



## The economics of wind power. Status and future perspectives

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*Publication date:*  
2004

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*  
Morthorst, P. E. (2004). *The economics of wind power. Status and future perspectives*. Abstract from 2004 European Wind Energy Conference and Exhibition, London, United Kingdom.

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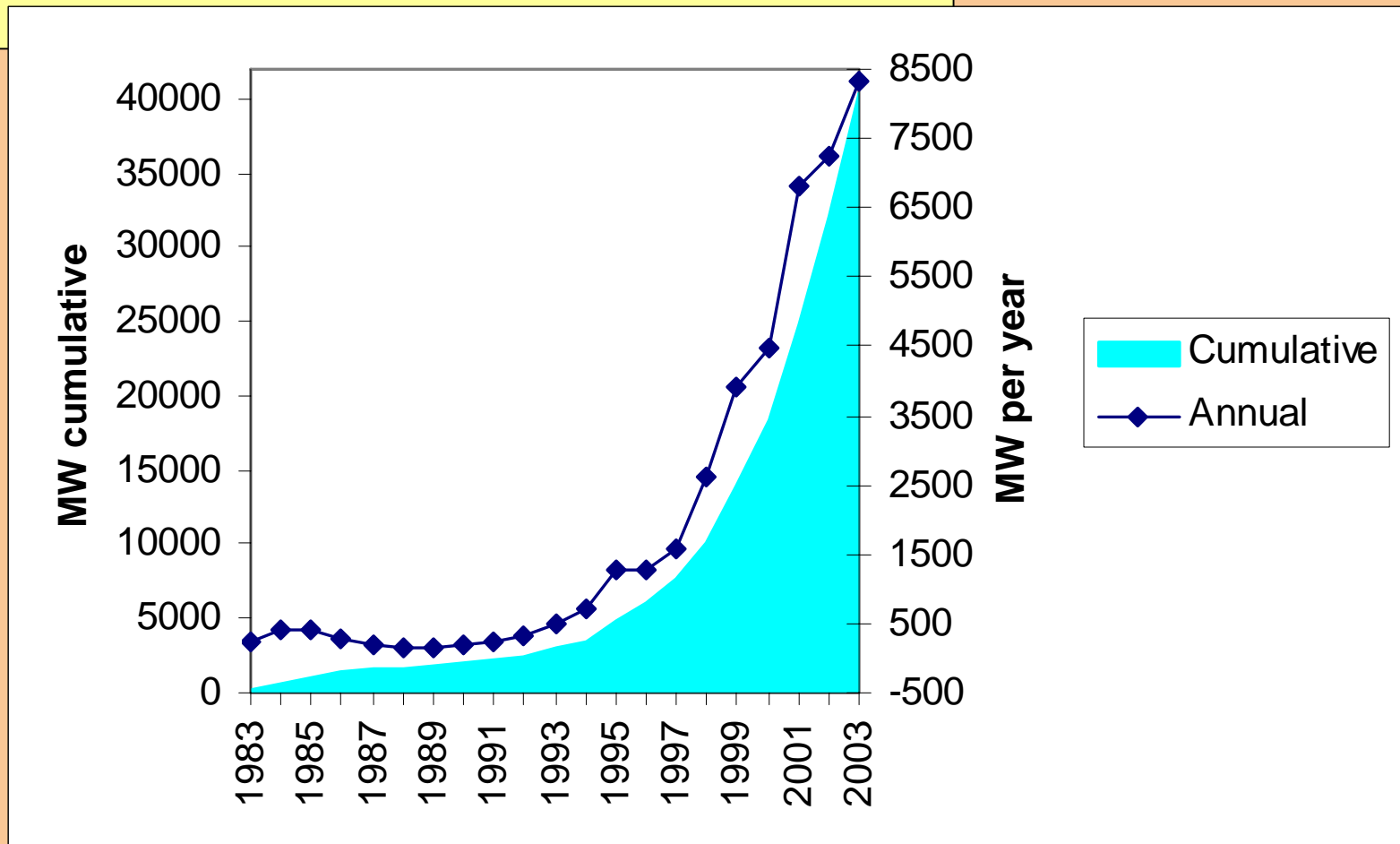
# The Economics of Wind Power

Status and future perspectives

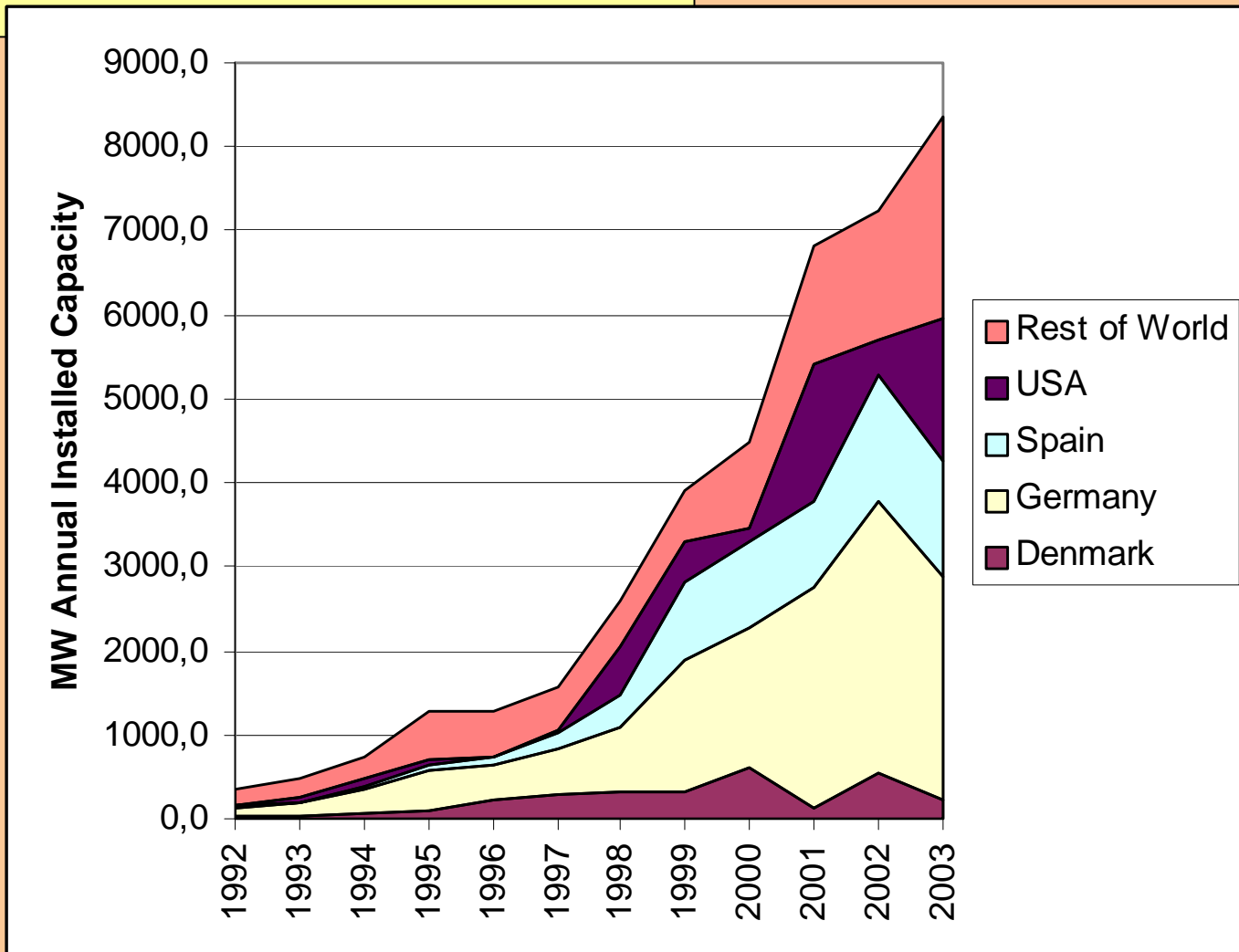


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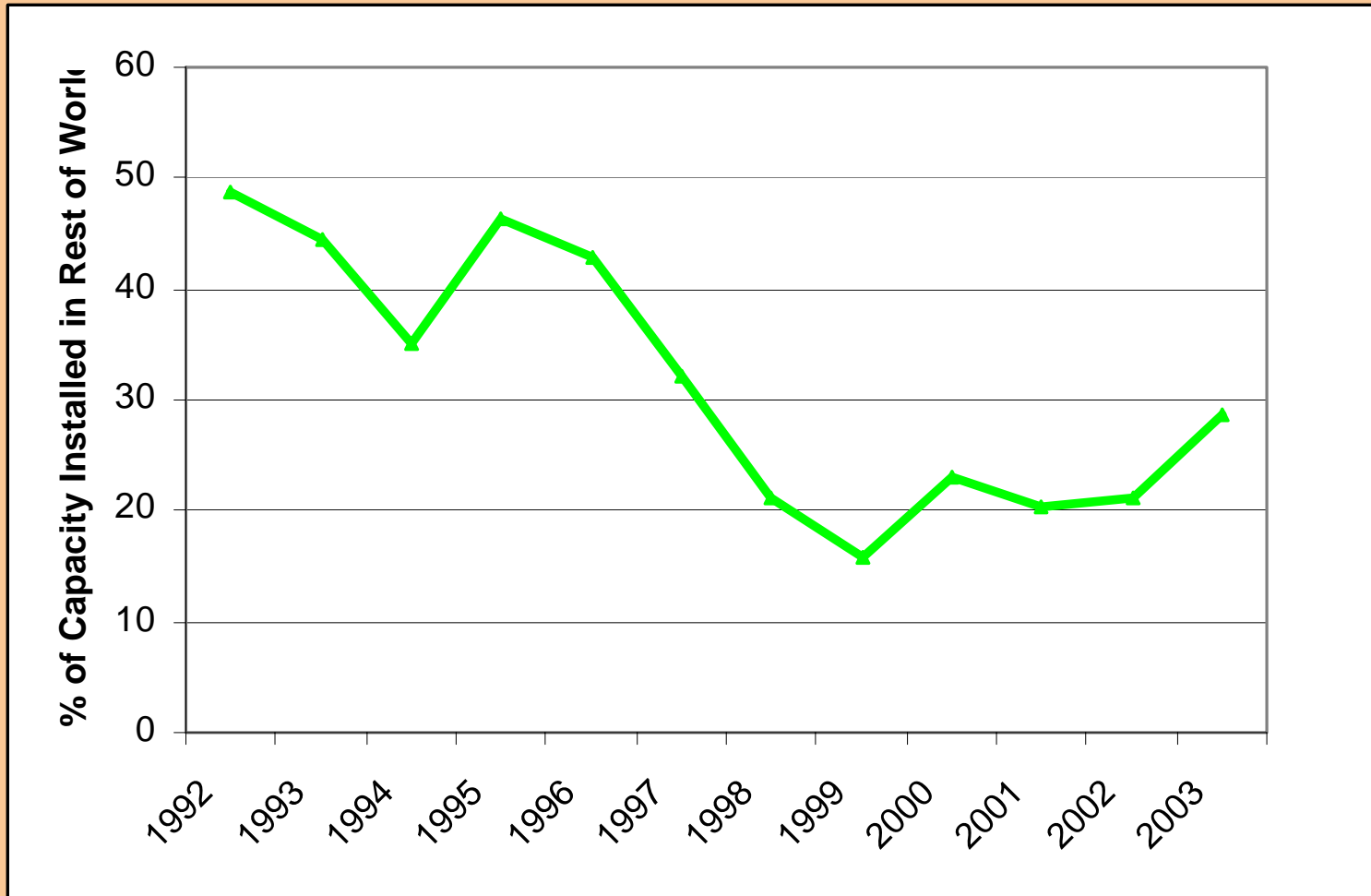
# Global development of wind power



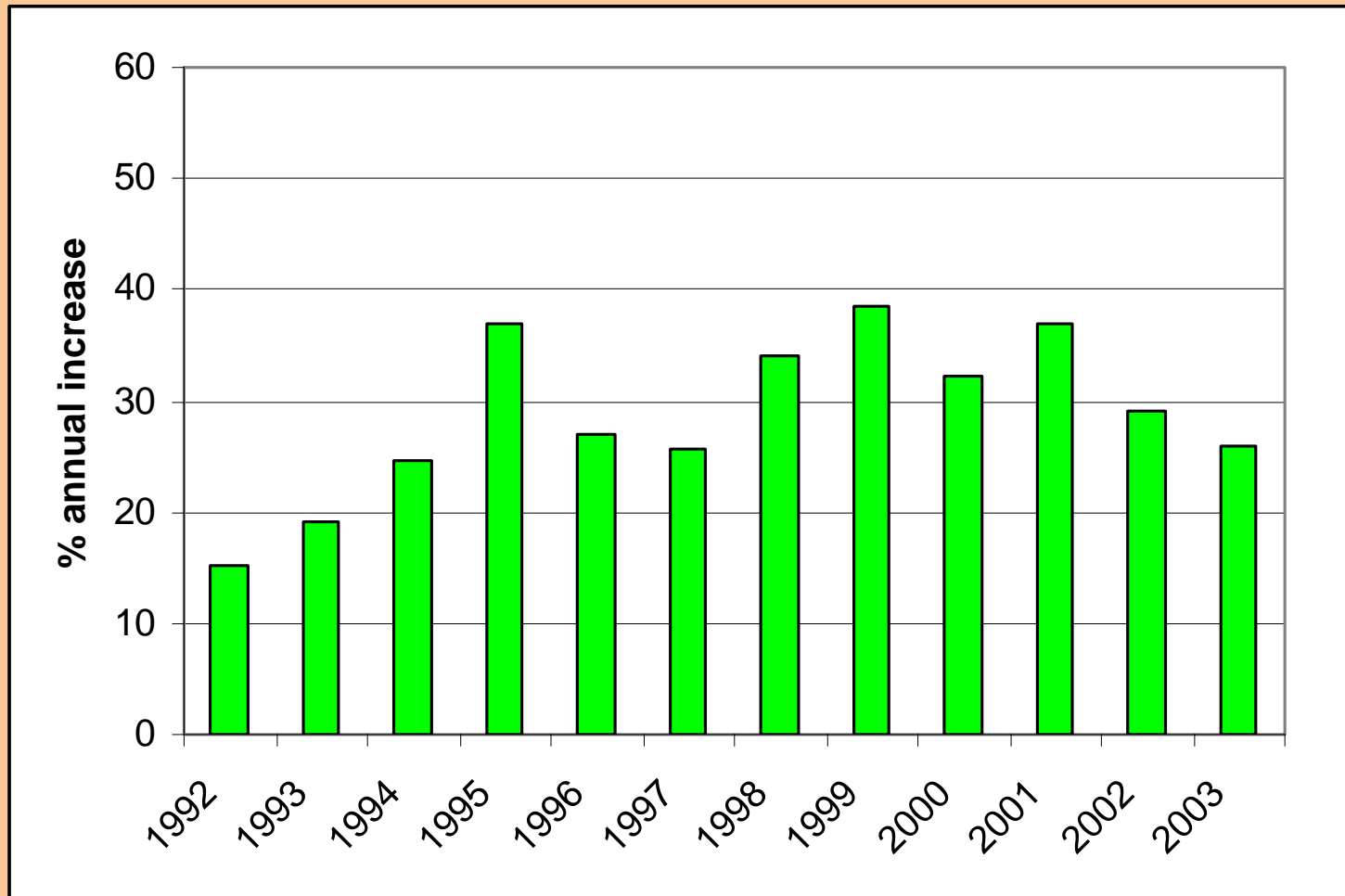
# A Few Countries Dominating



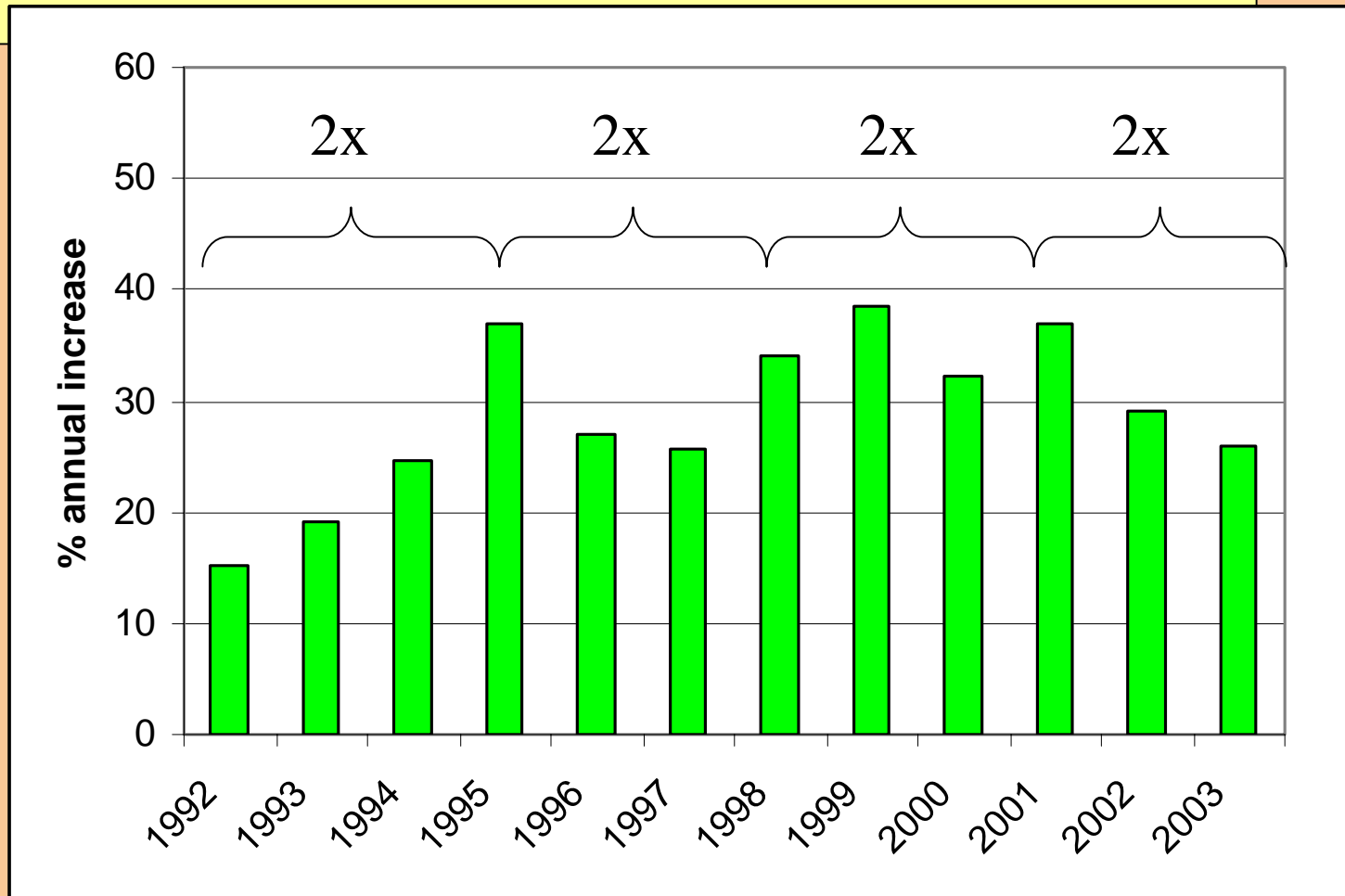
# Increasing Share of Annual Installed Capacity to "Rest of the World"



## Total Accumulated Capacity Increase per Year



## Capacity Doubling approximately each Third Year



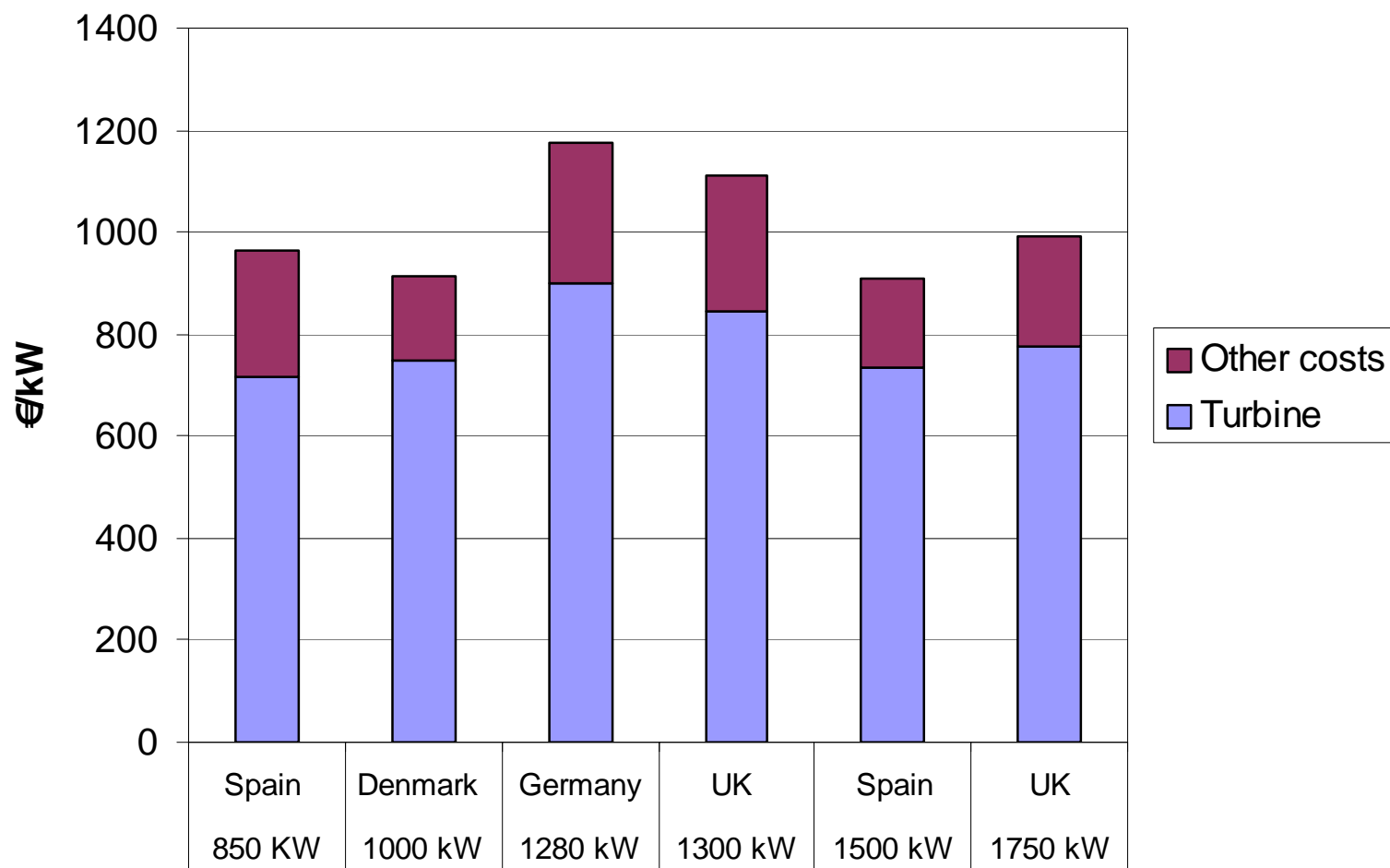
## The main economic parameters

The main parameters governing wind power economics include the following:

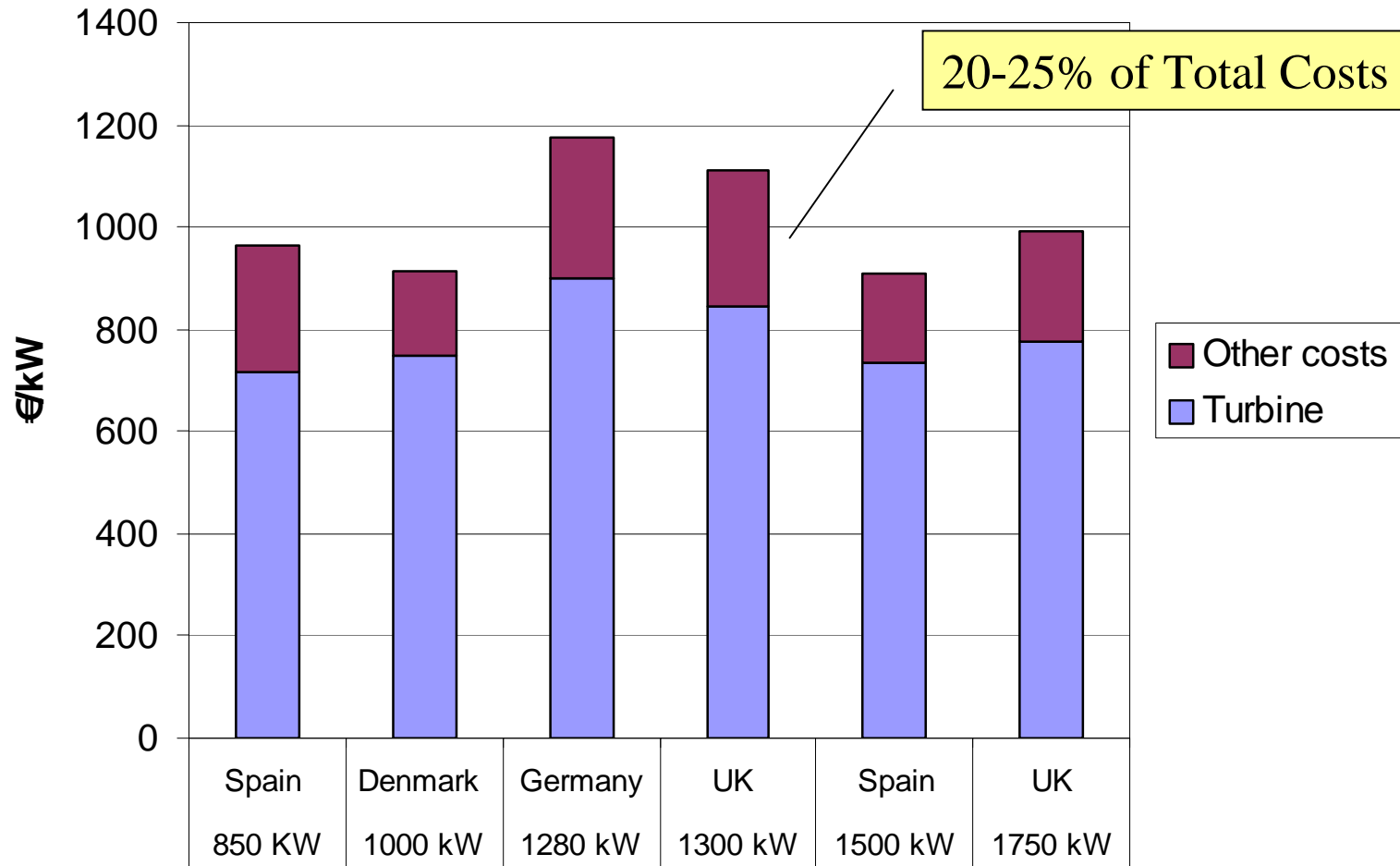
- Investment costs, including auxiliary costs for foundation, grid-connection, and so on.
- Operation and maintenance costs
- Electricity production / average wind speed
- Turbine lifetime
- Discount rate



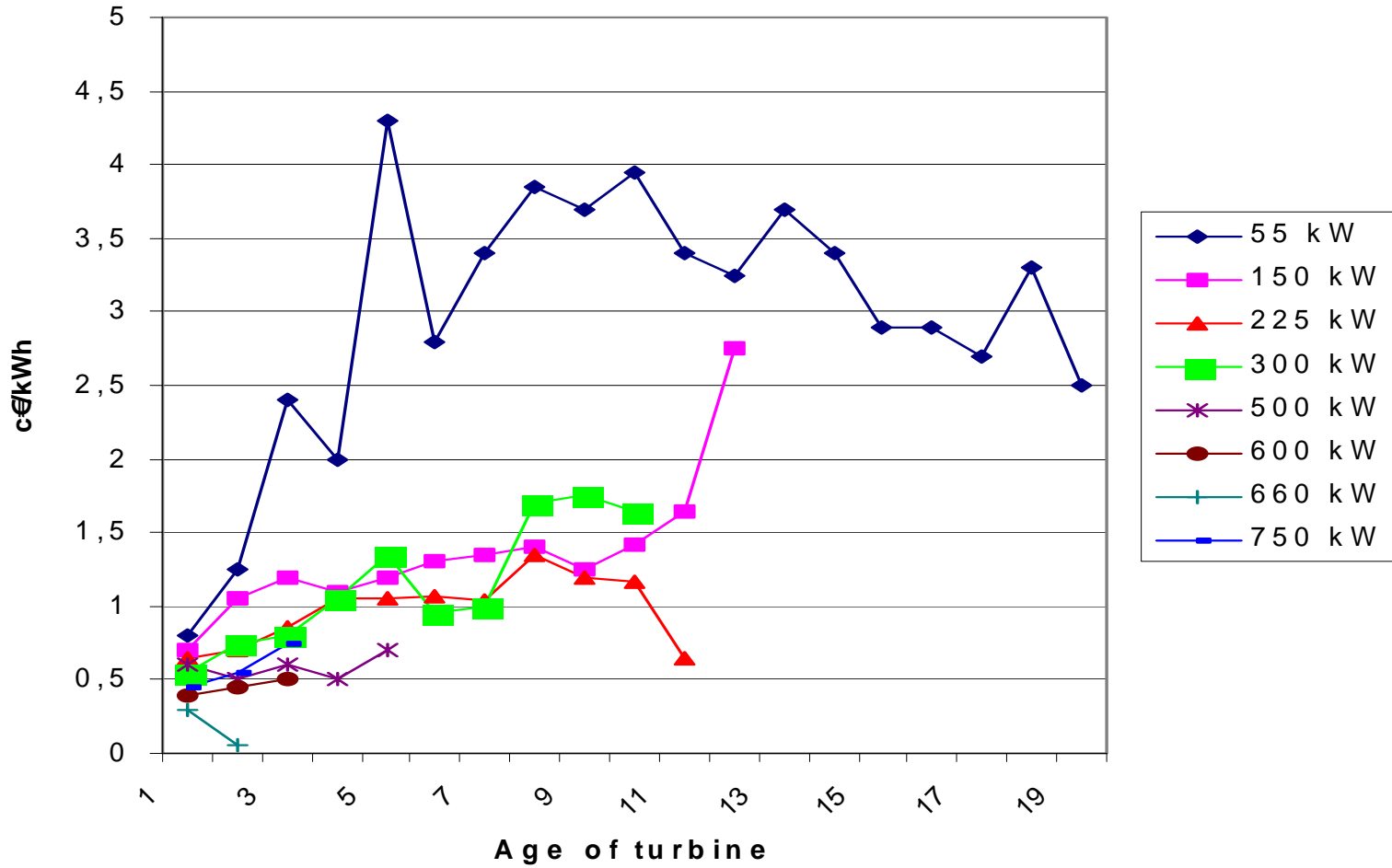
## Investment Costs per kW



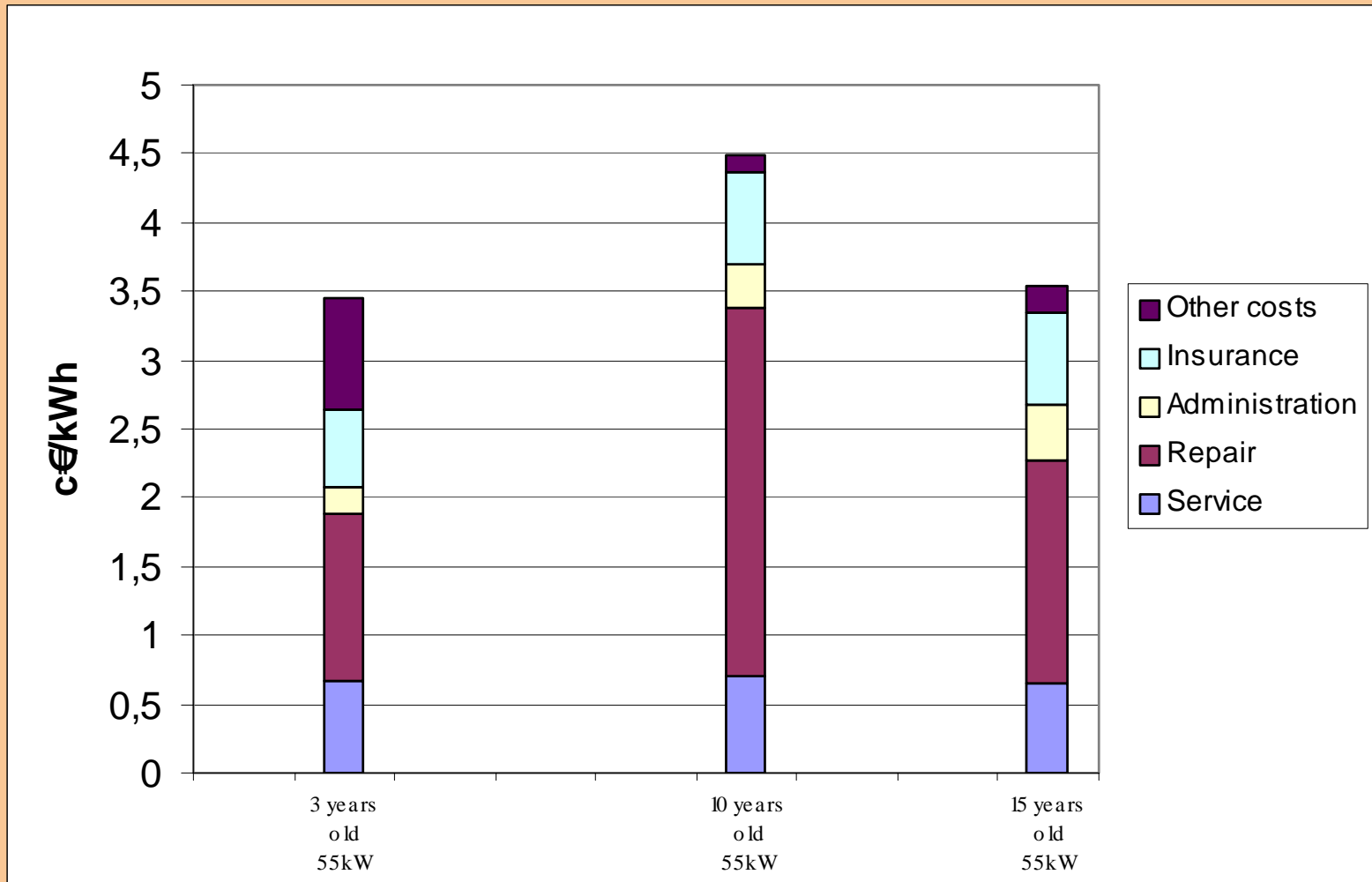
# Investment Costs per kW



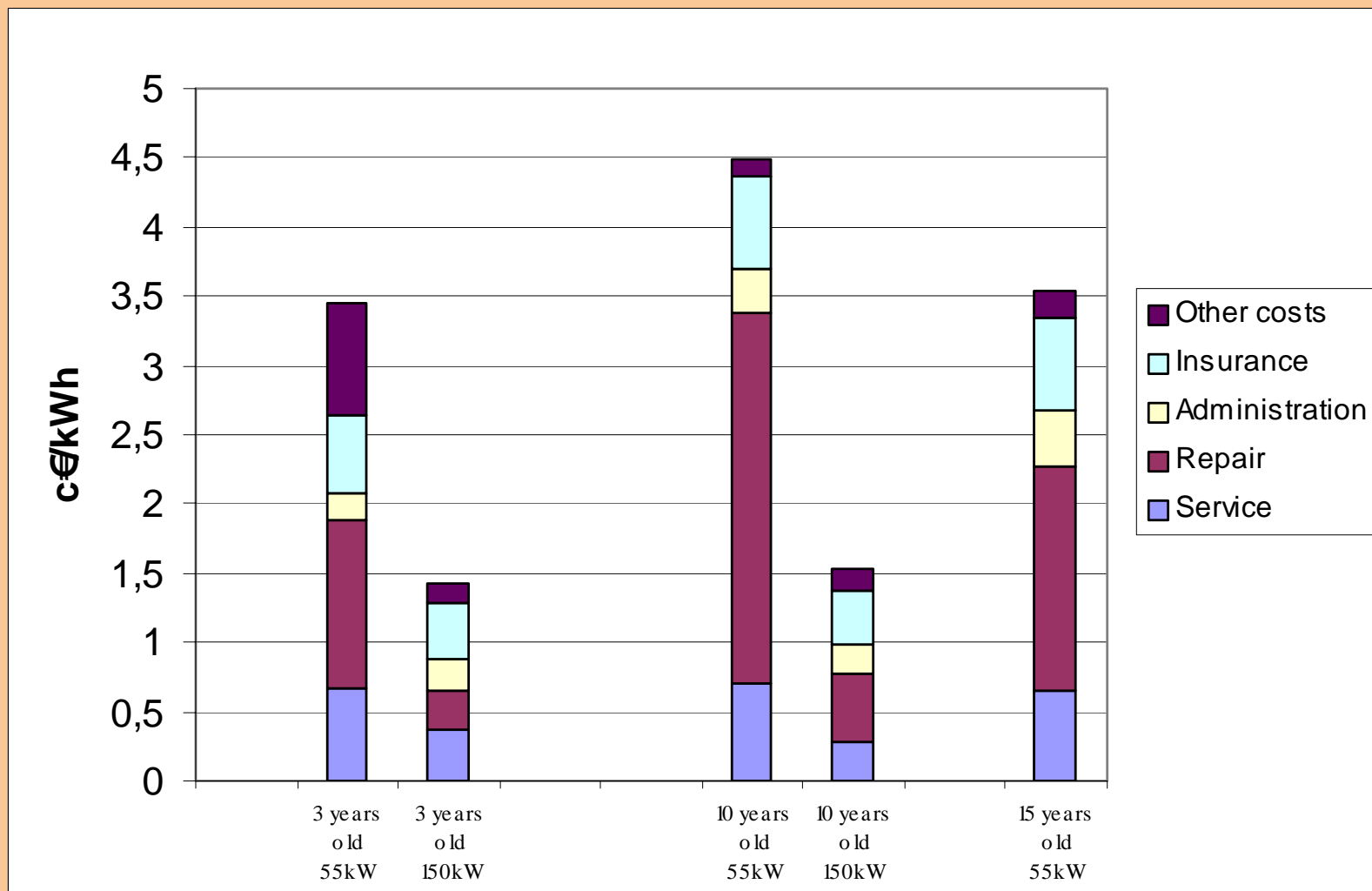
# O&M-costs



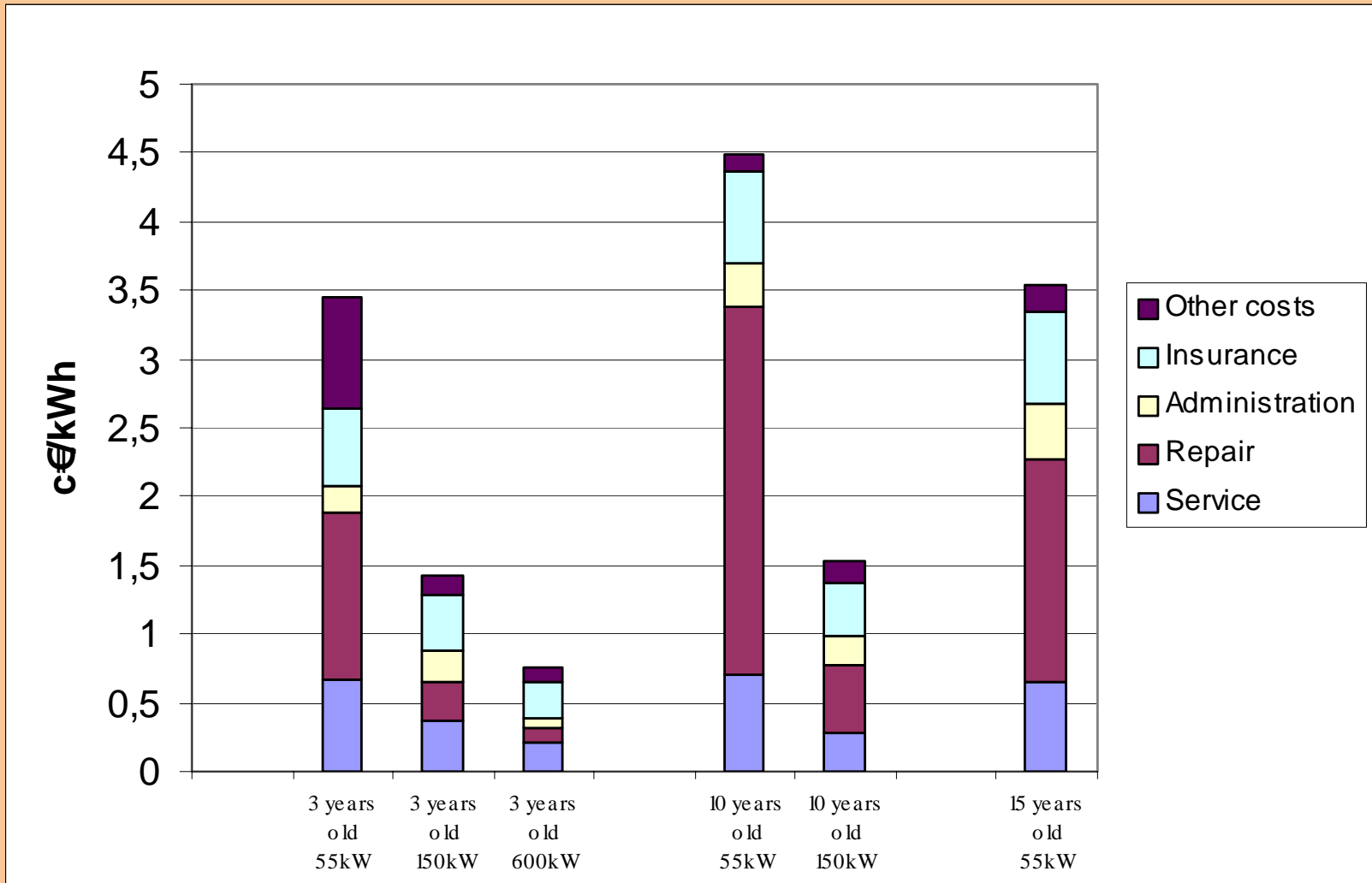
# O&M costs 55 kW



## O&M costs 55 kW and 150 kW



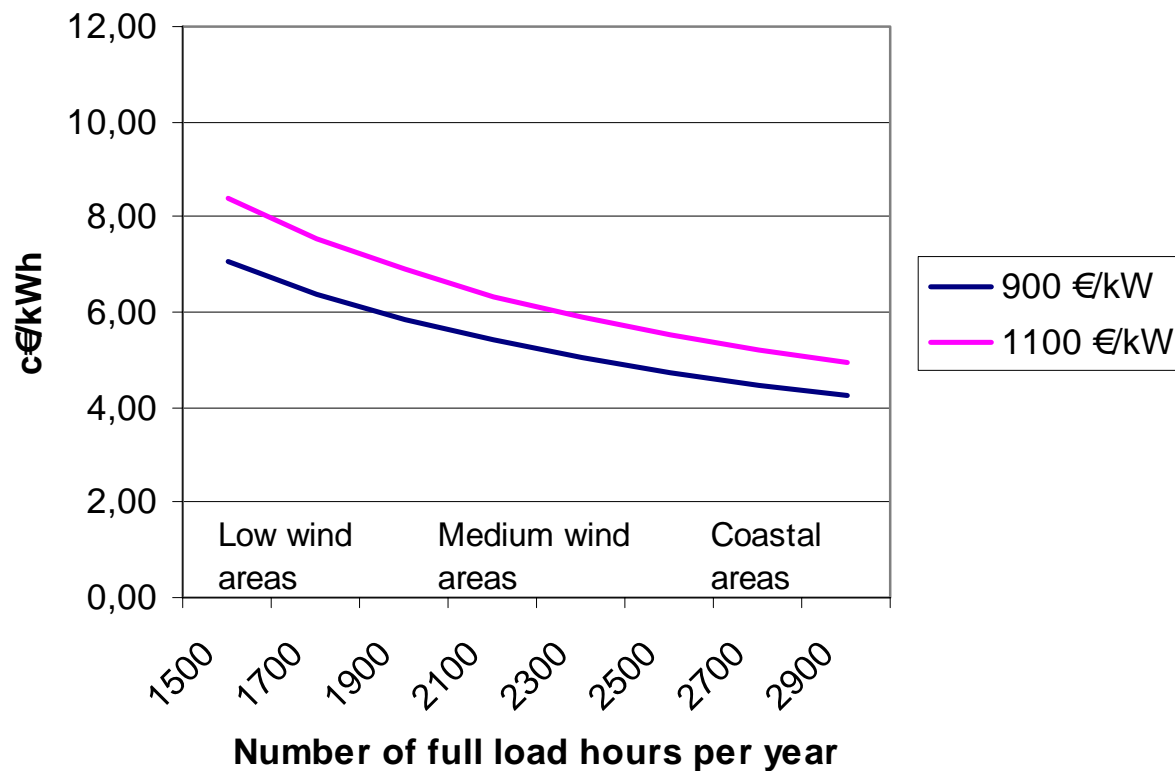
# Comparison of O&M-costs



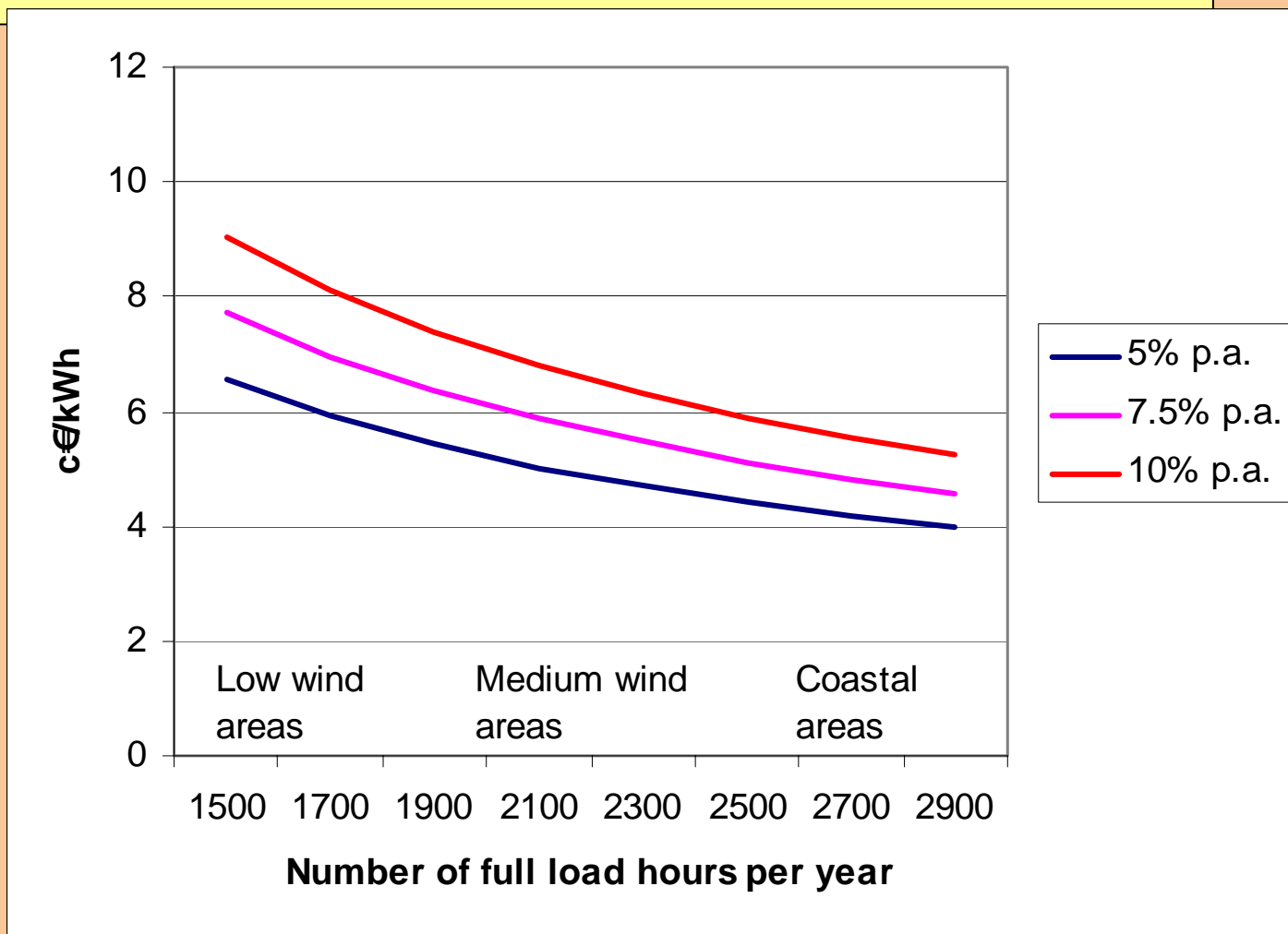
## Production Costs Depending on the Wind Regime

### Assumptions:

- Simple economic analysis – no taxes, depreciation, risk premium etc.
- O&M of 1.2 c€/kWh
- Lifetime 20 Years
- Discount rate 7.5% p.a.

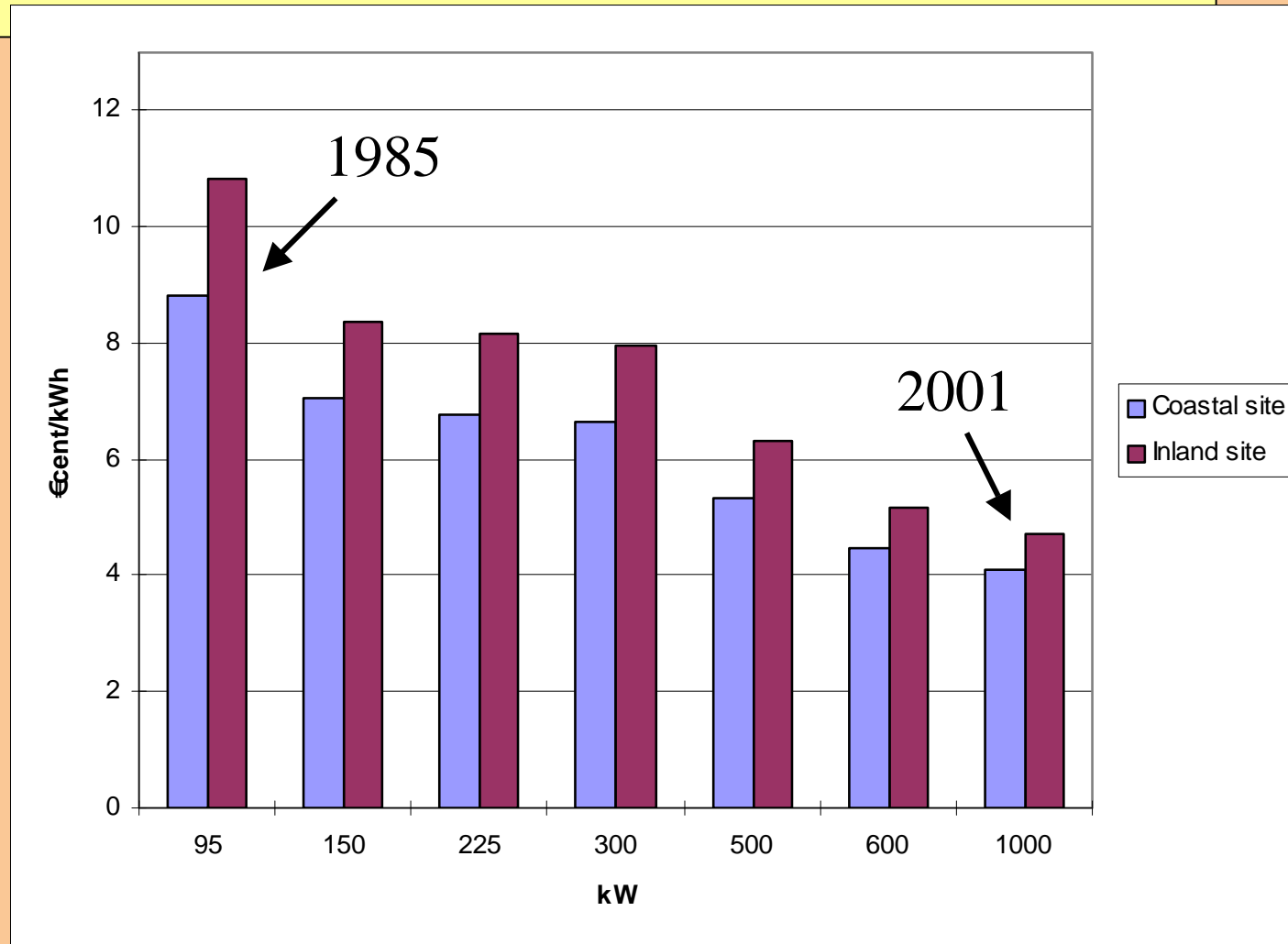


## Production Costs – Sensitivity of Discount Rate

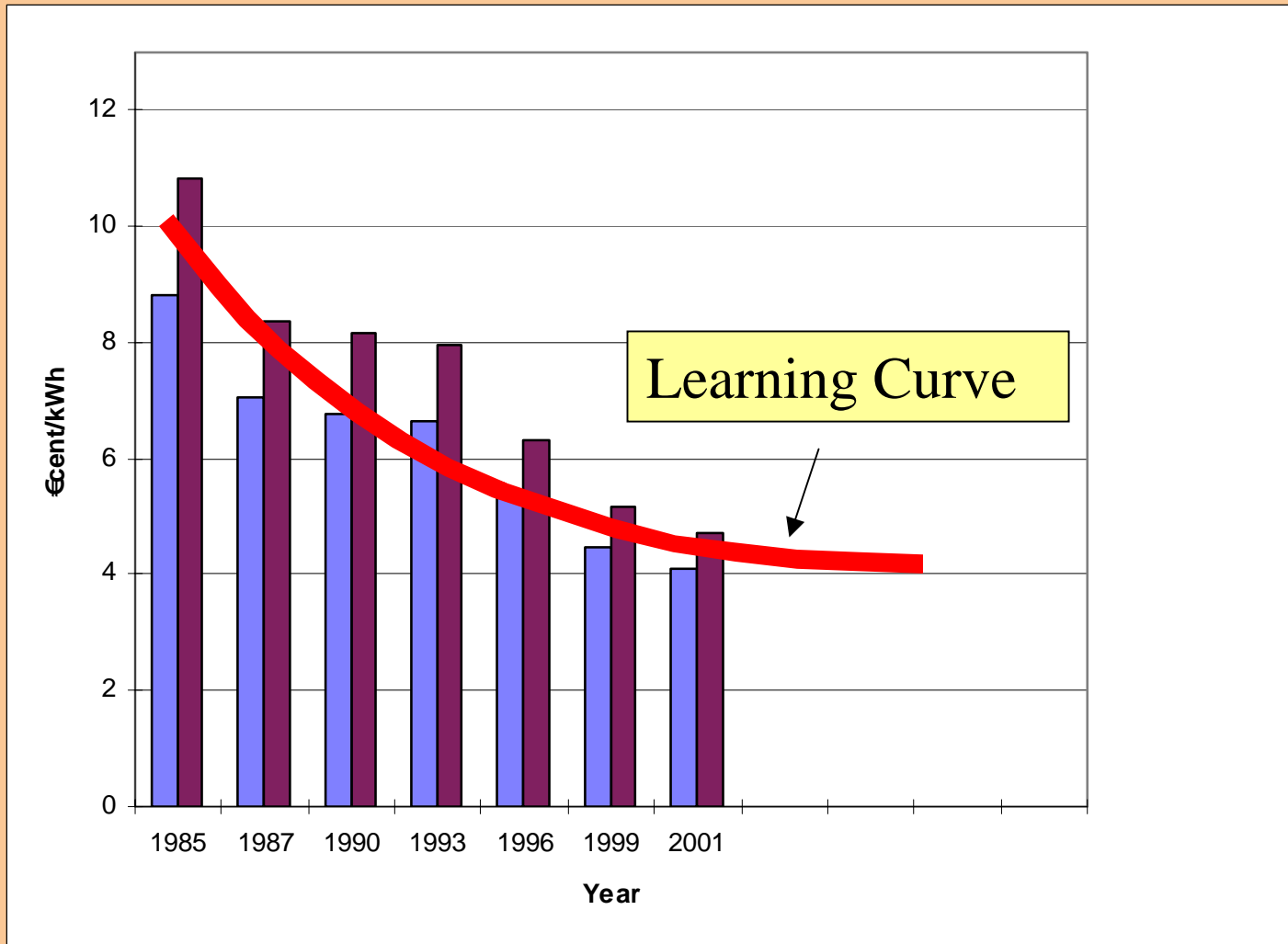




# Development of Wind Power Costs – Illustrated by the Case of Denmark



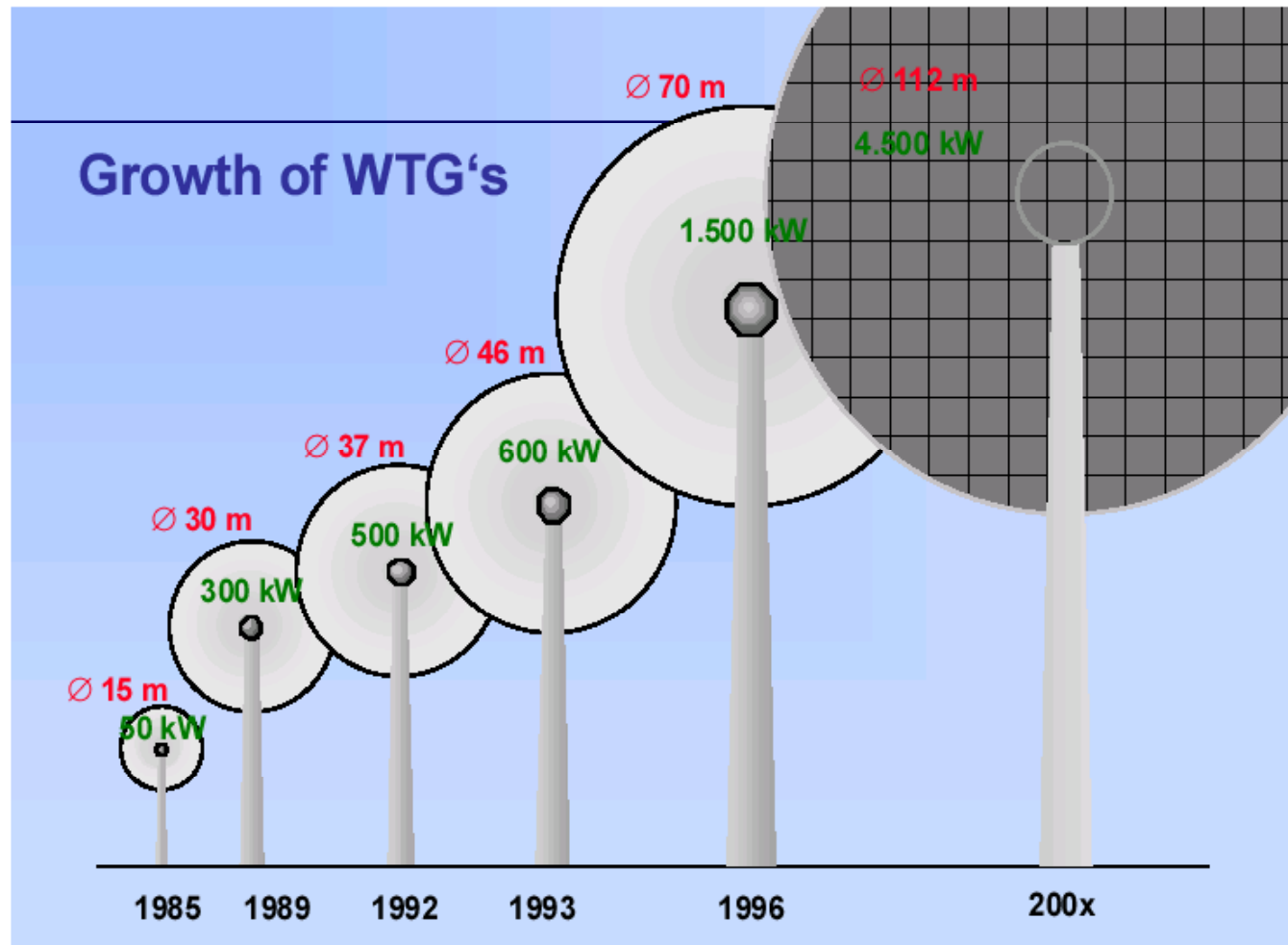
# Learning Rate for Wind Power



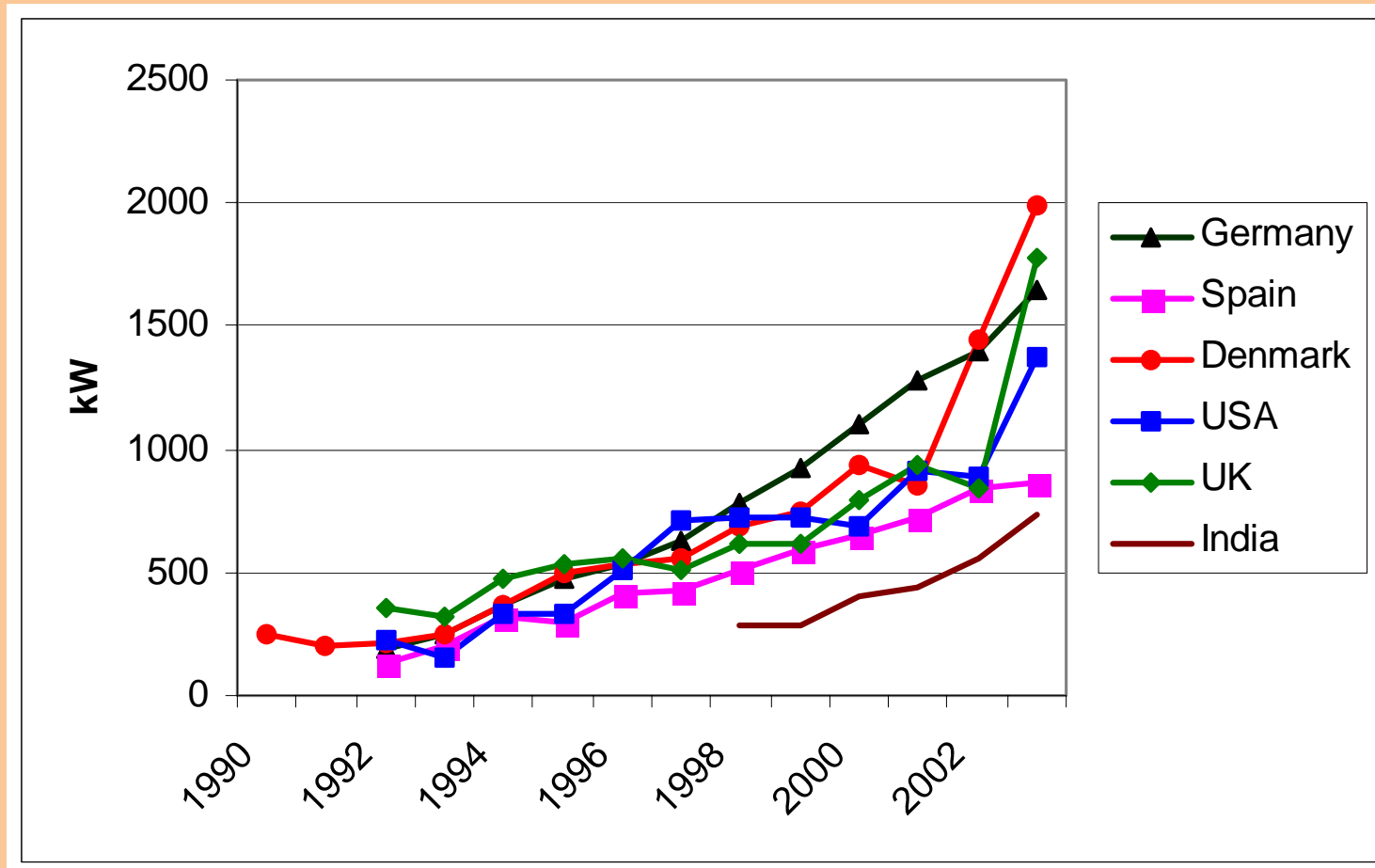
## Learning Curve Approach

- Cost reduction in relation to accumulated installed capacity
  - Simple way of looking at the cost-consequences of mass production
- EXTOOL-project
  - Excellent data for wind power
  - Learning rates between 9% and 17%
- Thus when the global capacity of wind power is doubled costs are reduced by 9 to 17% per kWh.

# Turbine size



## Average Size of Installed Turbines



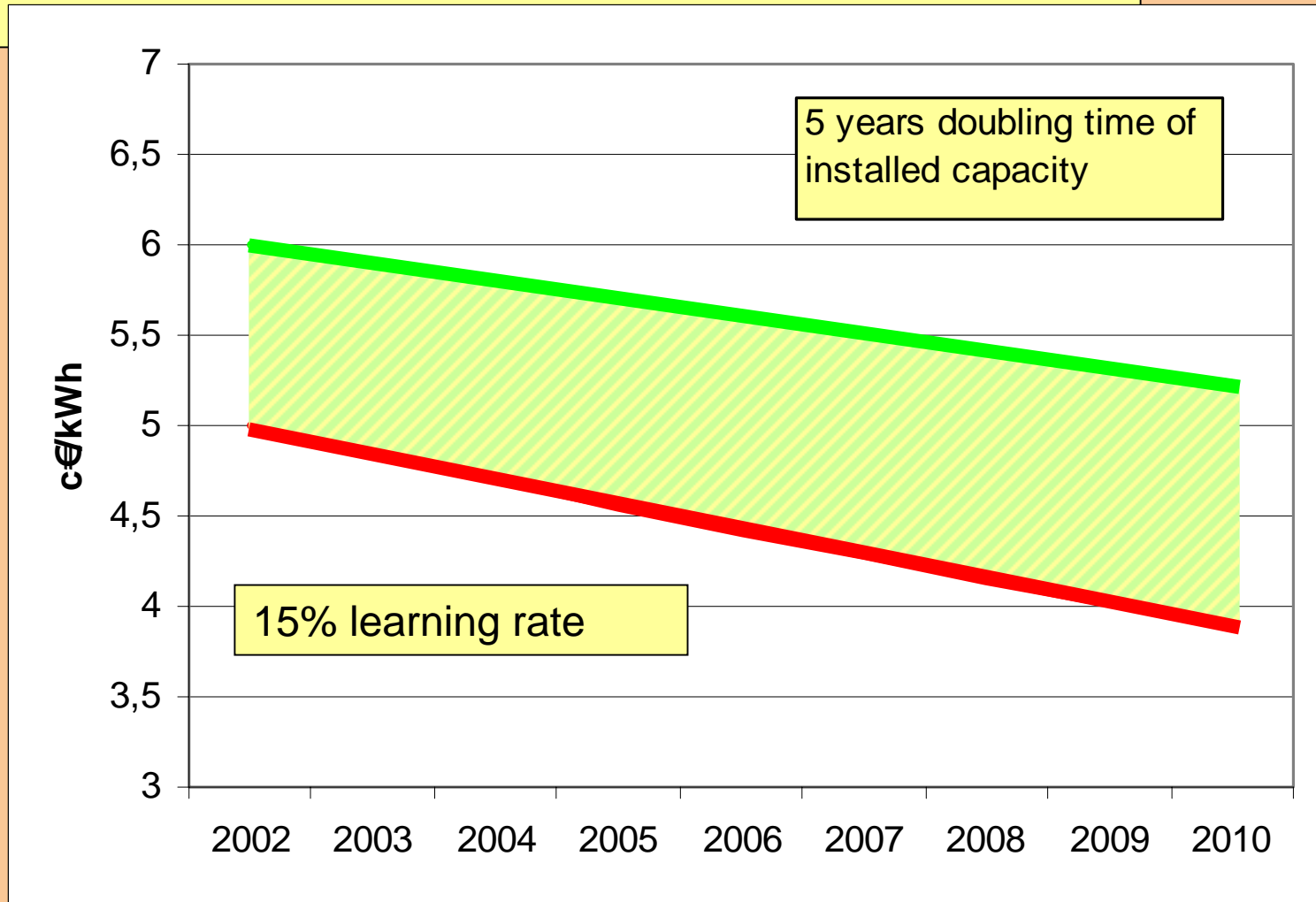
# Will up-scaling of turbines continue?

- The 5 MW machine is just about there
  - Rotor diameter of 110-120 m
- Weight is an important issue
  - The weight of nacelle and blades are relatively reduced
  - Vestas V90-3 MW has approximately the same weight as the V80-2 MW
- New materials are used in blade production
  - carbon fibres - hybrid constructions

# Significant cost reductions achieved through continued up-scaling

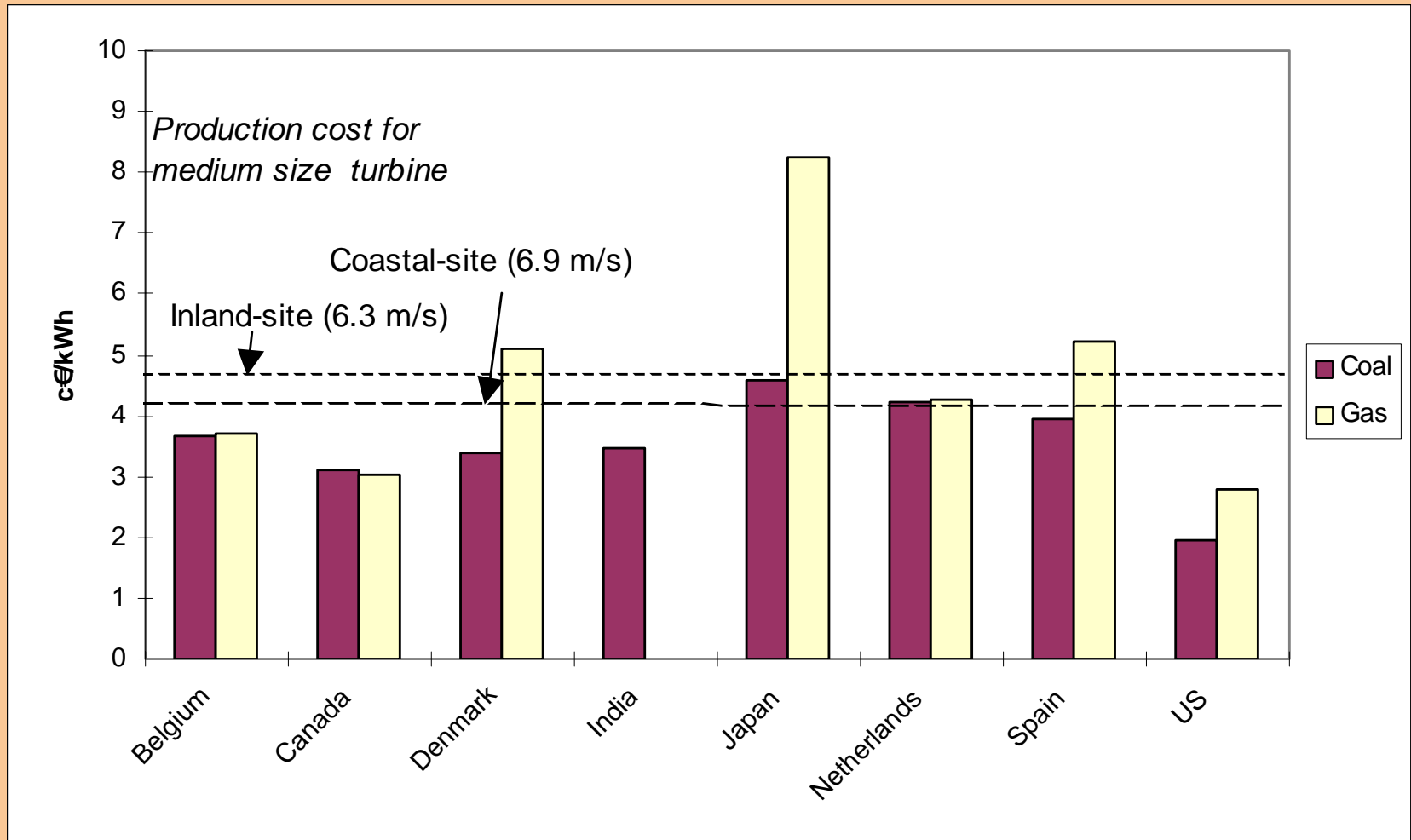
- Aerodynamic experts say no physical barriers before we are above 20 MW
- Up-scaling will continue for the next 20 years
  - 10 MW in 2010 - rotor diameter of 160 m
  - 20 MW in 2020 - rotor diameter of 220 m
- Perhaps we will see 30-40 MW machines
  - continued technological development
  - infrastructure might be the constraining factor

# Cost of Wind Power within the Next Decade Installed at a Site with Medium Wind Speed





# Cost of Conventional Power vs. Wind Power Today



## Wishful Thinking?

- Wind Power will be economic competitive with conventional power within the next decade
  - At many sites but of course depending on the wind regime
- Many uncertainties!!
  - The trees don't grow into the sky, neither will wind turbines
  - Unexpected constraints can appear
- Support Schemes are still needed, but will become more site specific
  - The risk premium will mainly depend on the kind of support scheme

## Denmark is back on the track again

- Energy Camp with more than 50 people from all over the energy sector:
  - More emphasis on renewables
  - Wind Power to cover 50% of power consumption in 2025
  - Considered to be feasible and realistic!
- The Danish Energy Authority: Wind Power is the cheapest supply option in 2015.