

2nd Solar Electric Utility Conference

**PV and liberalized electricity markets**

Munich, 6 March, 2009

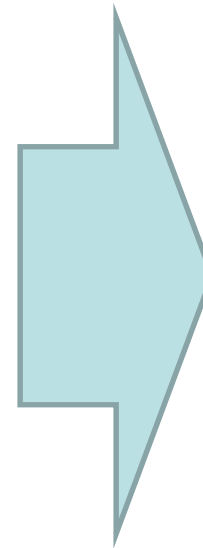
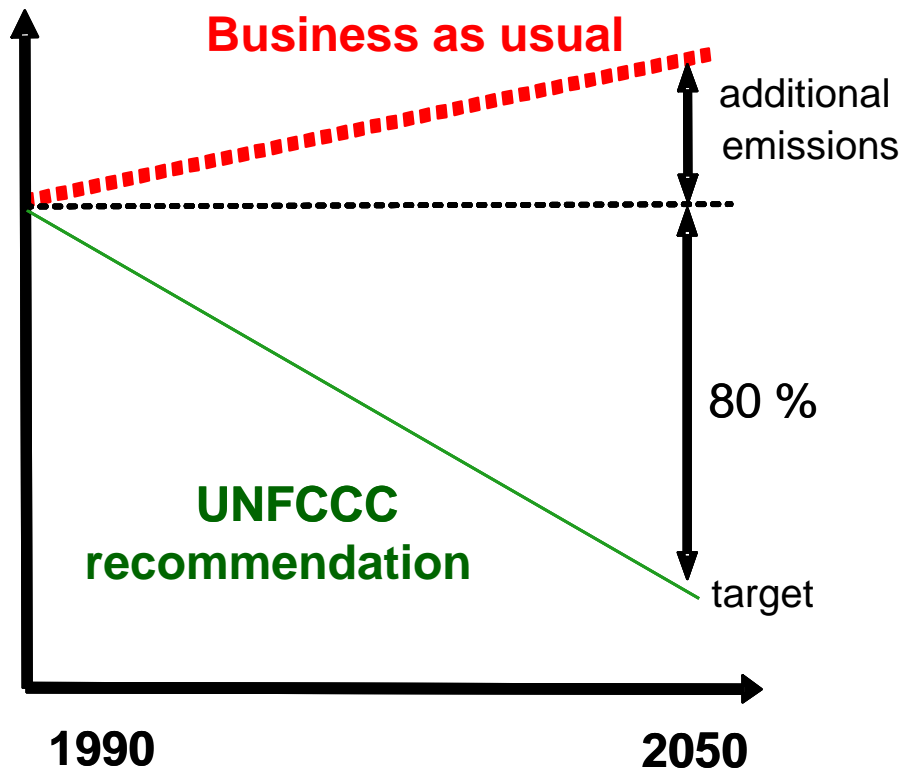
**Dr. Sven Bode**

[sven.bode@arrhenius.de](mailto:sven.bode@arrhenius.de)

# Background



## GHG emissions



- **Reduce emissions**
- **Increase renewables (RE)**
- **Efficiency etc....**

# Support for power production from RE

---



- As costs of power production from RE are currently higher power prices, increase of production is generally supported through public schemes such as:
  - Feed-in tariffs
  - Quota / tradable permits (GO)
  - Tenders
  - Investments subsidies...
  
- But:
  - How long?

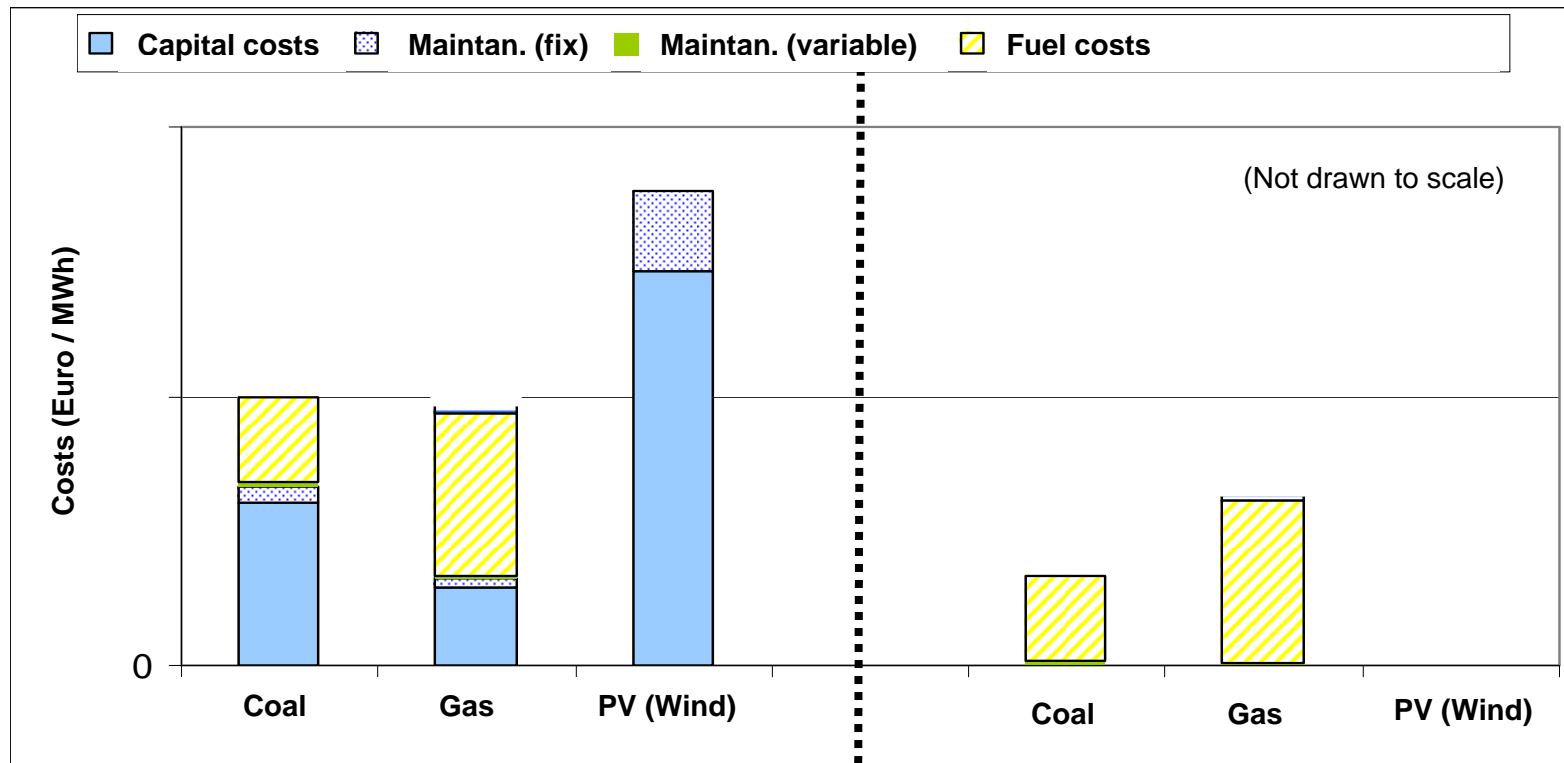
 What costs are we talking about?

# Different kinds of costs exist



Total average costs  
= total costs / quantity

„variable costs“ (marginal costs) =  
additional costs for the production of an  
additional unit (kWh)

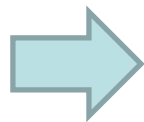


Relevant für **Investment decisions**

Relevant für **operational decisions / price formation**

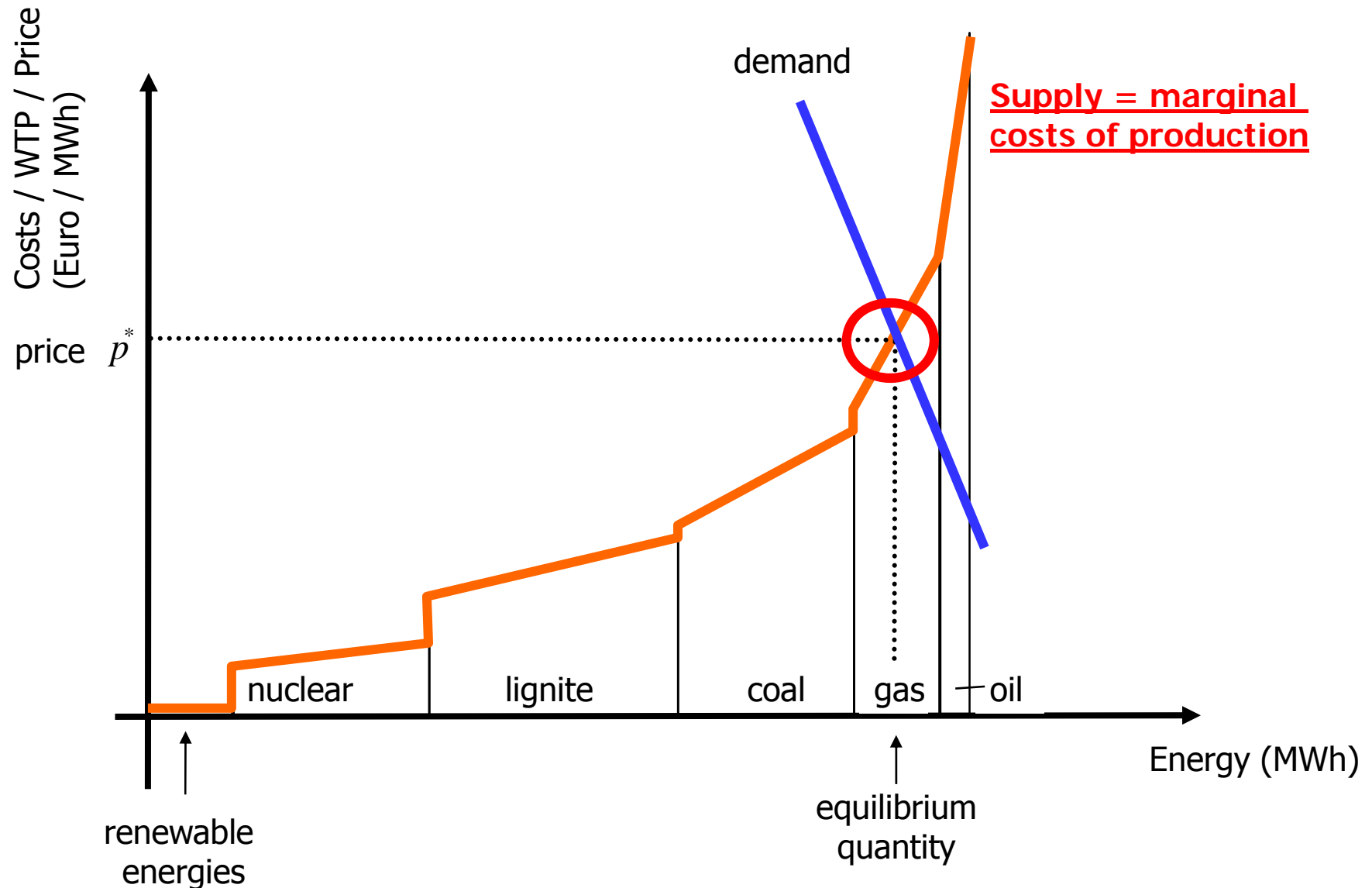


- Marginal analysis
  - thinking in small unit / small changes
- Market form: here perfect competition
  - ≠ Monopol etc.
- Short-term analysis
  - e. g. power market at EEX, tomorrow, 11-12 am

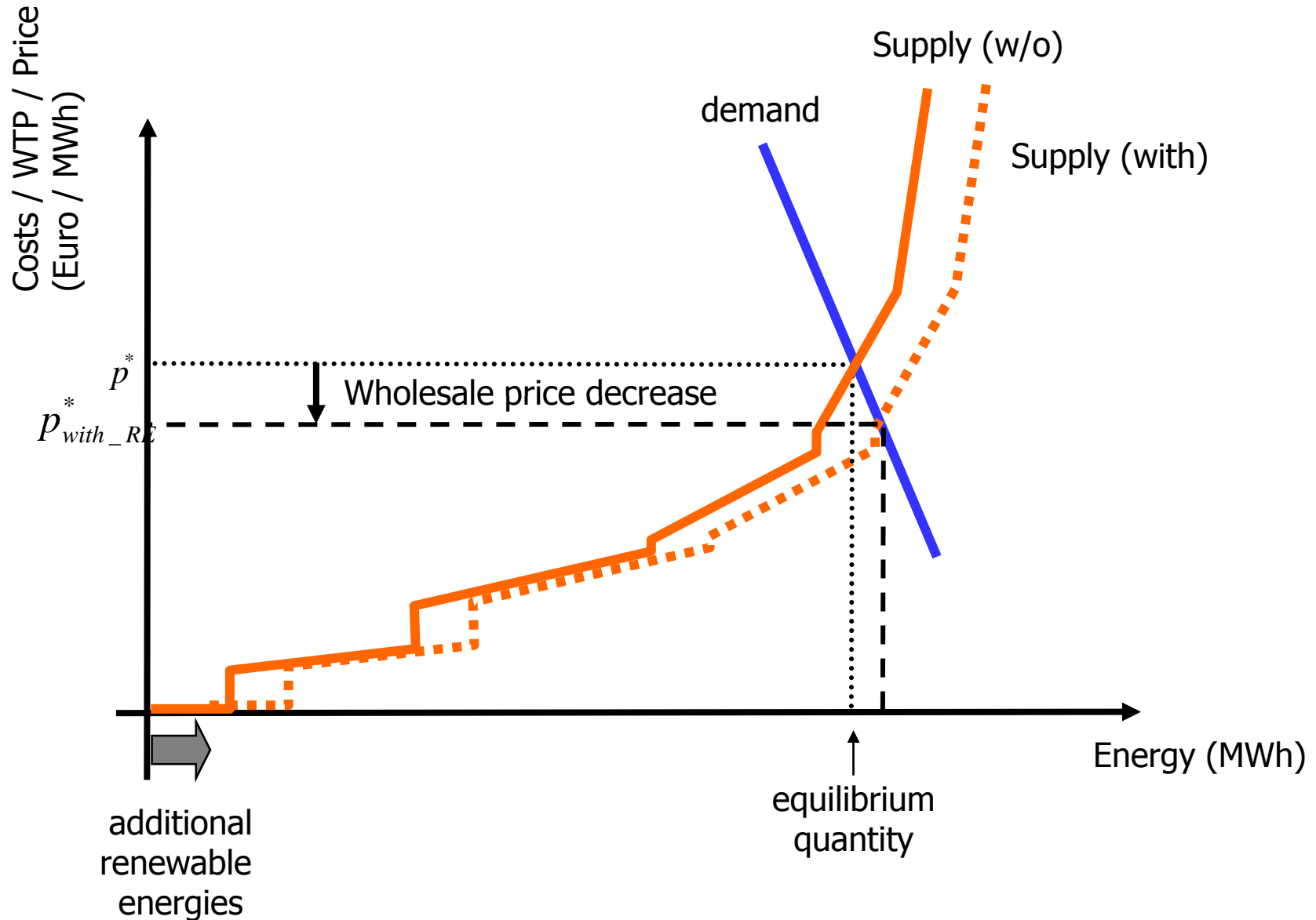


On the supply side, prices form on the basis of marginal costs of production

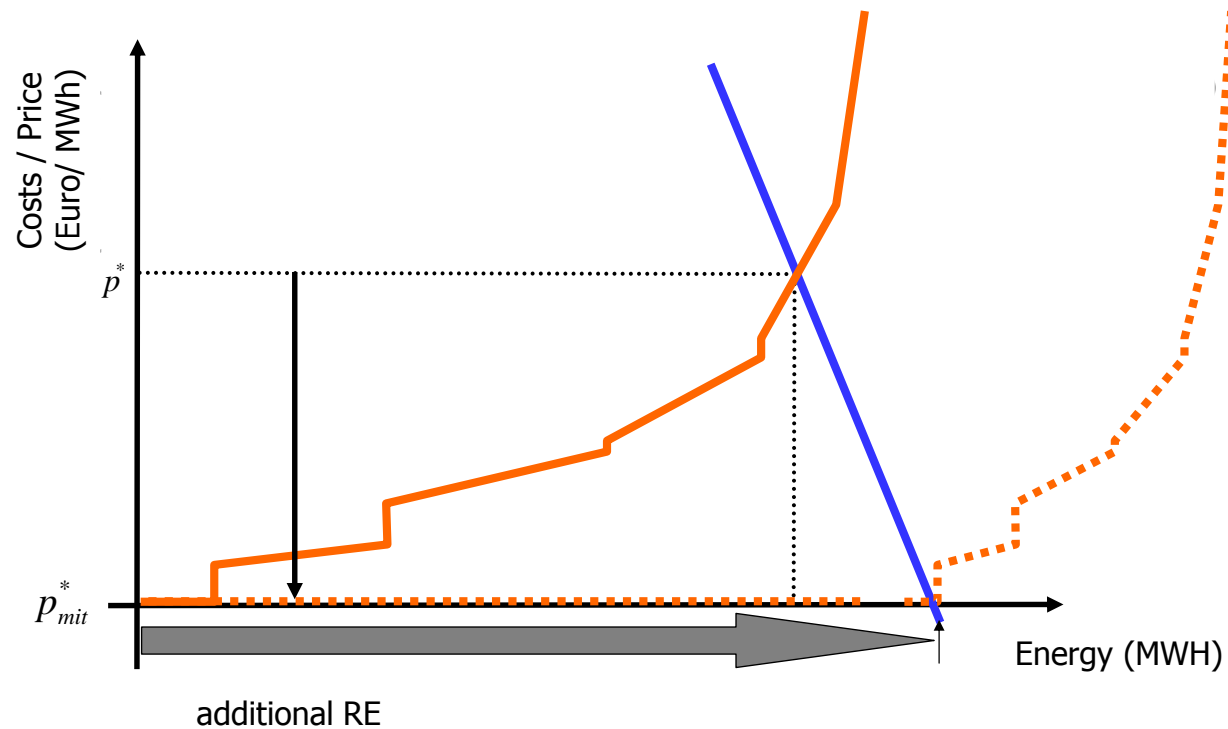
# Price formation in competitive markets



# Price formation in competitive markets



# Price formation in competitive markets



- Extreme: whole sale price = zero → revenue with direct sale = zero
- Systematic revenue problem for RE → support scheme permanently necessary, if high market penetration desired

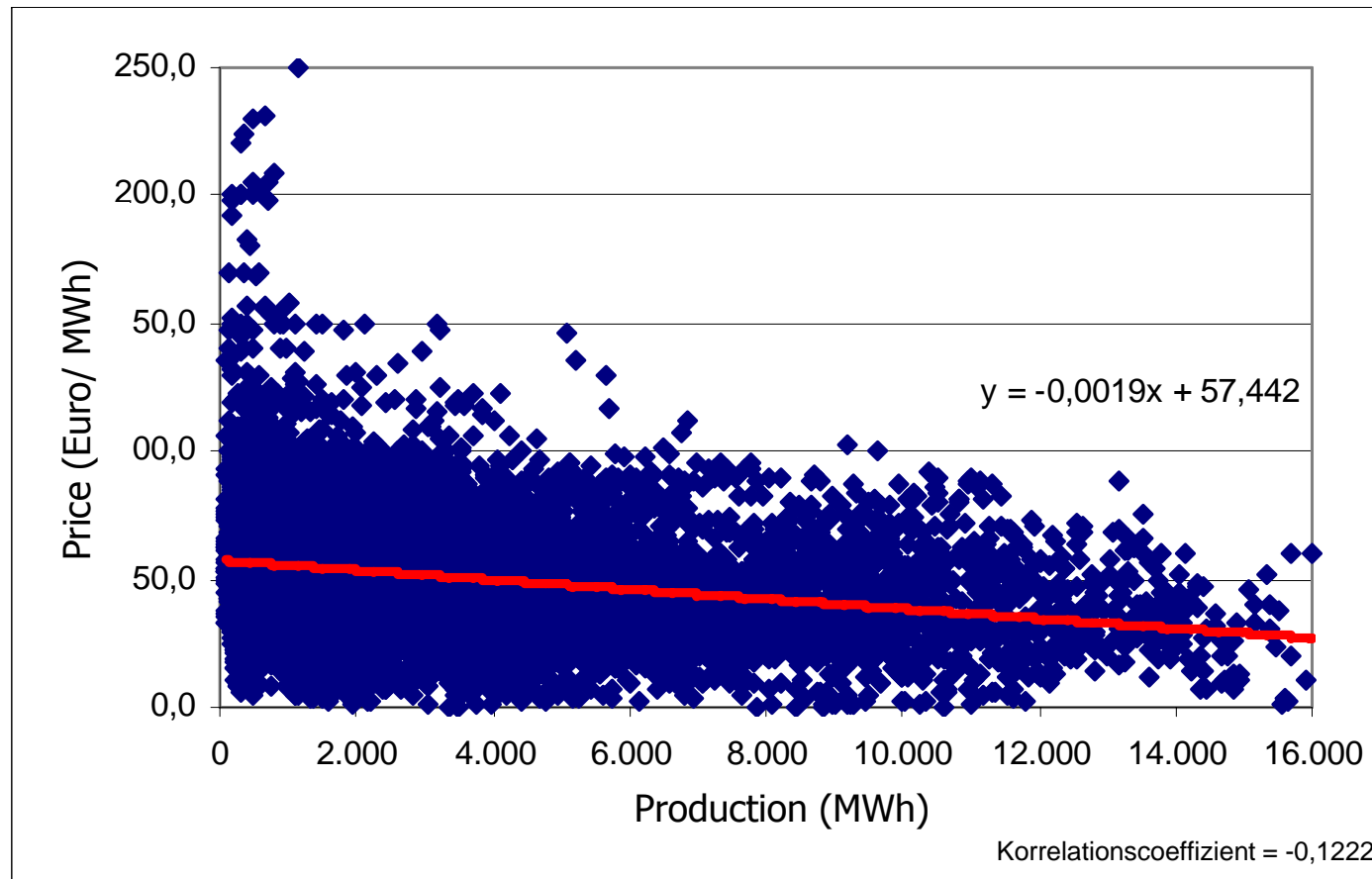
# Emperical evidence EEX (wind)

---

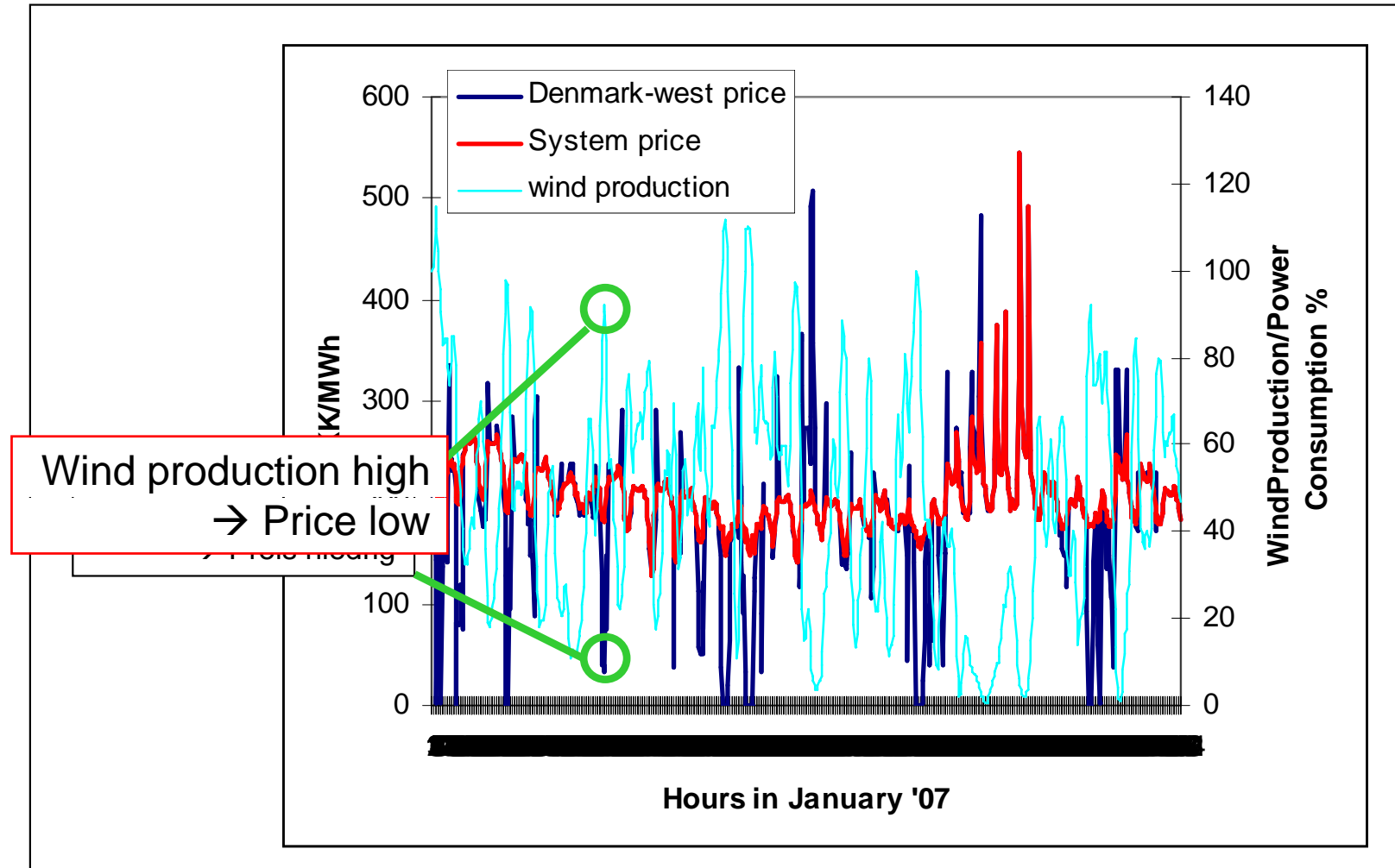


- Factors
  - RE production in Germany (hourly, 2006)
  - Other factors
    - CO<sub>2</sub>-prices
    - Fuel prices (Öl, Gas, Kohle)
    - Plant break downs
    - Im- and exports
    - ...

# Wind power and EEX prices

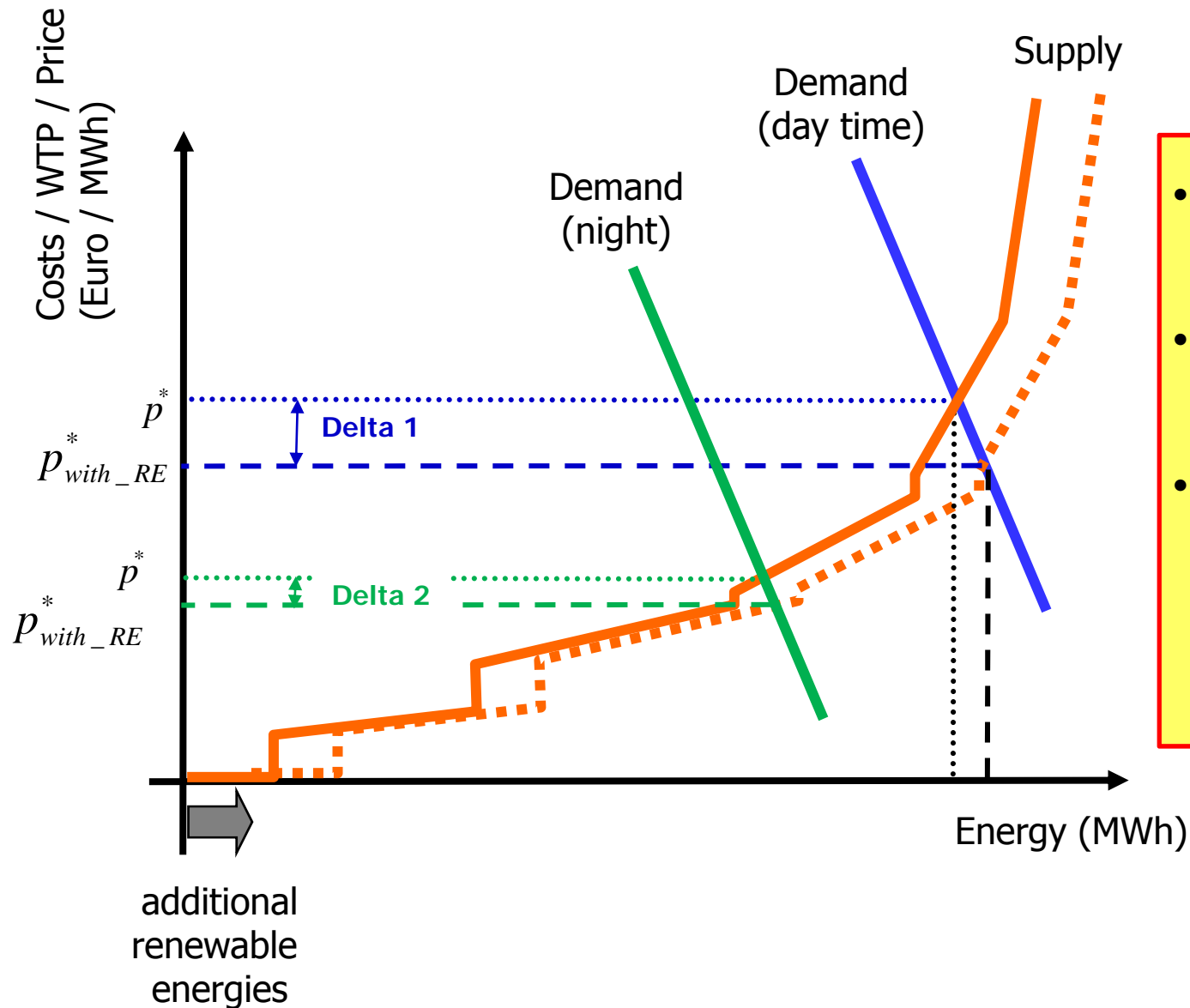


# Wind energy and power prices in Denmark



Quelle: Morthorst, Poul (2007) Impacts of Wind Power on Power Spot Prices

# Price and the impact of PV



- Slope of supply curve generally increasing
- PV: power production at high load / prices
- Price reducing effect of PV on average higher than for other RE (relevant for higher PV capacity)

## A broader market view

---



- Power production from PV, wind, hydro causes a decrease of power prices (whole sale market)
- Conventional plants also affected
- Fluctuating production of PV and wind causes disruptions of continuous operation of "base load plants" (as we know to day)
- If plants to be operated with CCS – technical problems are likely to occur

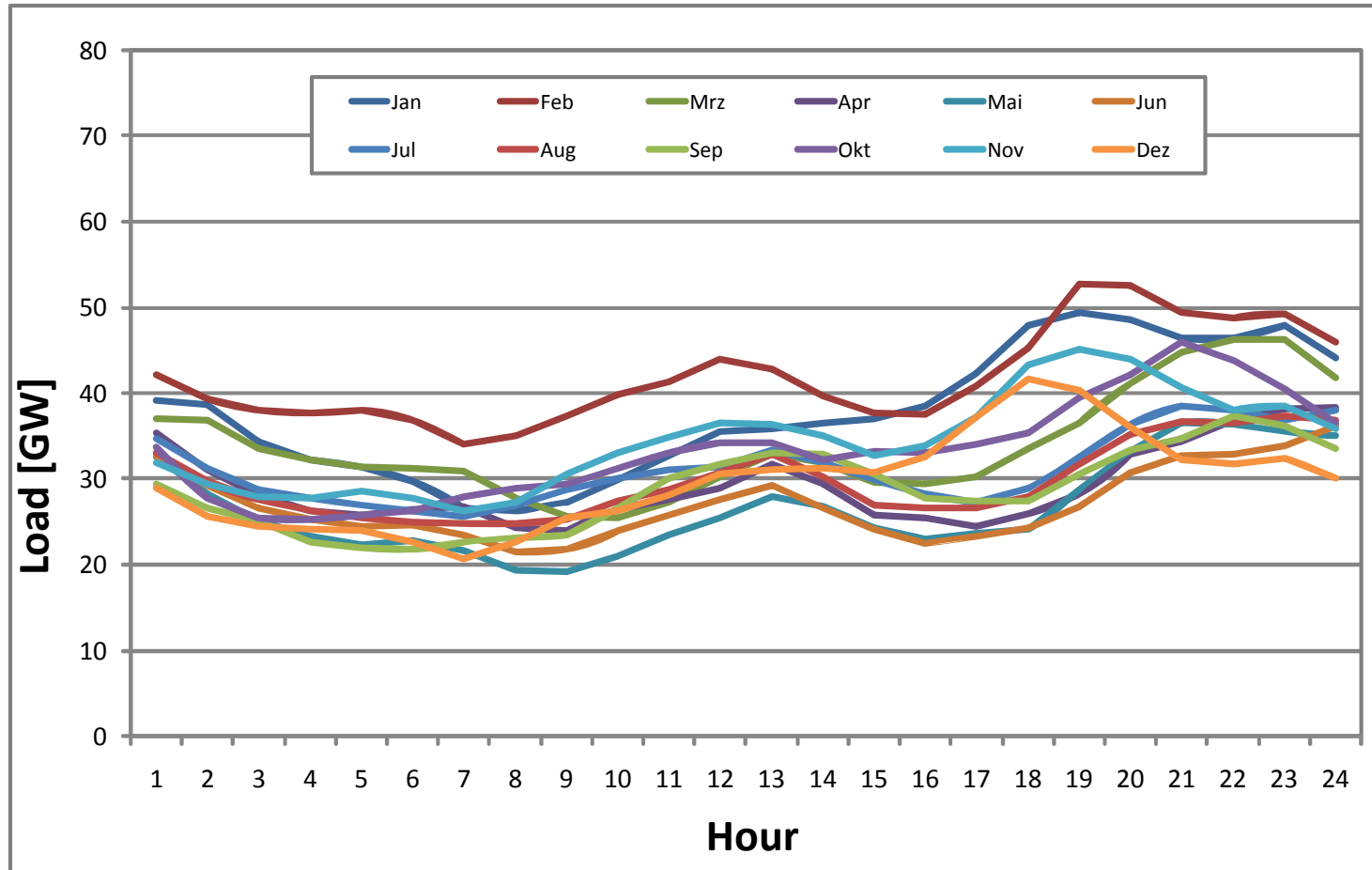
→Decarbonisation of a liberalised power market is a tricky issue

# A broader market view



## Minimum monthly remaining load (Germany 2006)

(Remaining load = consumption minus power production from RE)

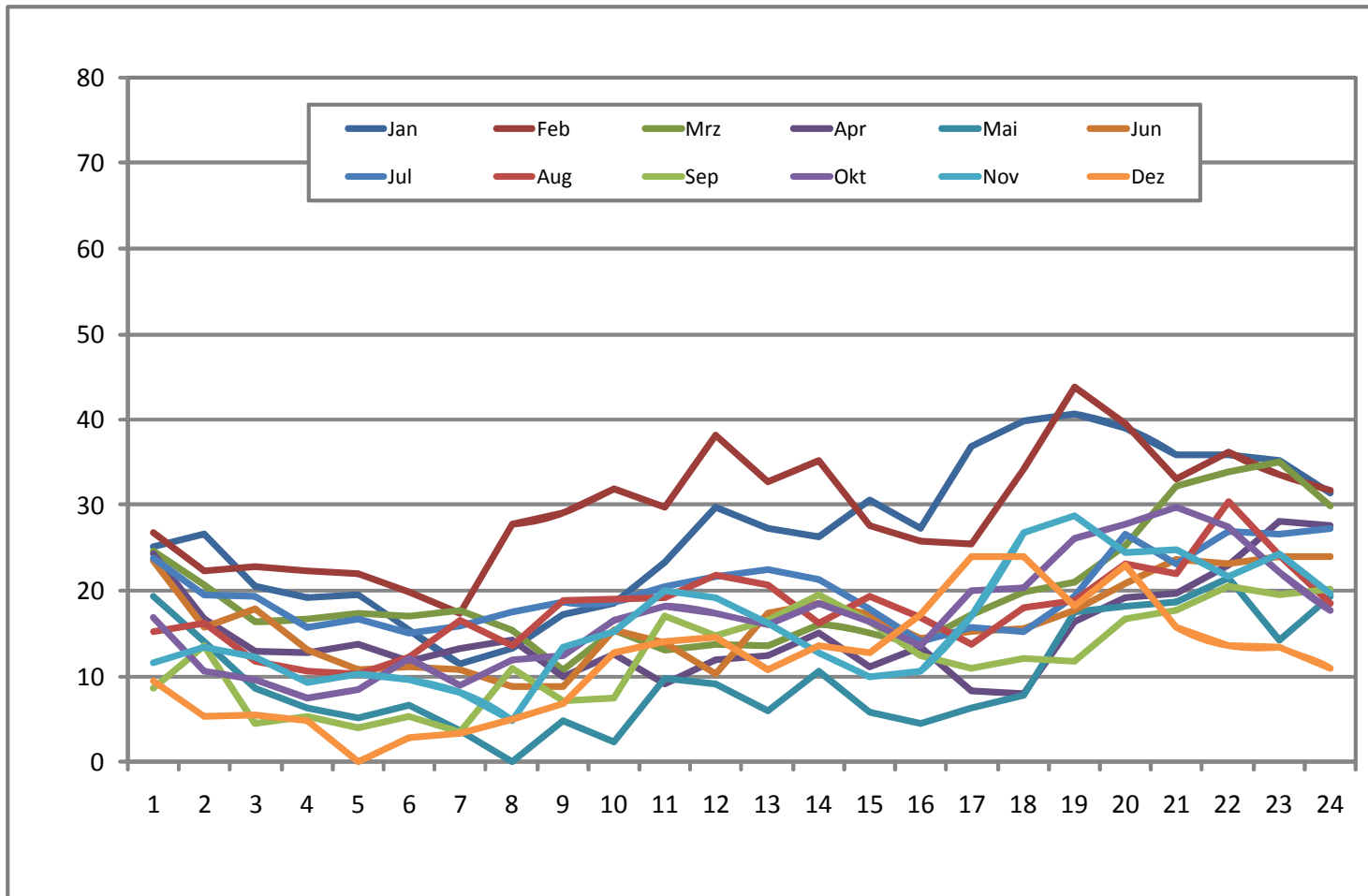


# A broader market view



## Minimum monthly remaining load (Germany, 2030)

(Remaining load = consumption minus power production from RE)



# Conclusion

---



- Costs of power production from PV generally  $>$  power price, i. e.  $>$  revenue
- Support schemes have been introduced
- In competitive markets RE (PV) can still reduce the whole power price given its low marginal costs of production
- Systematic reduction of power price (e.g. „when the sun shines“) reduces the revenue stream systematically if power sold at power exchange
  - Long-term support scheme presumably necessary (even if total cost of production of RE  $<$  TAC of fossils; lobbying necessary?)
  - To be considered during investment decision making in liberalised market, especially with high RE penetration

2nd Solar Electric Utility Conference

**PV and liberalized electricity markets**

Munich, 6 March, 2009

**Dr. Sven Bode**

[sven.bode@arrhenius.de](mailto:sven.bode@arrhenius.de)

## Further reading (selection)

---



- Bode, Sven; Groscurth, Helmuth (2009) Incentives to Invest in Electricity Production from Renewable Energy under Different Support Schemes, arrhenius Discussion Paper 1 E
- Bode, Sven (2008) Renewable Energie and Power Prices: Incentives to Invest under Different Support Schemes, European Wind Energy Conference 2008, Brussels, March 31 - April 3 (ppt- file)
- Bode, Sven (2007) Erneuerbare Energien – Preistreiber oder Preisdämpfer? Jahreskonferenz Erneuerbare Energie - ee07, Berlin, January 16 (ppt-file)
- Bode, Sven; Groscurth, Helmuth ( 2006) The Effect of the German Renewable Energy Act (EEG) on “the Electricity Price”, HWWA Discussion Paper No. 358
- Bode, Sven (2006) On the impact of renewable energy support schemes on power prices, HWWI Research Paper 4-7
- See Bode, Sven (2006) Long-term greenhouse gas emission reductions – what’s possible, what’s necessary? In: Energy Policy

More available on: [www.arrhenius.de](http://www.arrhenius.de)