

Introduction to Demand Response

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Vision for the energy system

- All components can communicate and negotiate in real-time
- Buying and selling is not hindered by administrative rules or procedures
- All technologies are equal
 - Environmental impact is internalised
- Demand and generation are treated equally

Visions - References

- DOE (2003): Grid 2030
- EPRI (2003): Electricity sector framework for the future
- EU (2006): SmartGrids



Benefits

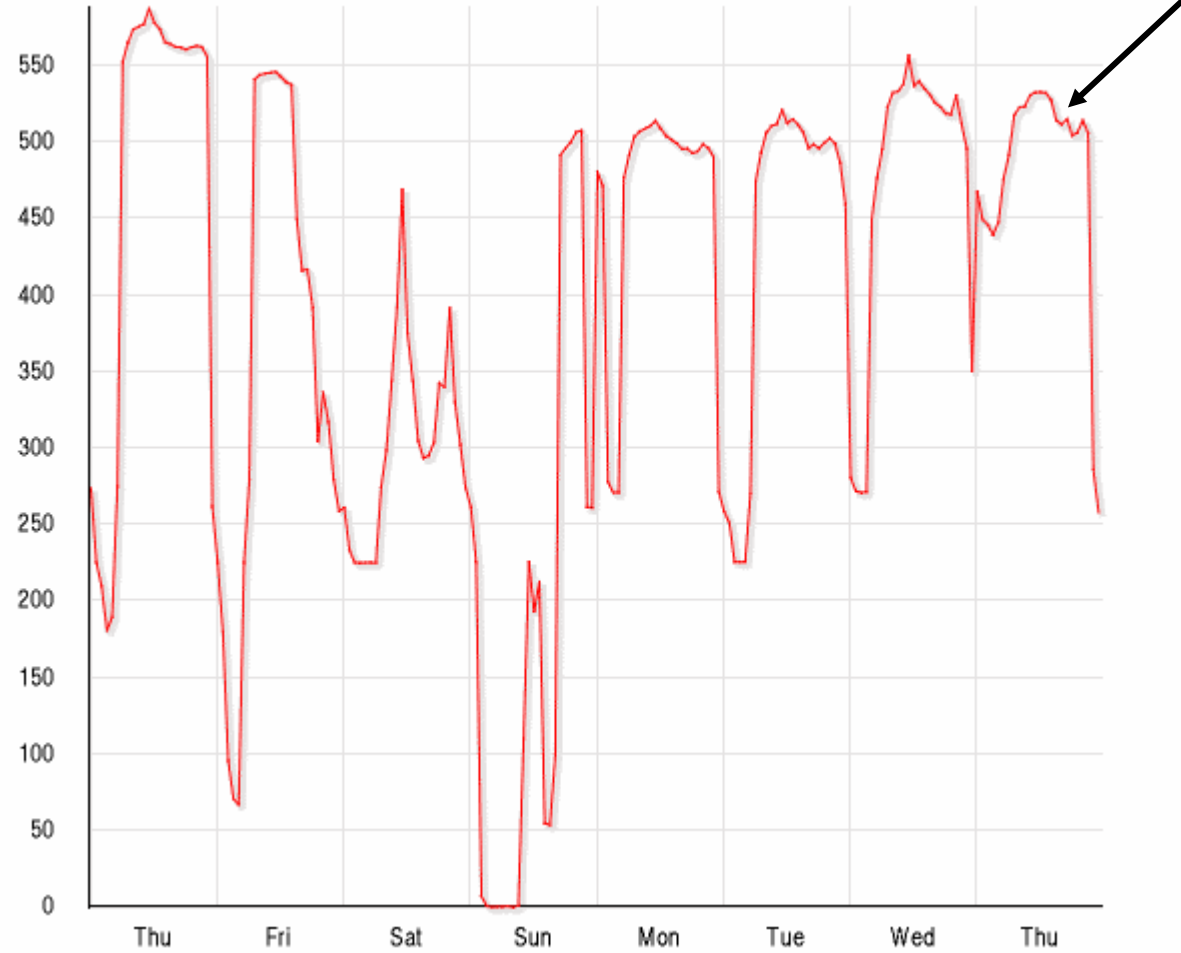
- Lower costs
 - A wider choice of technologies
 - Better utilisation of capital
- Higher security of supply
- Room for all technologies
 - Including environmental friendly technologies like wind power
 - Microgeneration (cogeneration)
 - Demand
- Quality a la carte

What is demand response?

- Demand response is voluntary adjustment of electricity demand as a reaction to prices
 - Can be done automatically
 - Comfort can be maintained
 - Consumer costs can be reduced
 - Prices include energy, transport and ancillary services
- "Demand response" in Danish = *"Prisfølsomt elforbrug"*

Wholesale price = Spot price

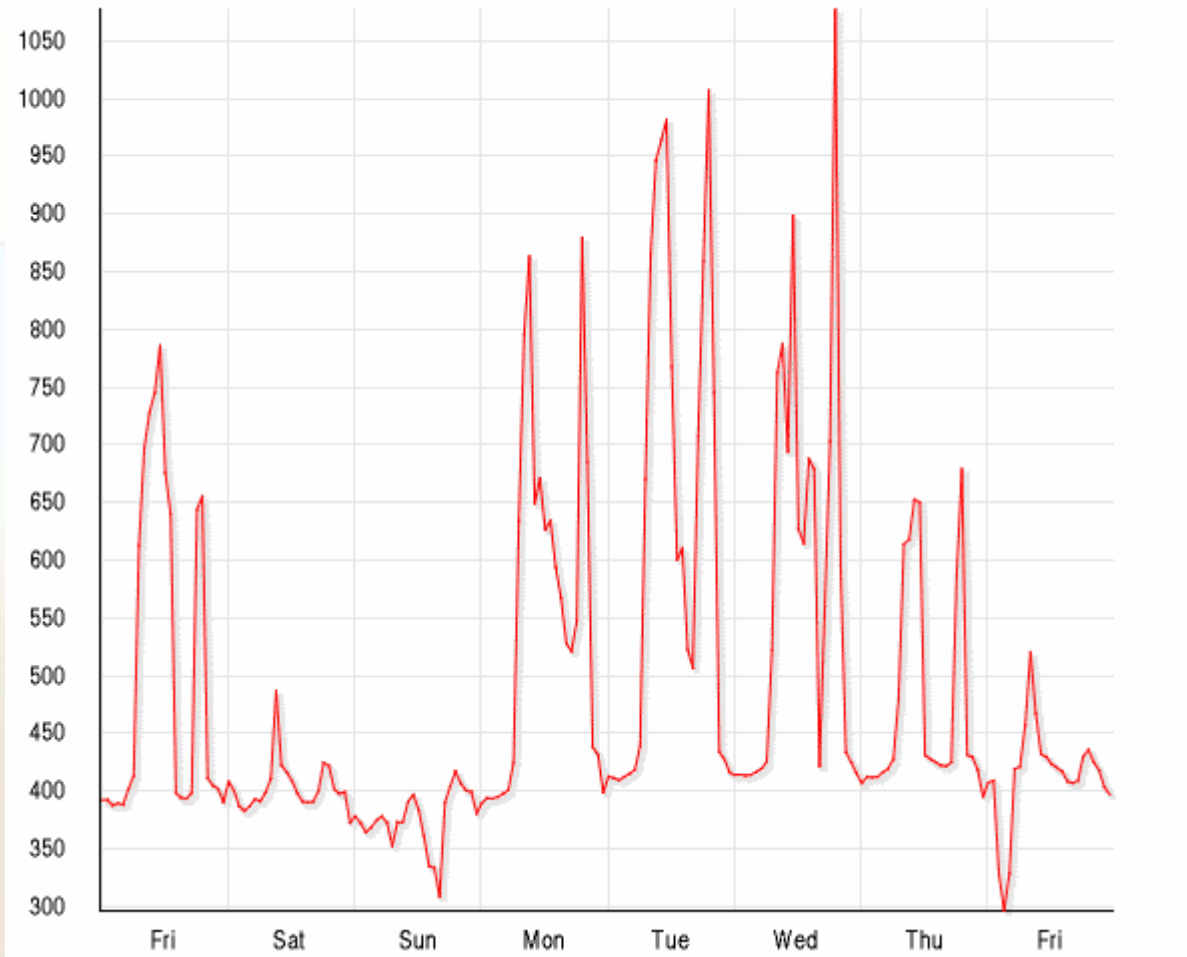
DKK/MWh



7 Sep. 2006
14.00-15.00

0-60 øre/kWh

Wholesale price = Spot price



30-110 øre/kWh

17 – 24 March 2006

In the future – Transport of electricity

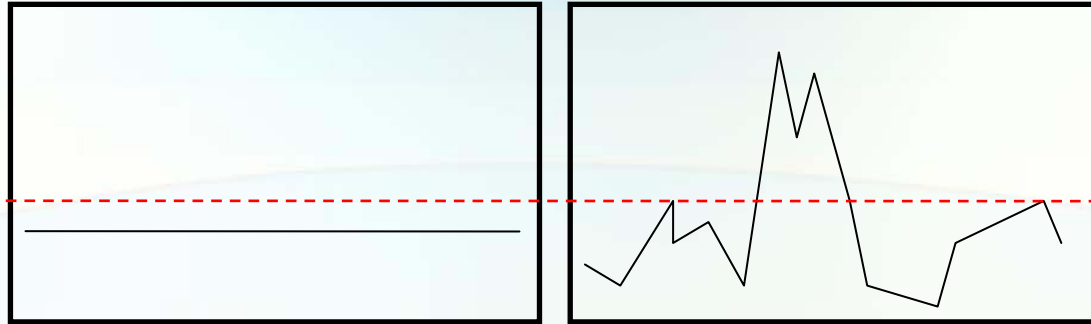
- Costs of transport of electricity vary hour per hour
 - Losses:
 - In average 7% of the electricity is lost
 - The marginal losses due to a marginal demand can vary from -20% to +20%
 - Capacity:
 - Different price areas are used in the spot market to signal capacity constraints in the transmission system – a similar concept could be developed for the distribution system

In the future – Reserves activated by price

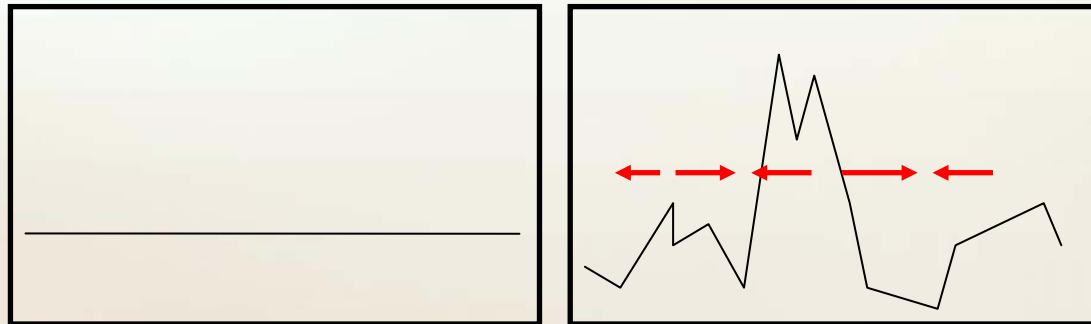
- Today reserves are mainly generation that can be activated with a notice of 15 minutes
 - Some reserves have a notice time of only 5-30 sec.
- This can in the future also be delivered by demand
- All reserves could – as a vision – be activated by voluntary actions in response to a price signal

Dynamic price = New opportunities

Microgeneration



Demand





Næstved Water Facility

- Surplus capacity for pumps and water storage
- Low costs when delaying pumping
- A low cost, loss free energy storage





Demand response projects: EFFLOCOM

- 25 houses with electric heating
 - Automatic, extreme flexible user settings
 - Up to 100 interruptions per winter
 - High user satisfaction (24/25)
 - Up to 5 kW reduction per household

User preferences

5 zones

3 prices

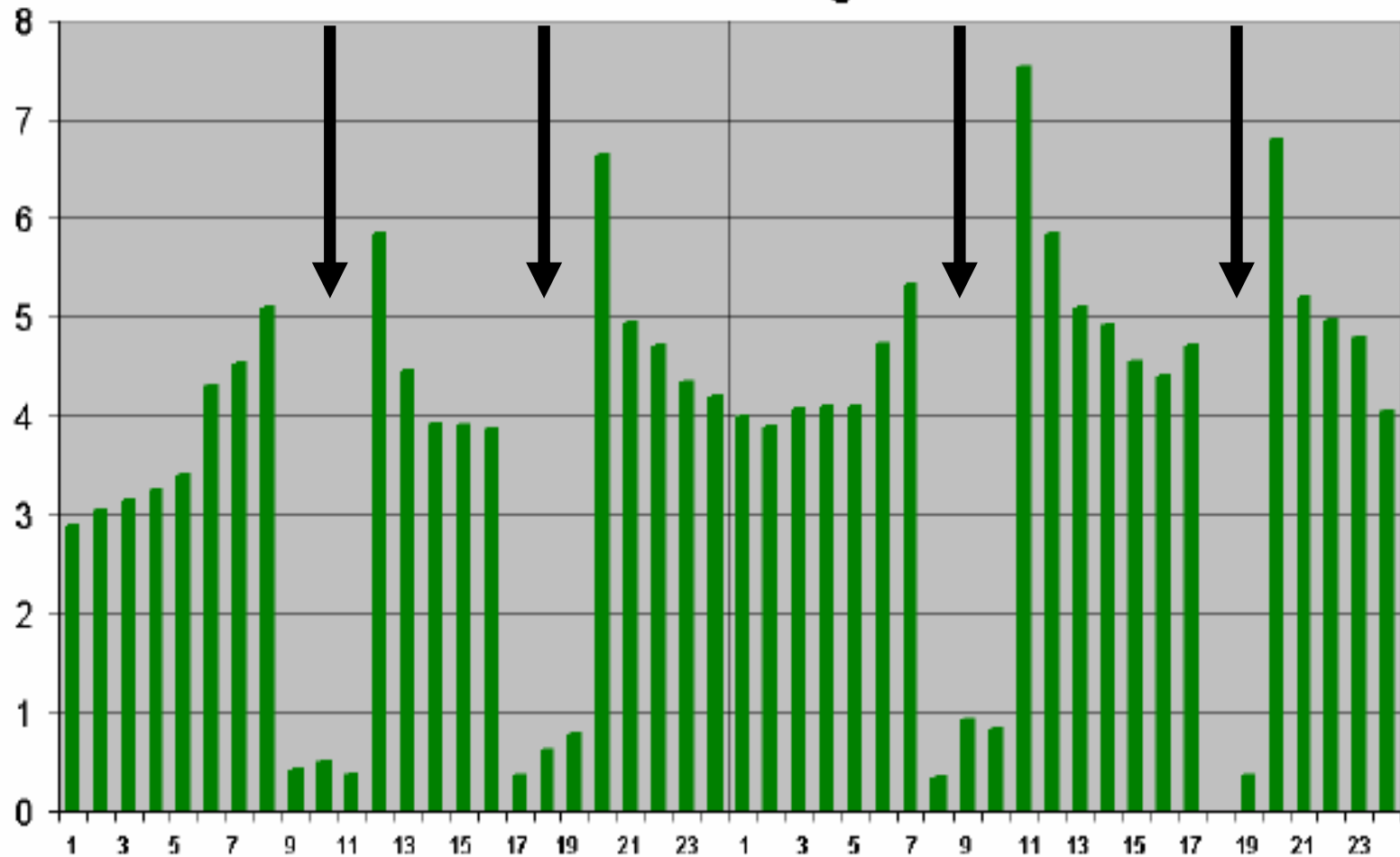
2 periods

Maximum curtailment time	Payment/electricity price						h
	1 DKK/kWh		2 DKK/kWh		3 DKK/kWh		
	6.00-11.00	16.00-19.00	6.00-11.00	16.00-19.00	6.00-11.00	16.00-19.00	
water heater	3	3	3	3	3	3	h
living room	1	1	2	1	3	2	h
bedroom	3	3	3	3	3	3	h
office	3	1	3	1	3	1	h
guest room	3	3	3	3	3	3	h

User sets maximum duration of curtailment

Average kW per house

Electric Heating



21 Jan. 2004

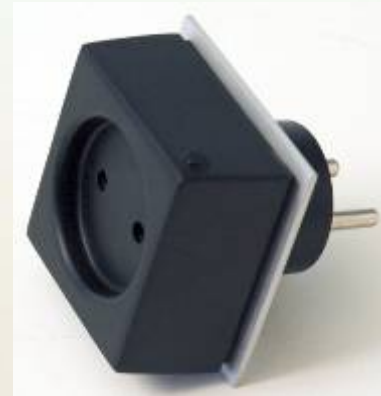
22 Jan. 2004

Demand response for the mass market

- Demand response for the mass market
 - Danfoss/Siemens/Energiindustrien/SEAS-NVE/Syd Energi/Ea Energy Analyses
- Market-oriented, large-scale
 - Use of existing interval meters for hourly metering
- More than 300 households with interval meters and dynamic prices
- 50 houses with Danfoss control
- 50 houses with Tell-it-online equipment
- www.prisfolsomtelforbrug.dk

Tell-it-online

- Combining entertainment (news, emails, SMS, music), security and comfort with demand response



Other current projects

- Demand response in large industries
 - Dansk Energi Analyse
- Demand response in Greenhouses
 - DEG, FDKV
- New meters and demand response
 - NESAs
- Energy savings motivated by feed back
 - AKF, Zonith, Aarhus School of Business, Aalborg University, SYD ENERGI, Nordvestjysk Elforsyning, MidtVest Bredbånd, Energy Piano og B&O
- Security of supply as market issue
 - Ea Energy Analyses, Risø, DEFU, Cowi, RAM-løse edb

Literature

- Analyses of Demand Response in Denmark (October 2006)
 - Risø, RAM-løse edb, Ea Energy Analyses
- U.S. Department of Energy (2006): Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them
- Danske Energi Analyse og Norenergi (2005): Priselastisk elforbrug hos større elforbrugere. Gennemført for Energinet.dk.
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- Elkraft System og Eltra (2004): Dansk TSO-handlingsplan for priselastisk elforbrug. Nordel
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- Stoft, S. (2002): Power system economics. Designing markets for electricity. IEEE Press
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