



## Preconditions and assumptions for large scale utilisation of wind energy

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# Large scale Utilization of Wind Power

## - Preconditions and Assumptions



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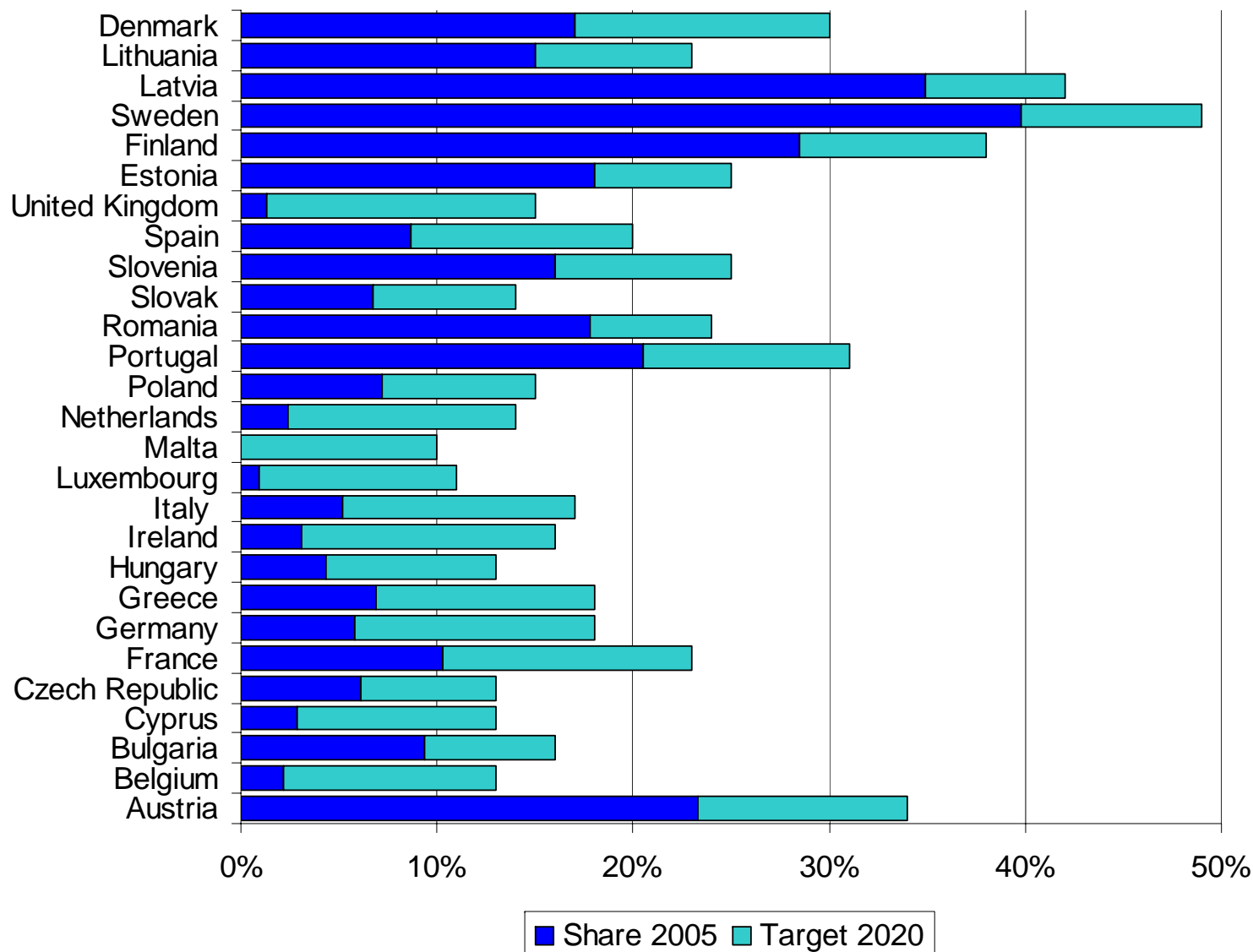
**Professor  
Poul Erik Morthorst  
Risø DTU**

# The Scene is Set

## EU Targets in place: 20 – 20 – 20 by 2020

- EU ETS is approved
  - Emissions of Greenhouse gases to be reduced by 20% compared to 1990
- EU Renewables Directive is approved
  - 20% of Final Energy Consumption to be supplied by Renewables and Wind Power will be an important contributor
- 20% Energy Conservation by 2020
- 10% of Transport fuels have to be supplied by Renewables

# National RES Target



# Future Challenges

## Medium term

- Volatility in prices might be a barrier towards future investments
- Delaying the necessary process towards a sustainable energy system

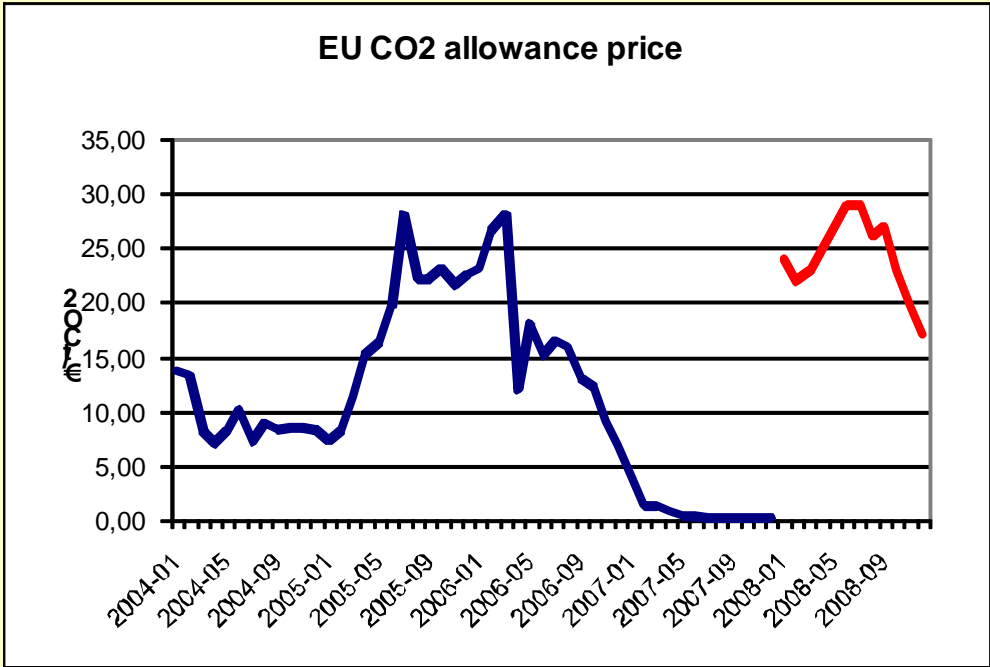
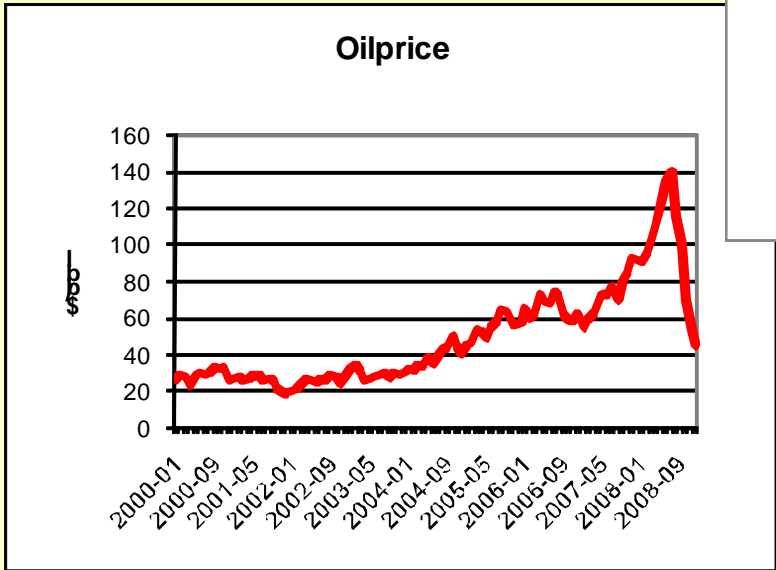
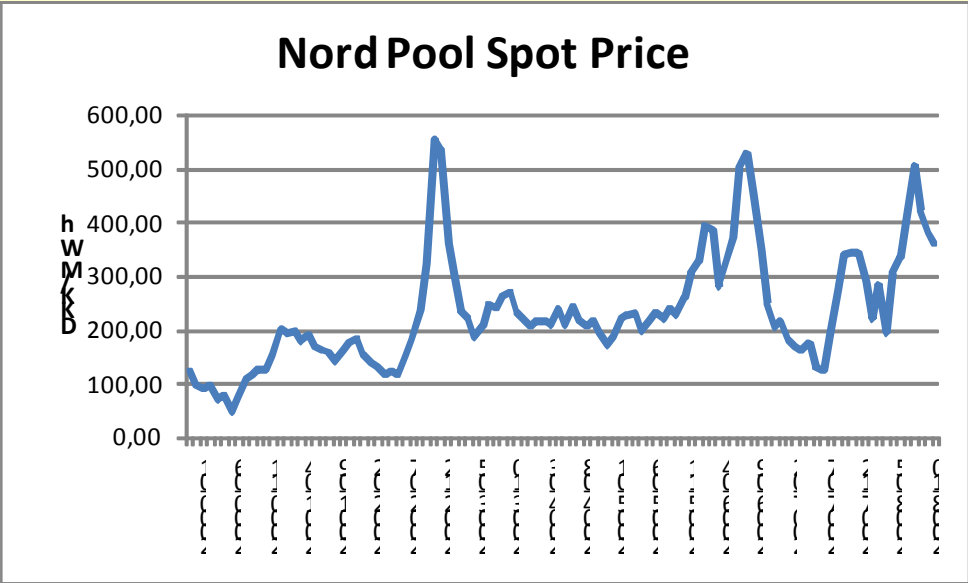
## Longer term

- Integration of Wind Power into the energy system is a pressing matter
- Do we have the right market set up?

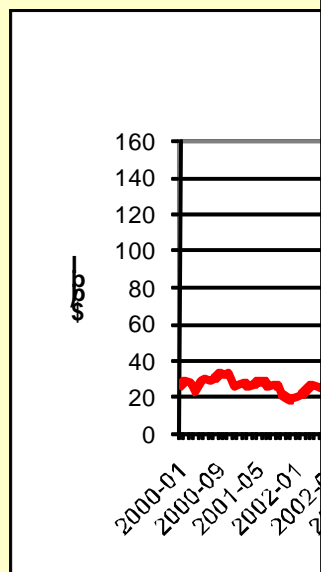
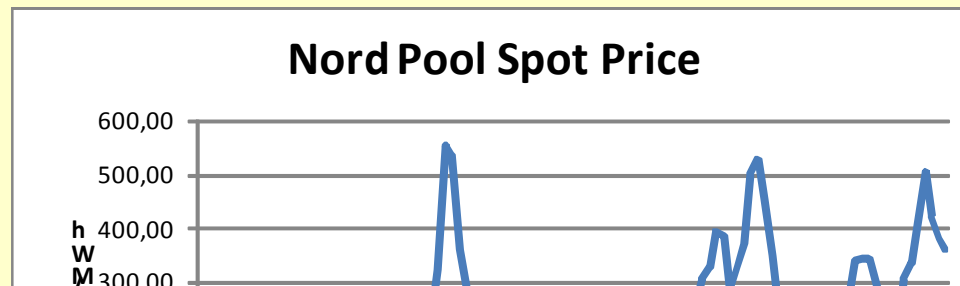
## Future Support System

- **Feed-in tariff and Large Scale deployment of Wind Power does not go well together**
  - In Denmark 20% of power production should be taken out of the market
  
- **A Market Compatible System is needed**
  - Premium System: Spot Price plus an adder
  - Green Certificate System could also do the job, if defined for a large geographical area

# Prices

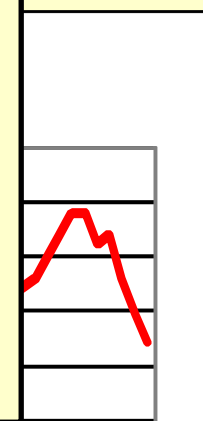
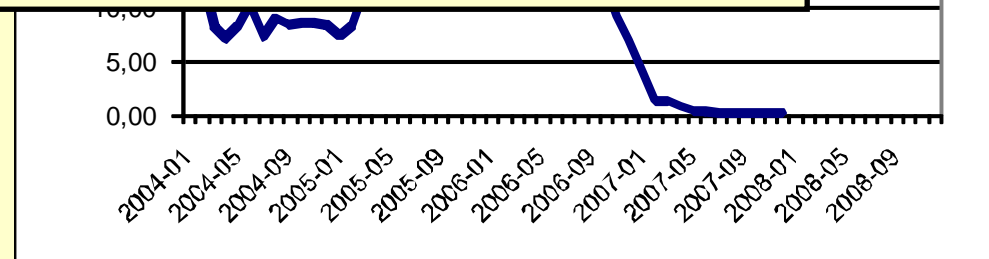


# Prices



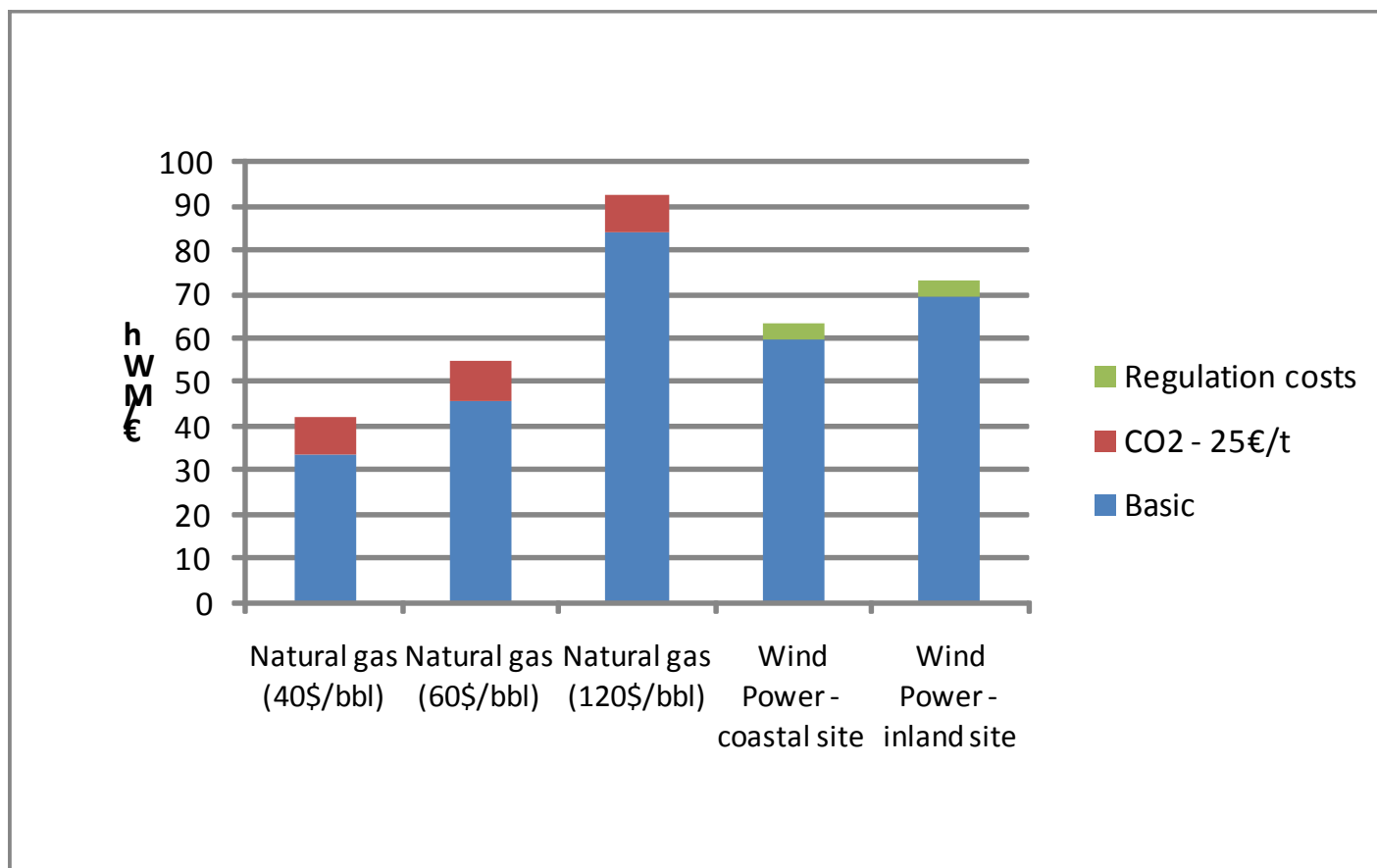
Volatility will probably be an integral part of the future system, simply because we are moving on a knife edge.

We are in a significant transition period and marginality will be the rule rather than the exception

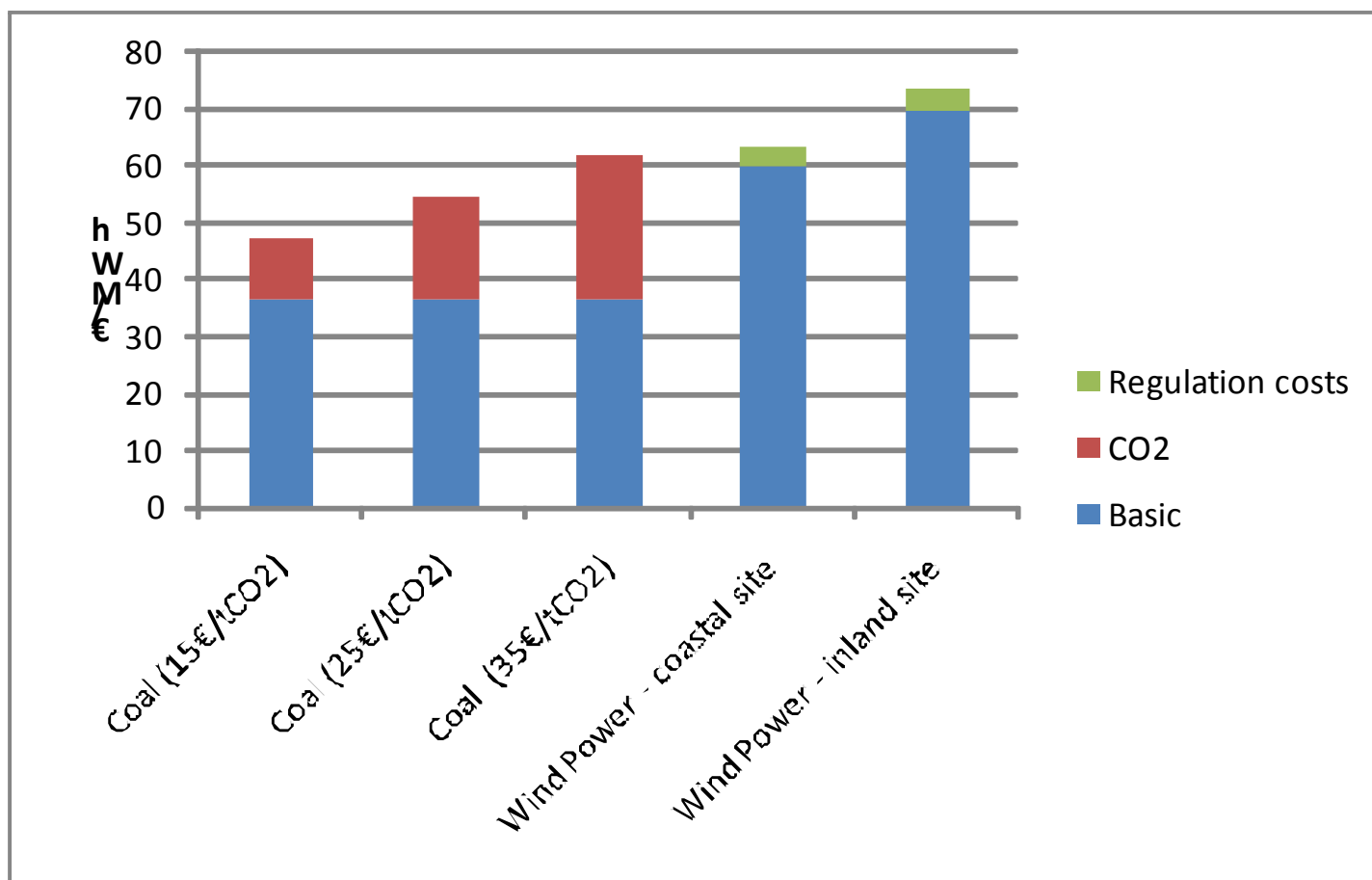




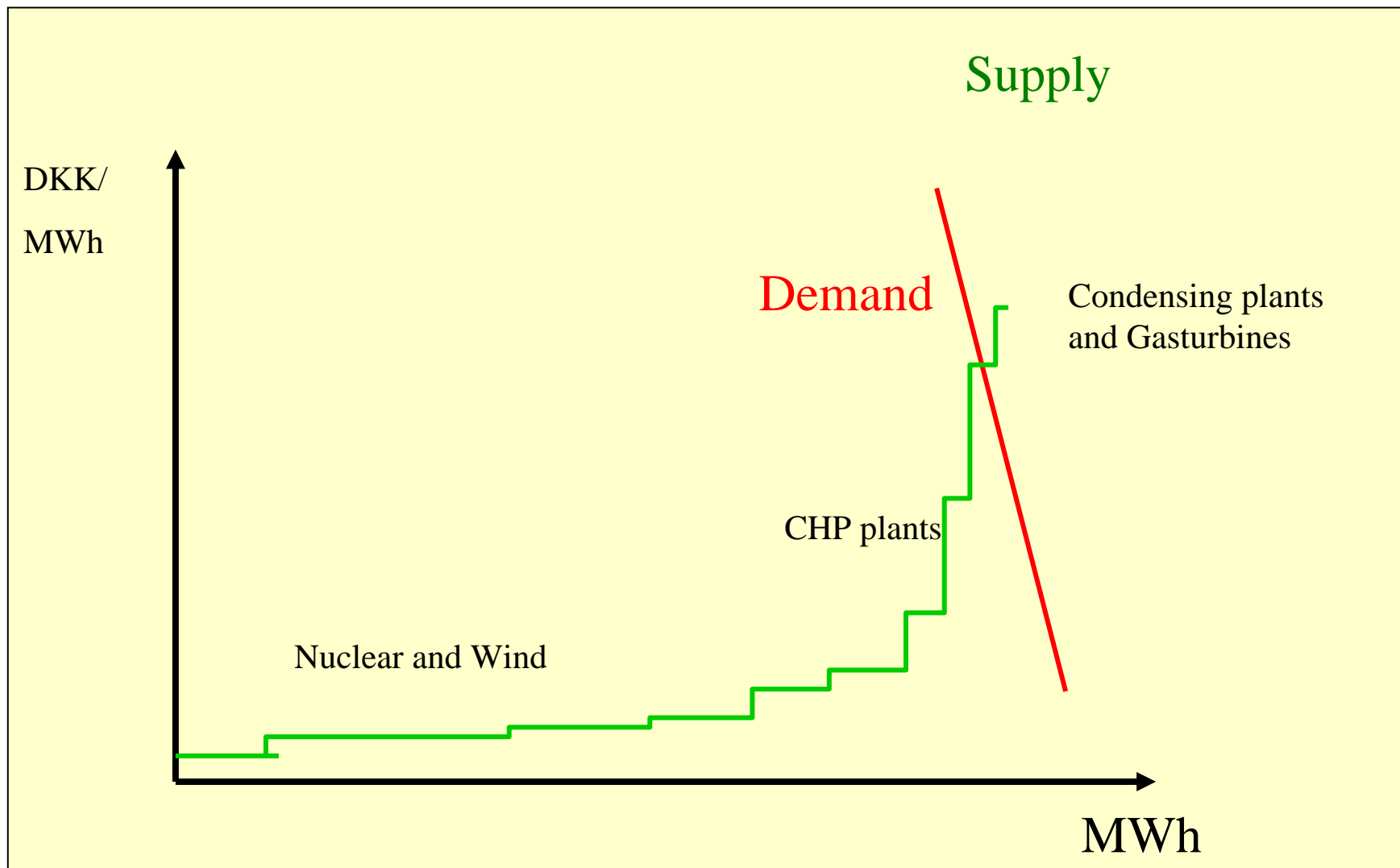
# Wind Power Compared to Natural Gas Power Plant



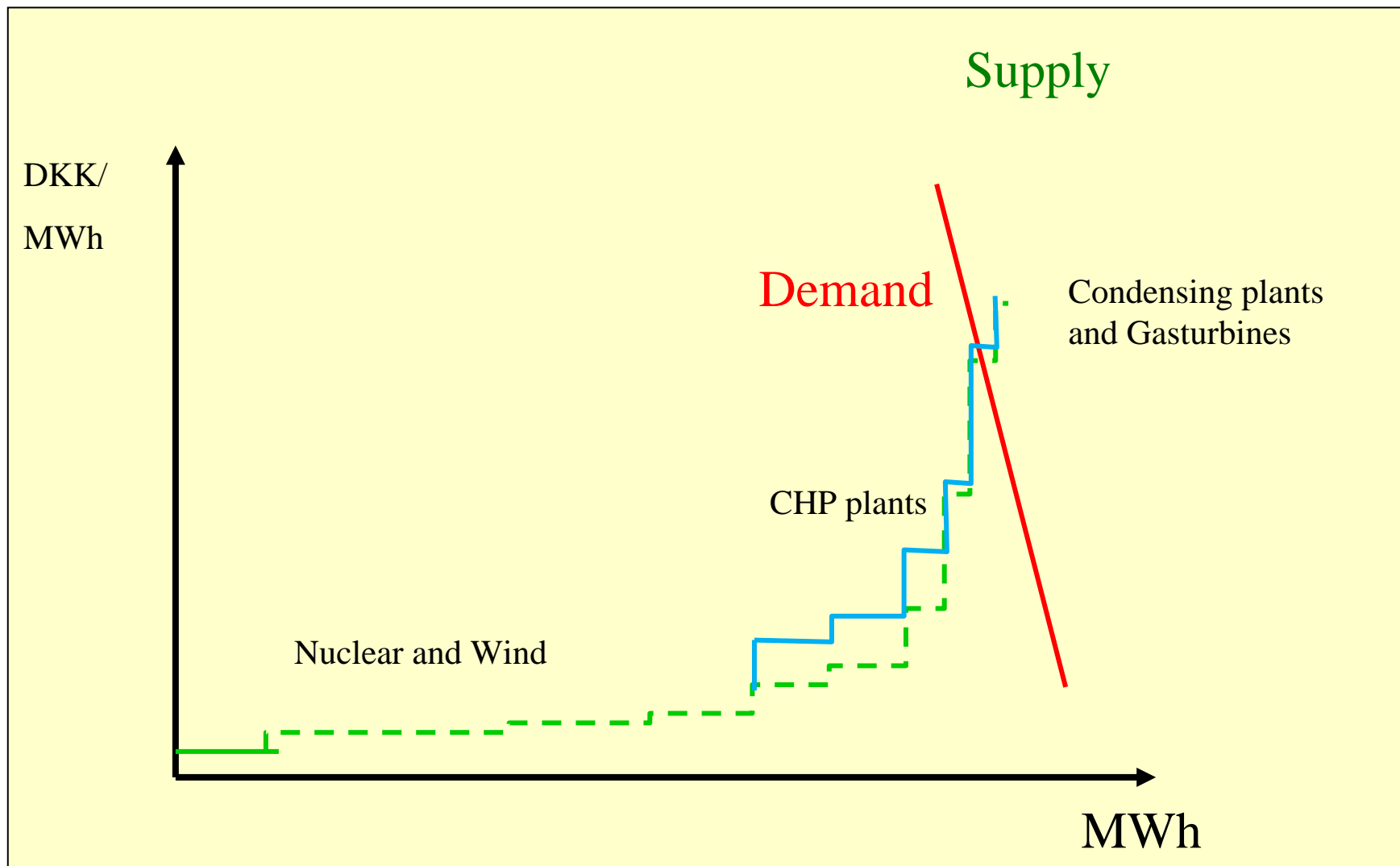
# Wind Power Compared to Coal Fired Power Plant



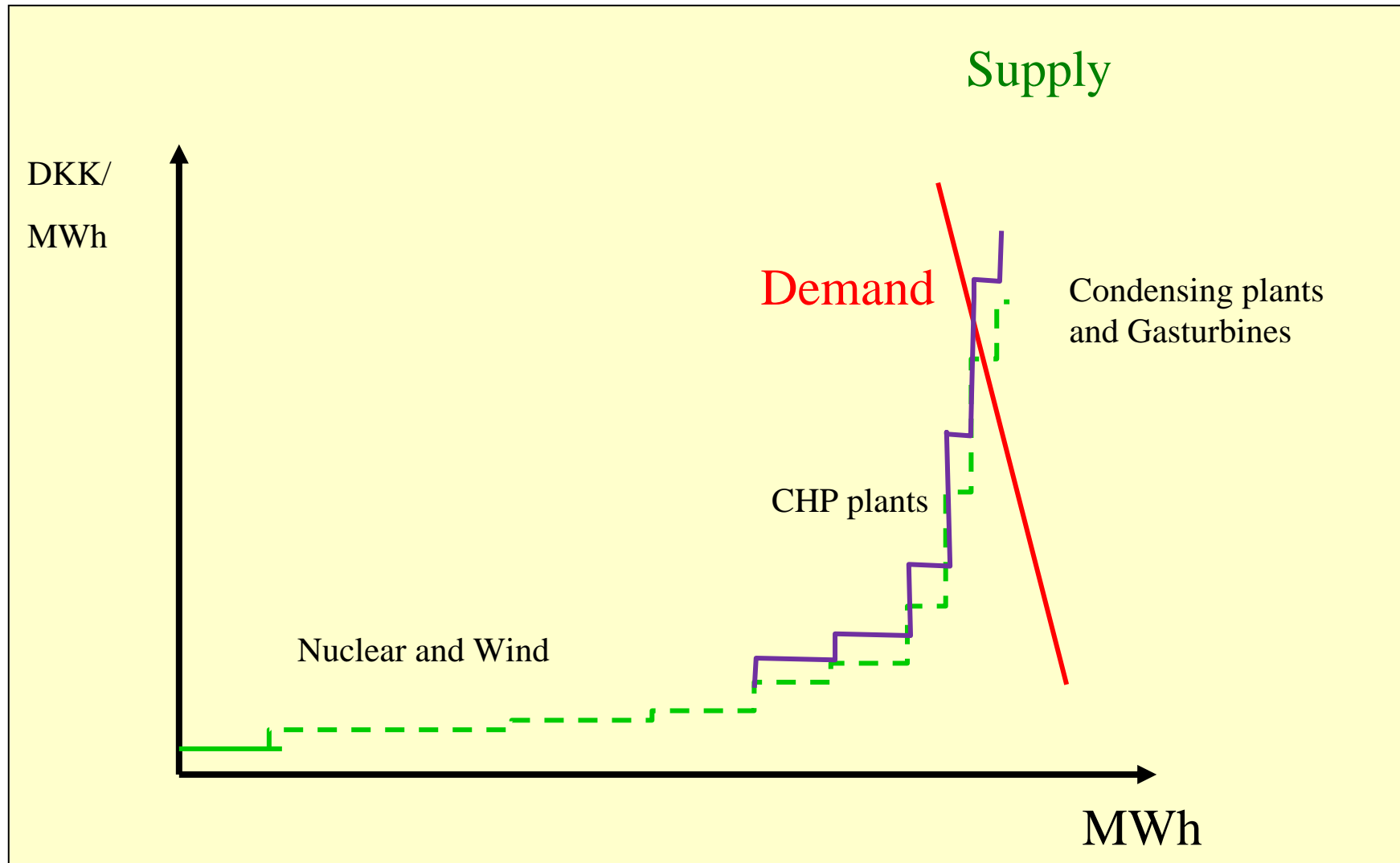
# Determination of the Power Price



# The Consequence of CO2 on Power Price



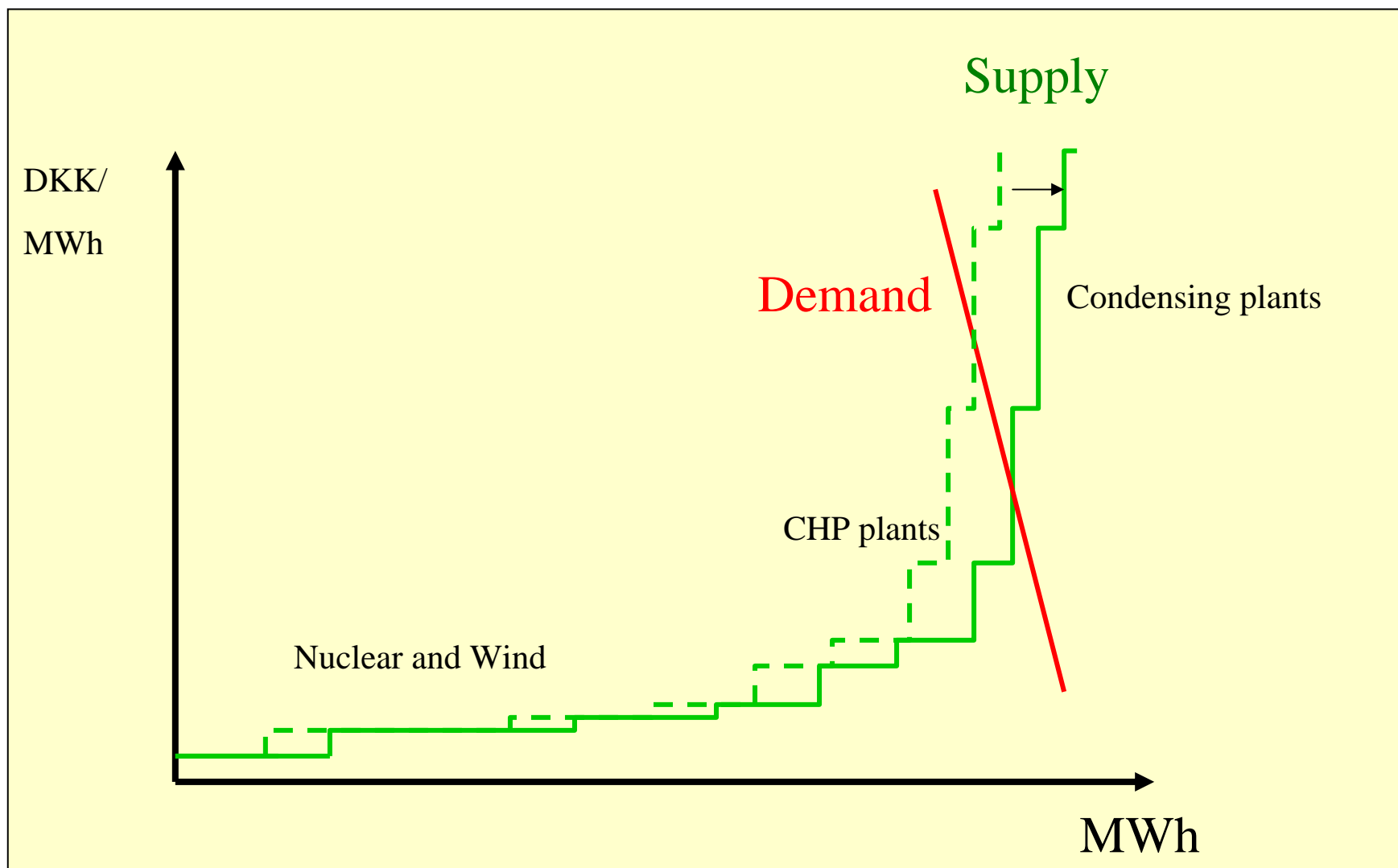
# The Consequence of Fuel price increase on Power Price



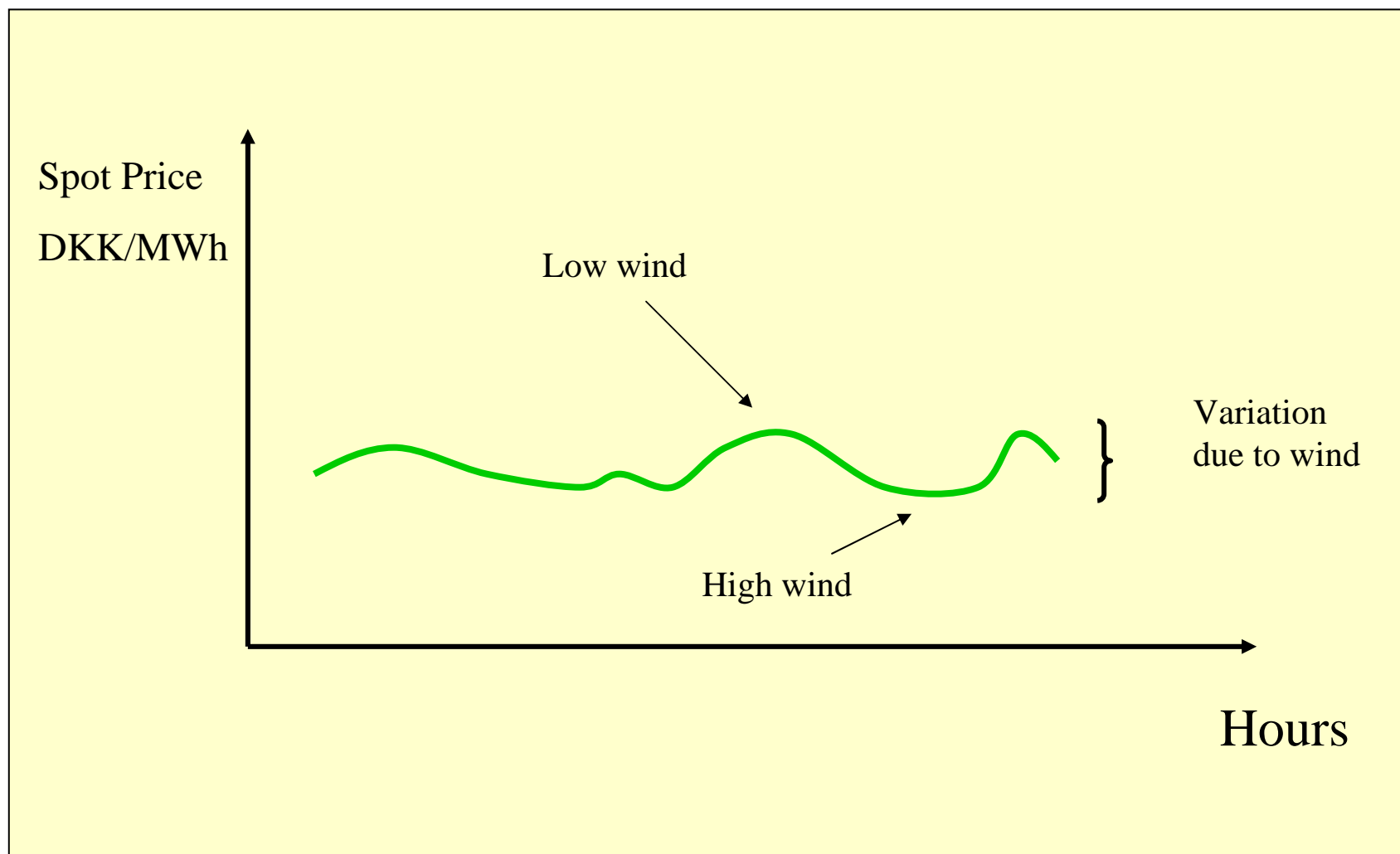
## Where are we now?

- **Price volatility increases the risk for investors**
  - Wind Power constitutes a firm component in the Power Industries' portfolio
  - However low fuel prices might imply losses for wind power investments
  
- **ETS market will not by itself generate the needed economic incentives for large scale deployment of wind power**
  - Specific support schemes are needed
  - The closer we relate support to the power market price the higher will be the required risk premium to investors

# Determination of the Power Price, when the wind is high

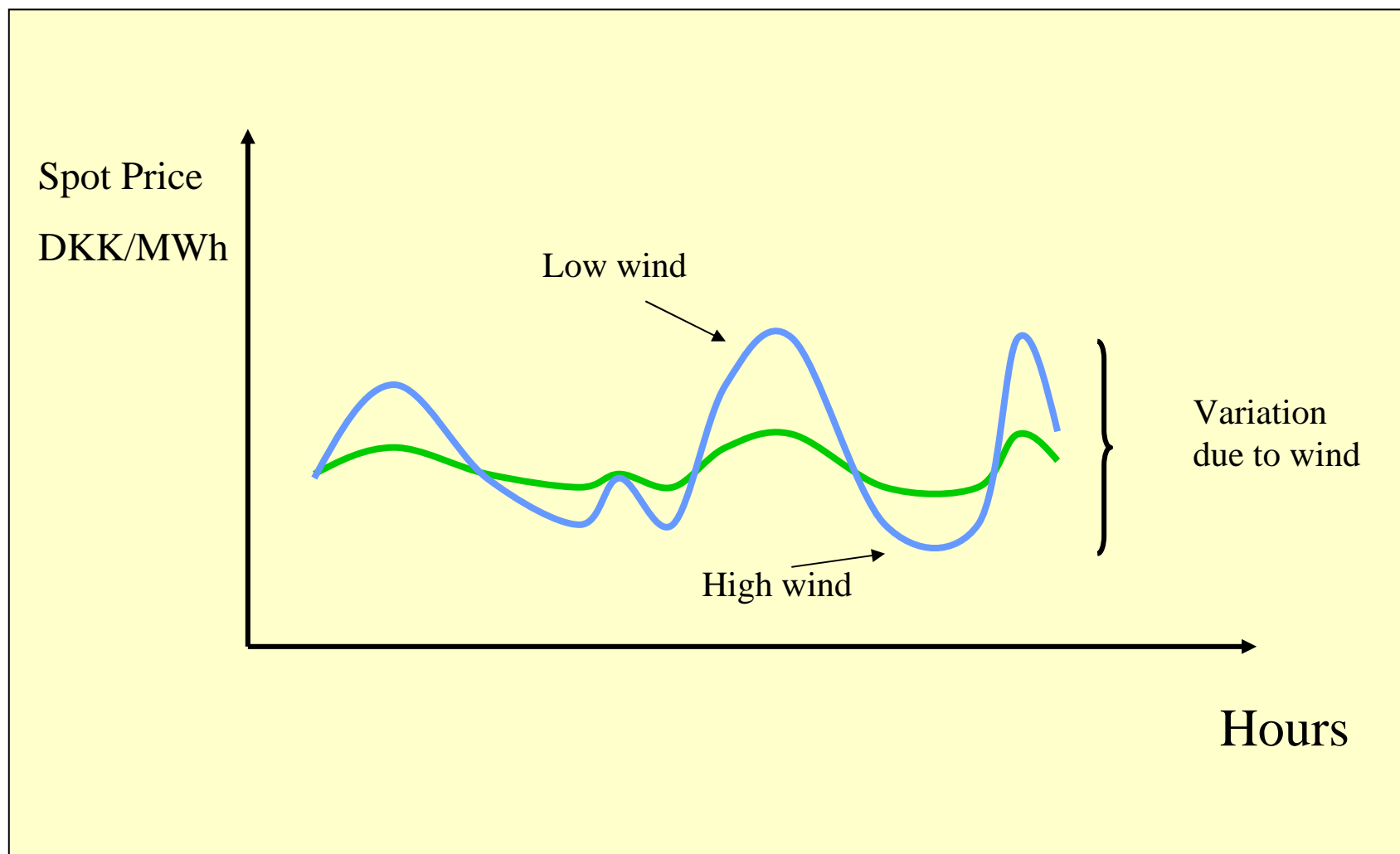


# Wind Power and Spot Prices – at present

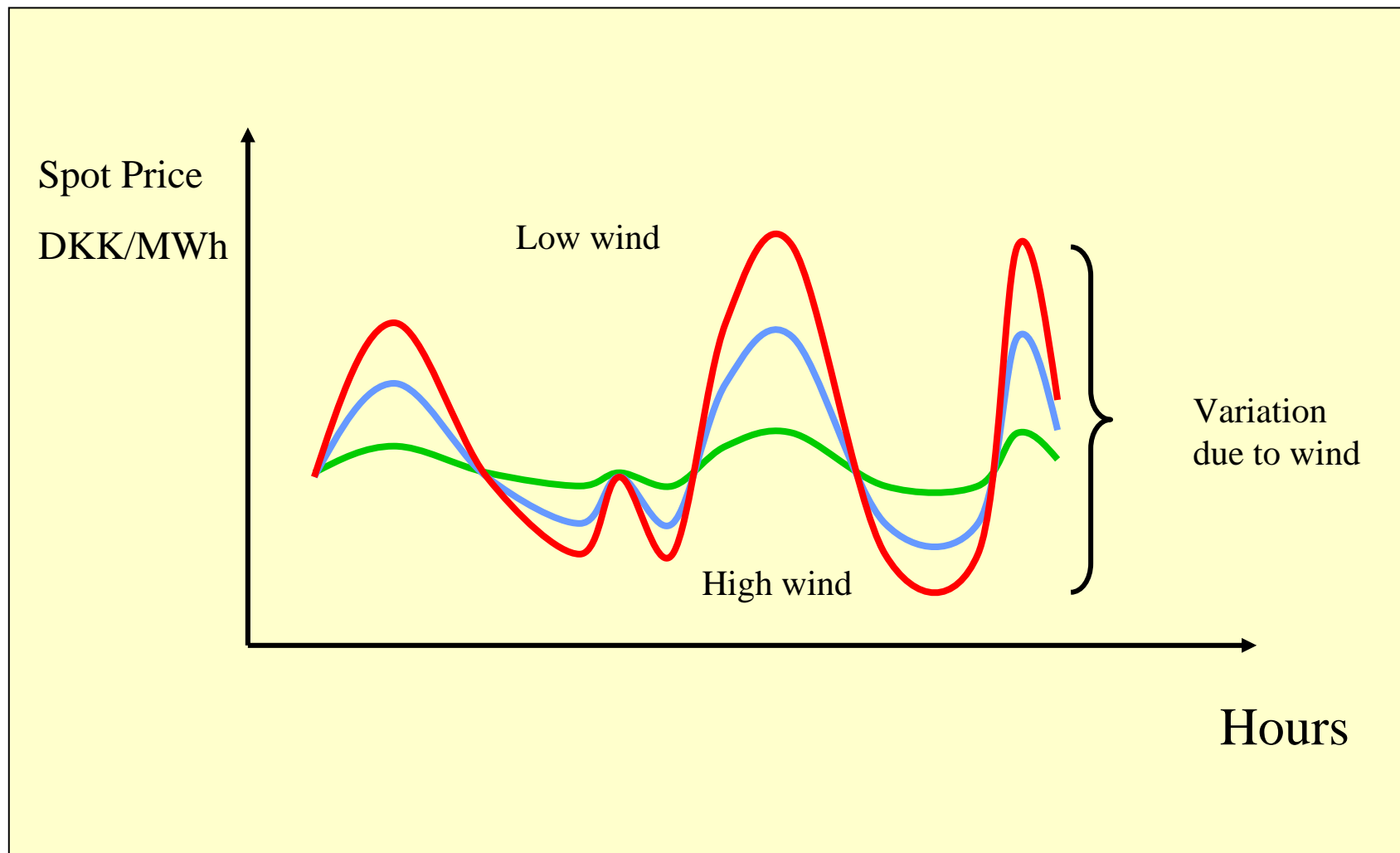




# Wind Power and Spot Prices – high penetration of wind power



# Wind Power and Spot Prices – very high penetration of wind power

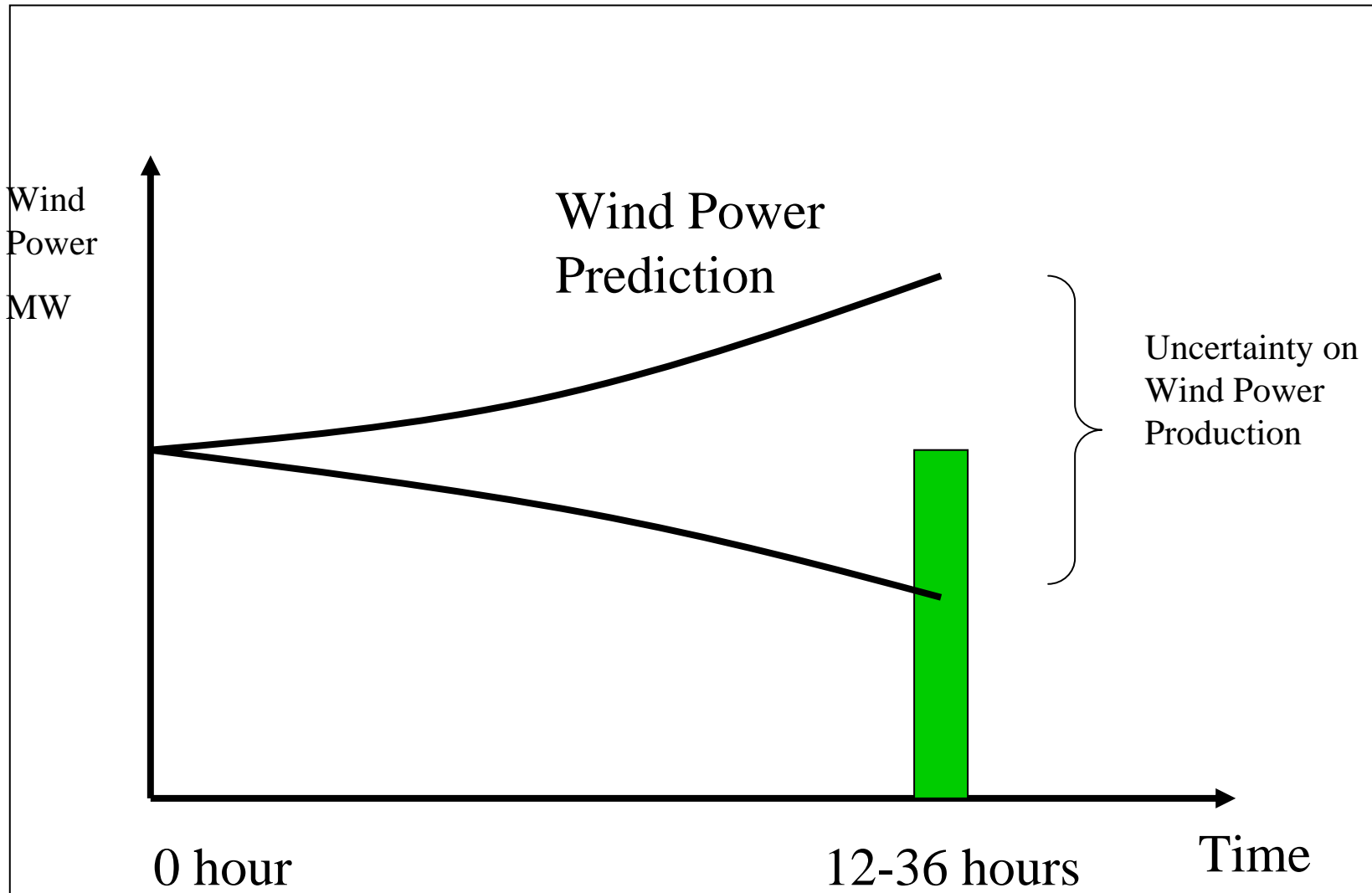


## A Market Problem?

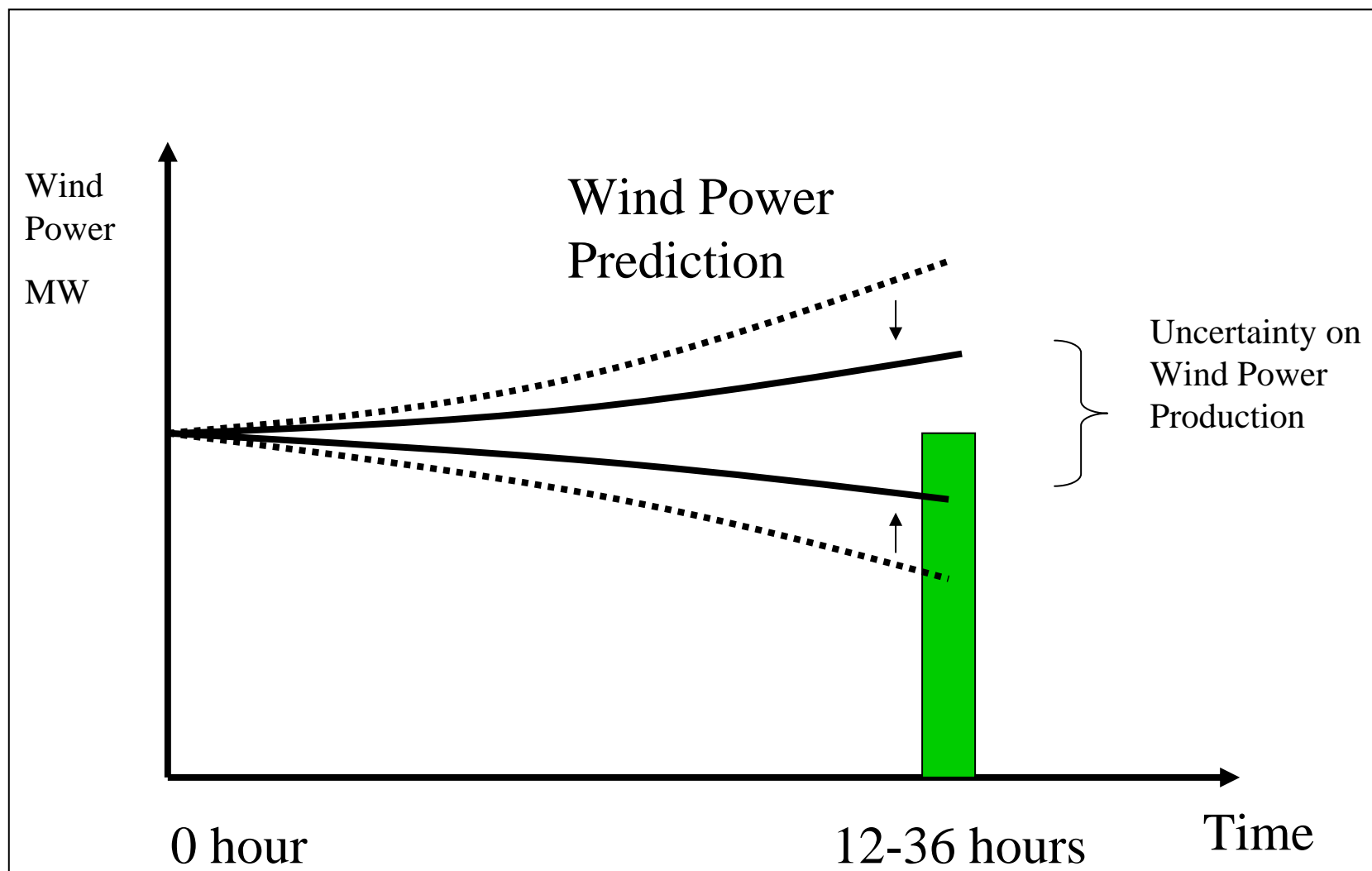
### **Will the market initiate the necessary investments in new capacity and storage facilities?**

- More transmission capacity to other countries
- New domestic capacity, preferably fast reacting natural gas combined cycle plants or gas turbines
- Medium term storage facilities (batteries, hydrogen etc.)
- Medium term possibilities for switching off power consumption at selected locations

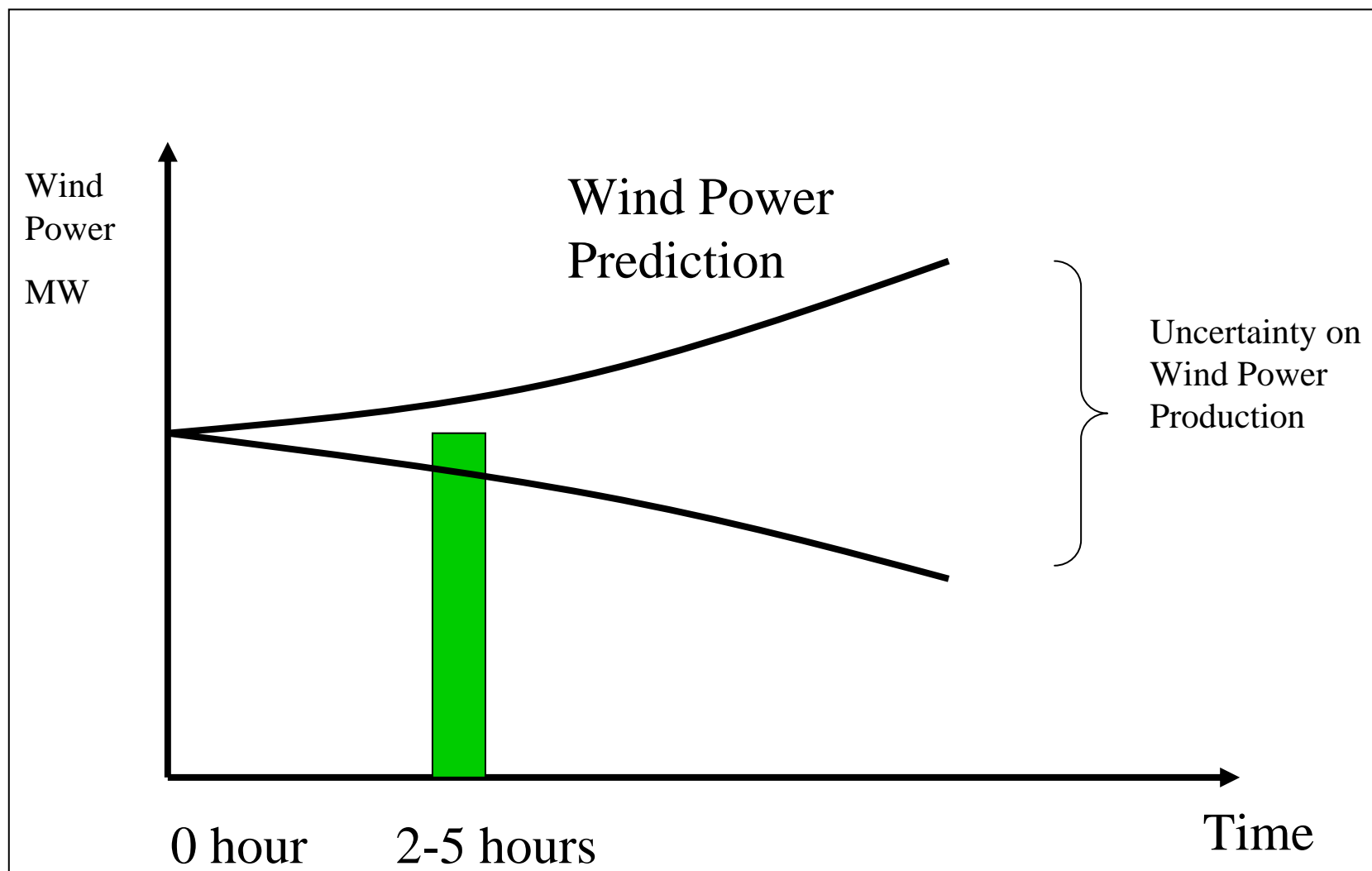
# The Importance of Wind Power Fulfilling its Bid



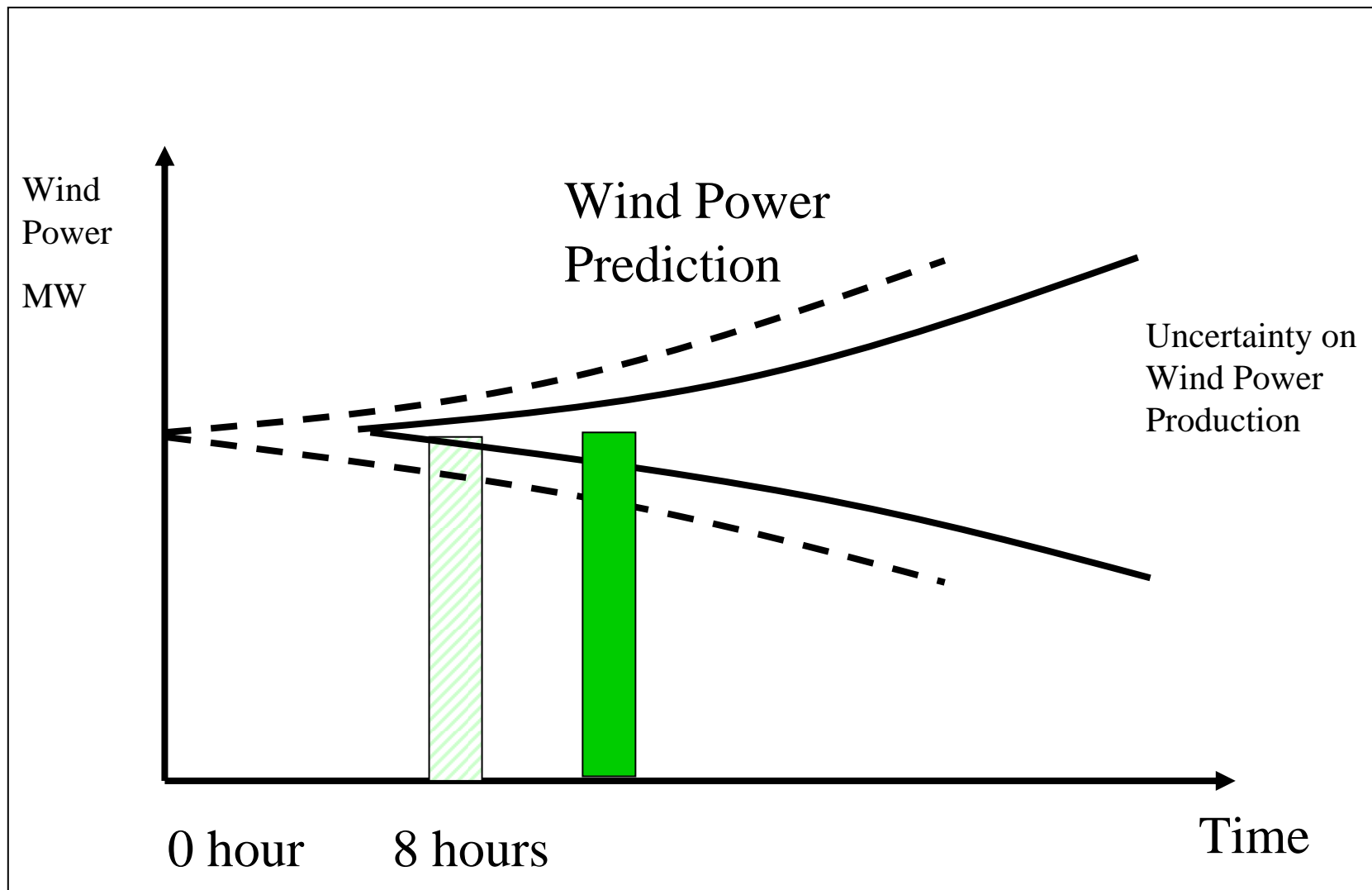
# Better Predictions



# Shorter bidding periods



# Continuously bidding



## Conclusions

- **Wind power is going to be a significant part of the future energy system**
  - 1% of Global electricity consumption today – 25% in 2050
- **Price volatility on fuel markets might increase the risk premium for investments in wind power in the short term**
- **Electricity markets are not developed to technologies with variable output**
  - In the longer term new market designs could improve the integration of wind power