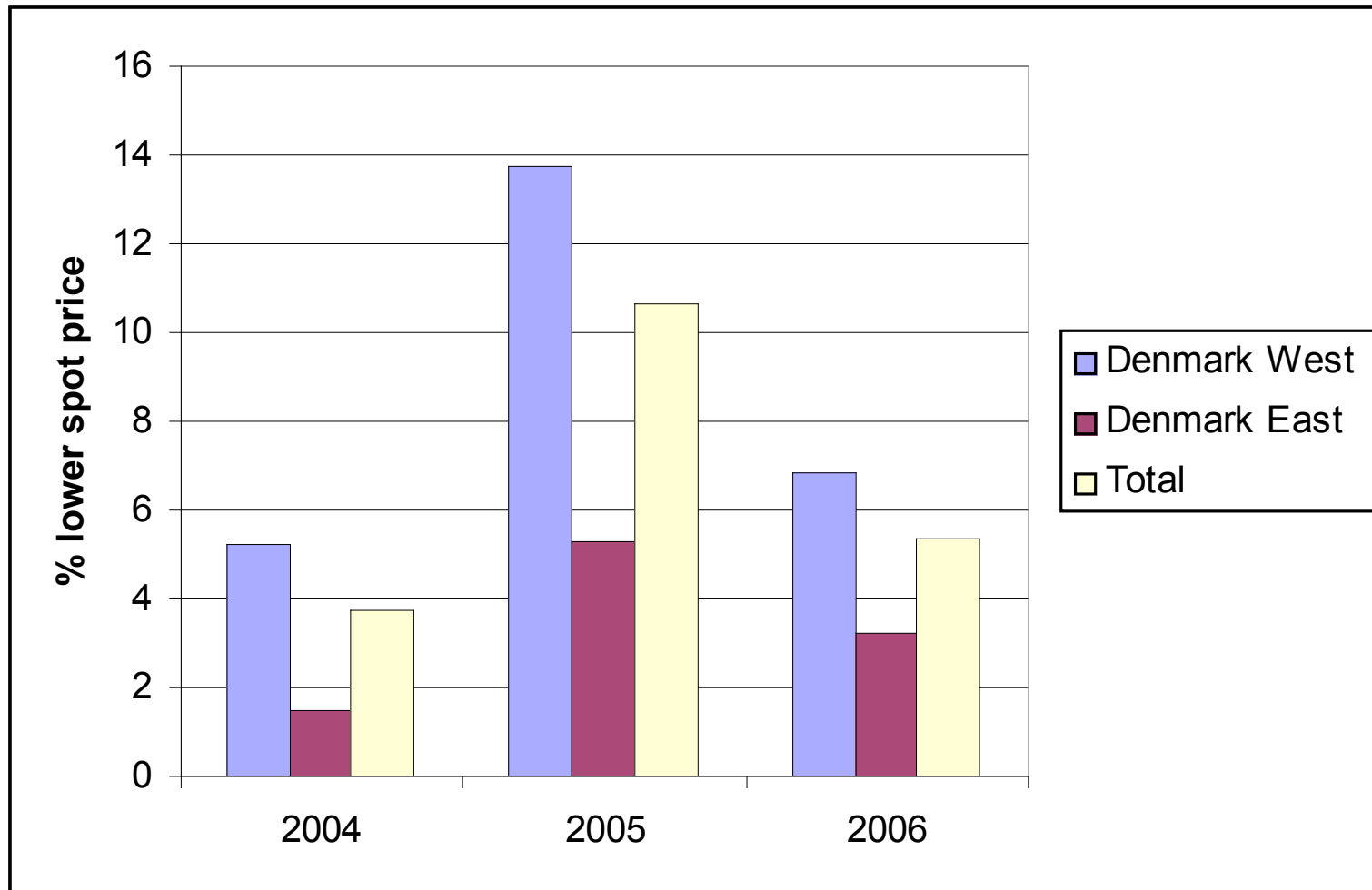
Consequences in 2005 and 2006 for power consumers in Western-Denmark



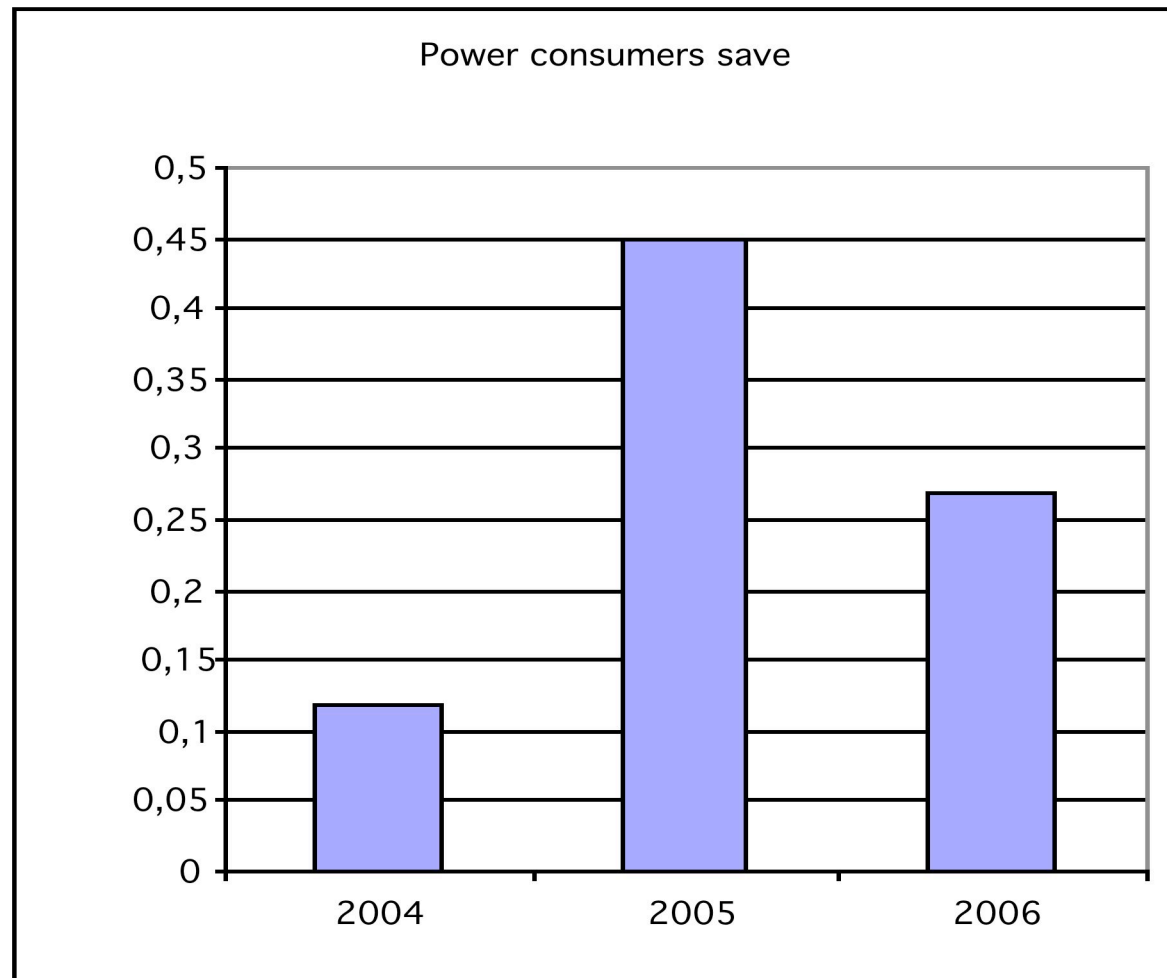
%-savings in 2005



Lower spot prices benefit the power consumers



Significant savings to power consumers



Observe that...

- Seen from the viewpoint of society only a smaller part of these savings are "real" cost reductions
 - Redistribution from power producers to power consumers
 - "Real" cost savings only for the marginal producing units
- Wind power production may reduce the possibilities for misuse of market power

Conclusions

- Power consumers in Western-Denmark has witnessed a significantly lower spot price
 - 6-7% reduction in 2006, 12-14% in 2005 and approximately 5% in 2004
- Subsidies to wind power amount to approximately 0.7 c€/kWh compared to reduced spot prices of 0.25-0.45 c€/kWh in 2005 and 2006
- It has not been possible to decompose all relevant impacting factors
 - Trade with Germany also influences power prices