



The economics of wind power. Status and future perspectives

Morthorst, P.E.

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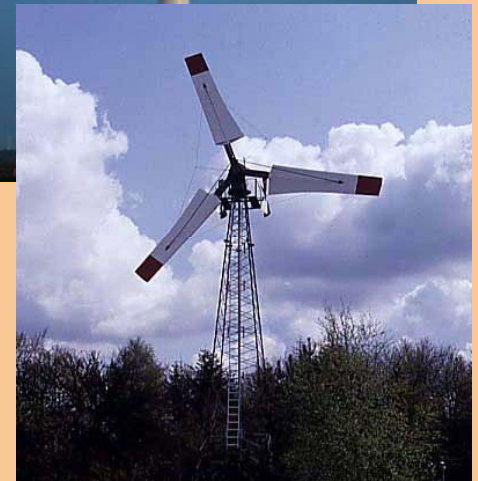
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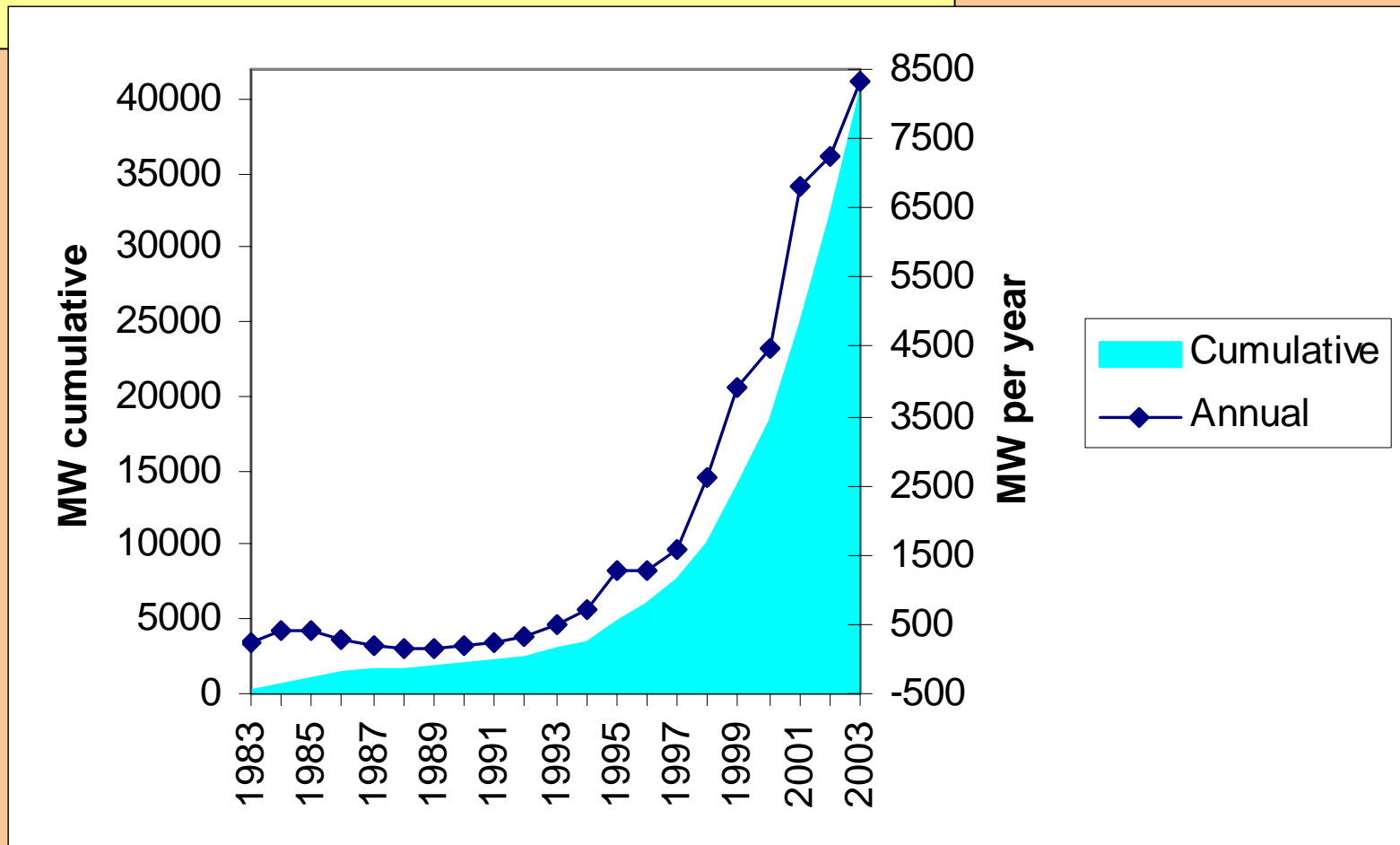
The Economics of Wind Power

Status and future perspectives

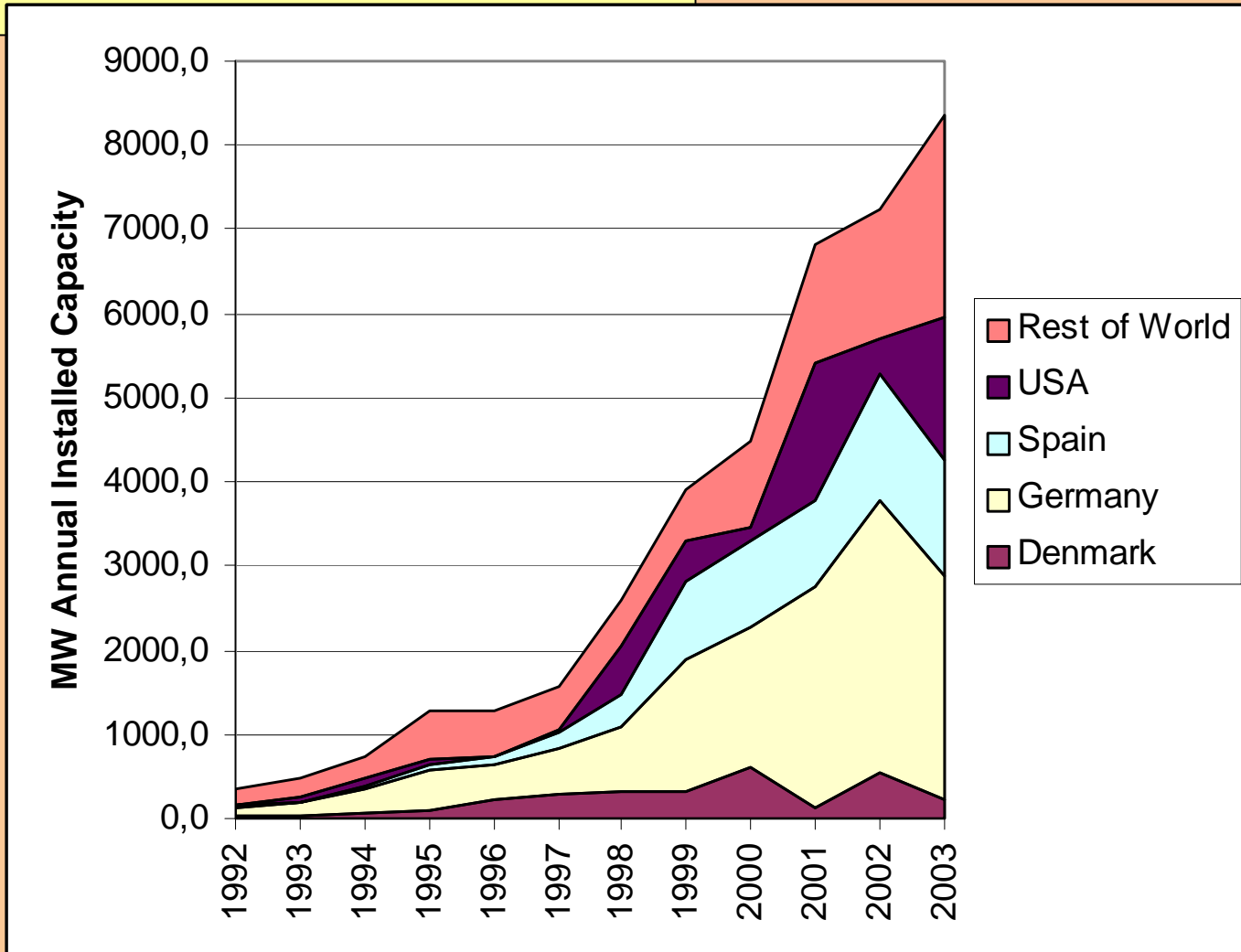


Senior Research Specialist Poul Erik Morthorst
Risø National Laboratory

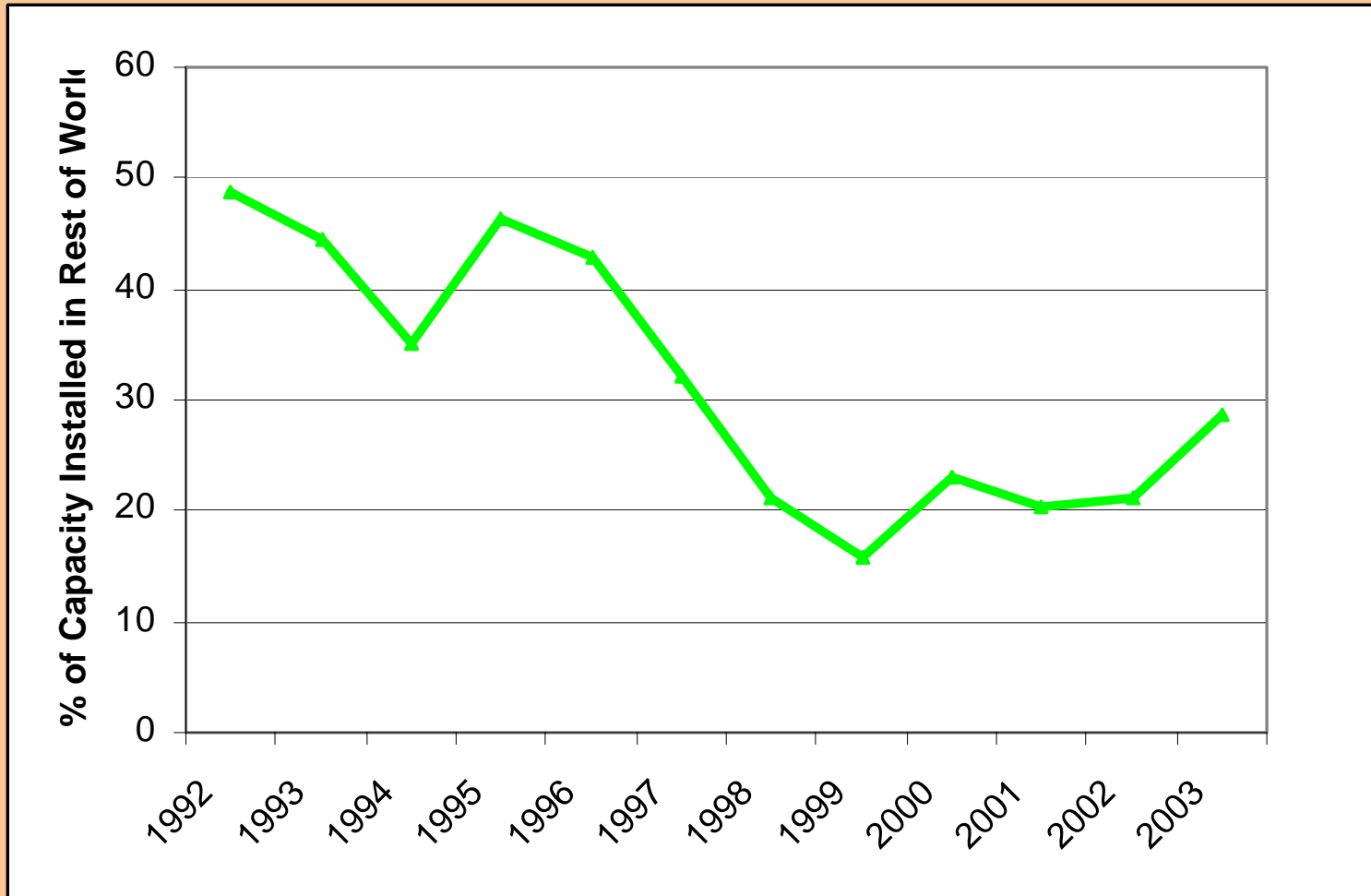
Global development of wind power



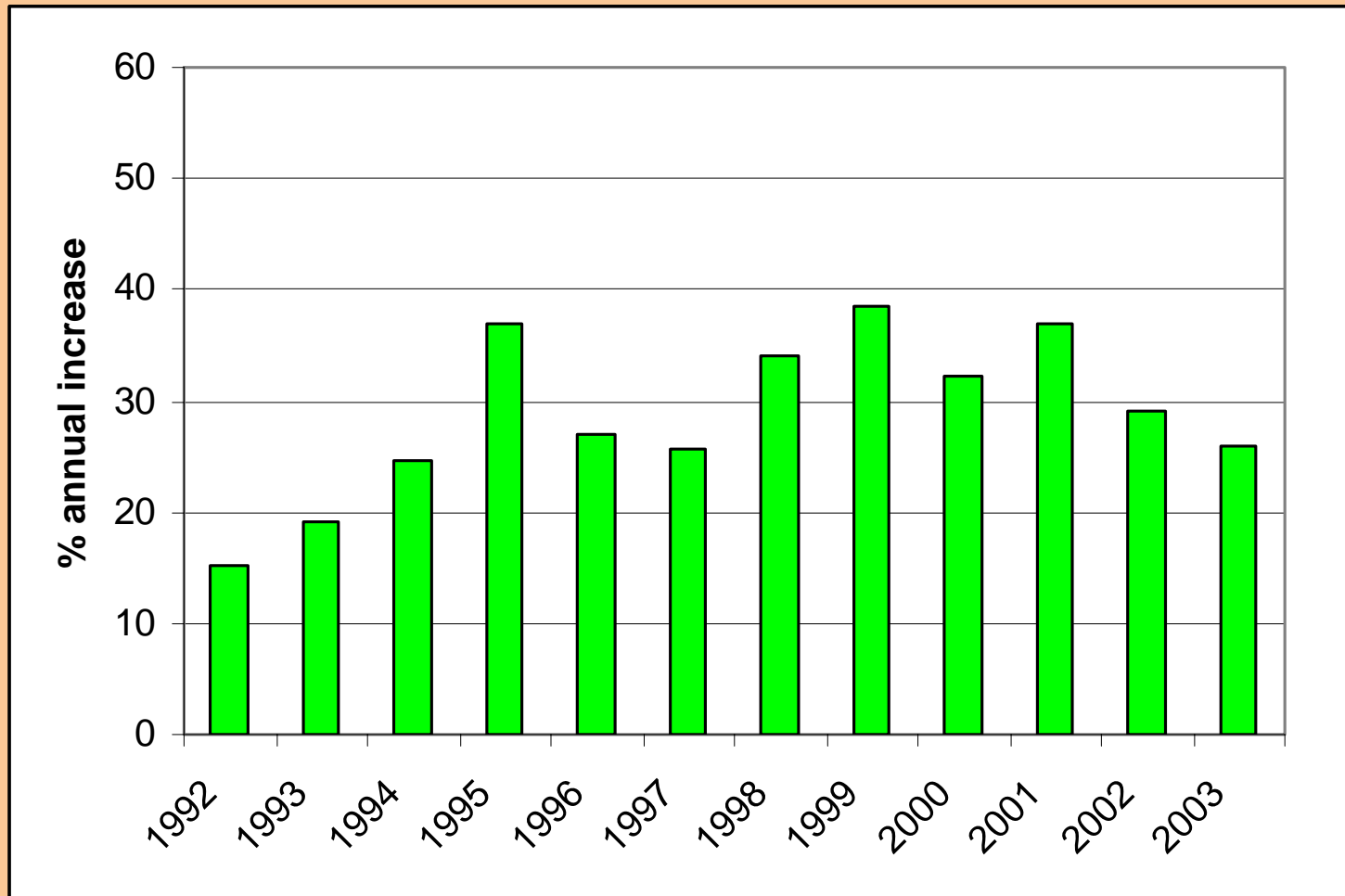
A Few Countries Dominating



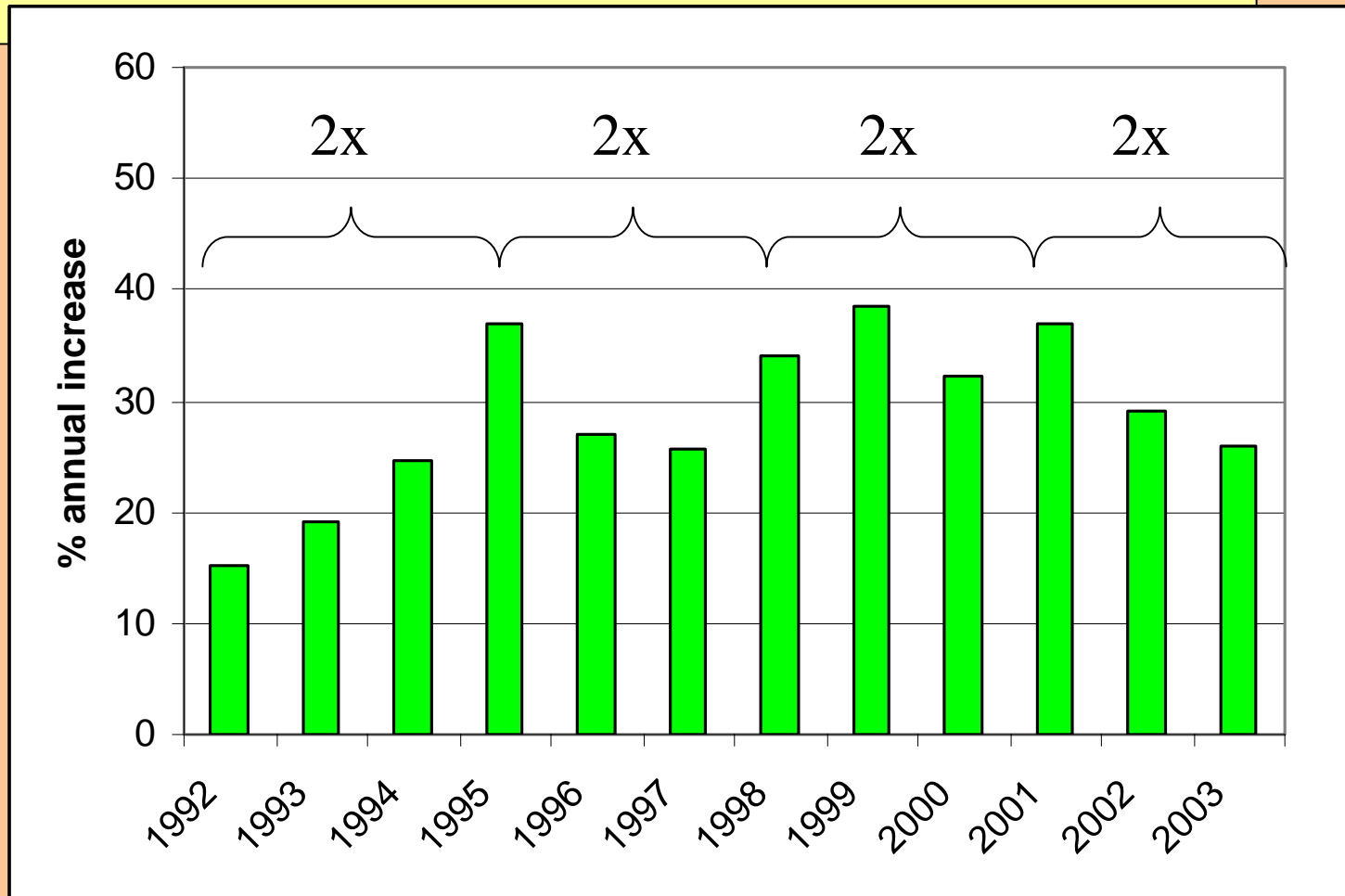
Increasing Share of Annual Installed Capacity to "Rest of the World"



Total Accumulated Capacity Increase per Year



Capacity Doubling approximately each Third Year

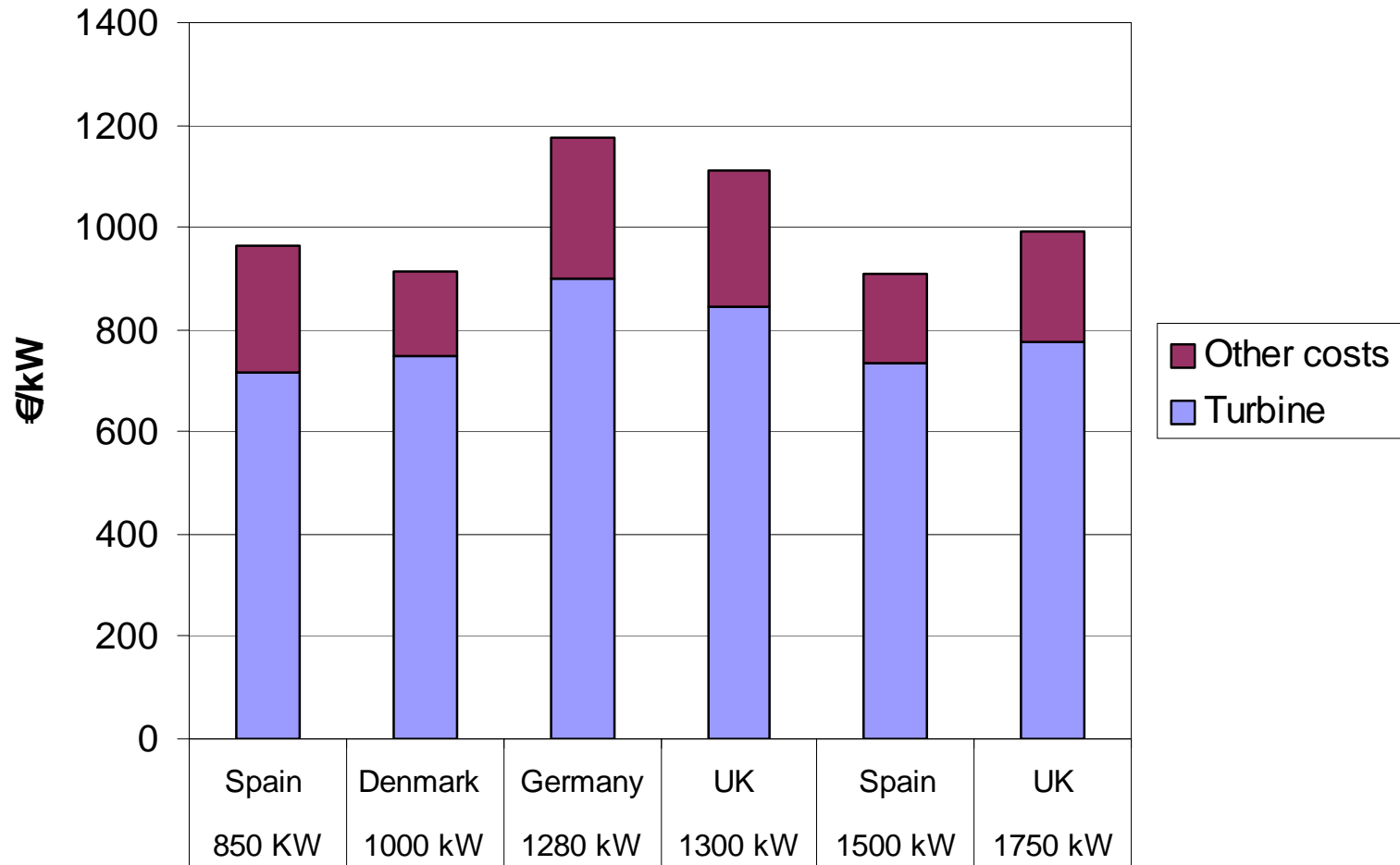


The main economic parameters

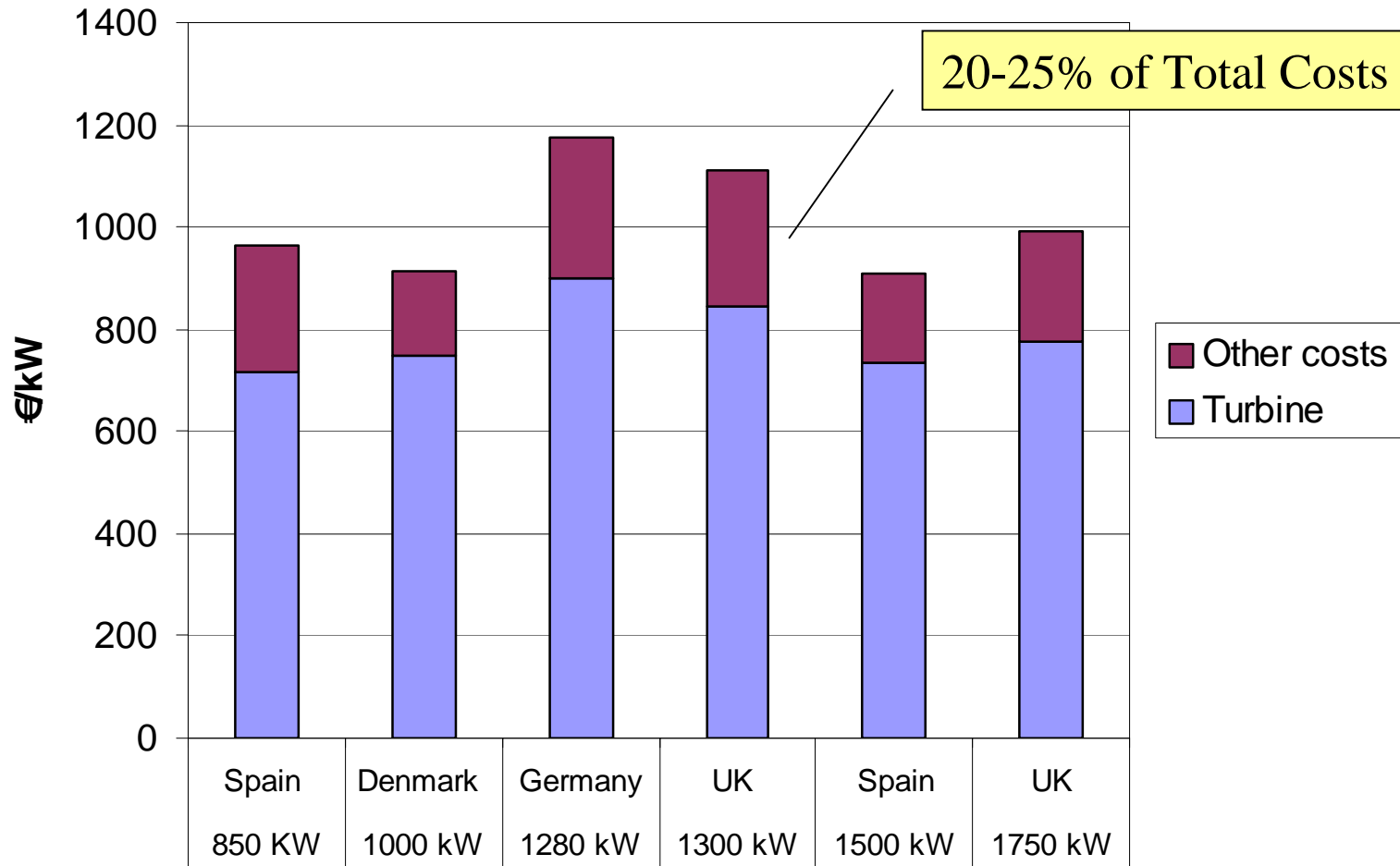
The main parameters governing wind power economics include the following:

- 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

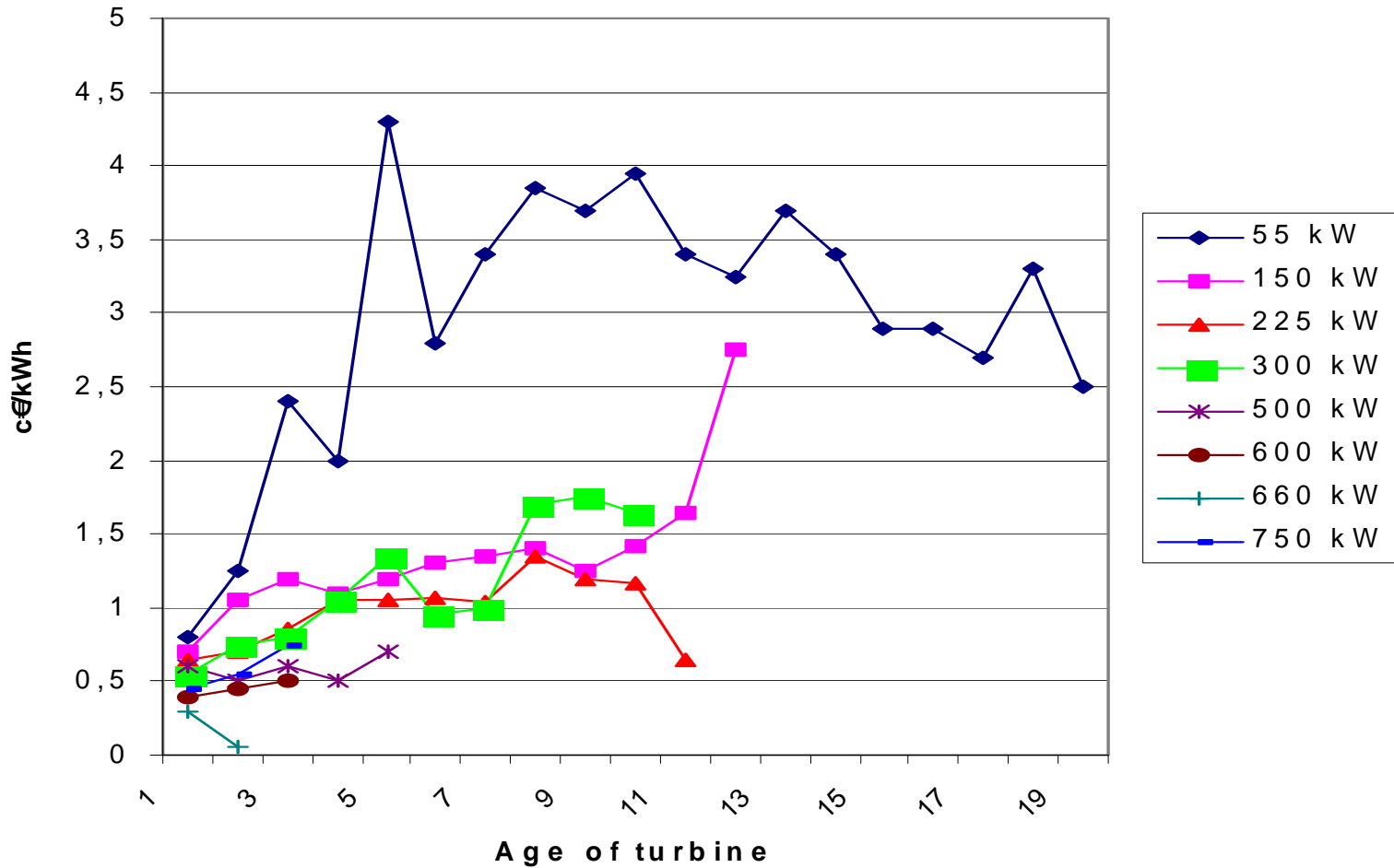
Investment Costs per kW



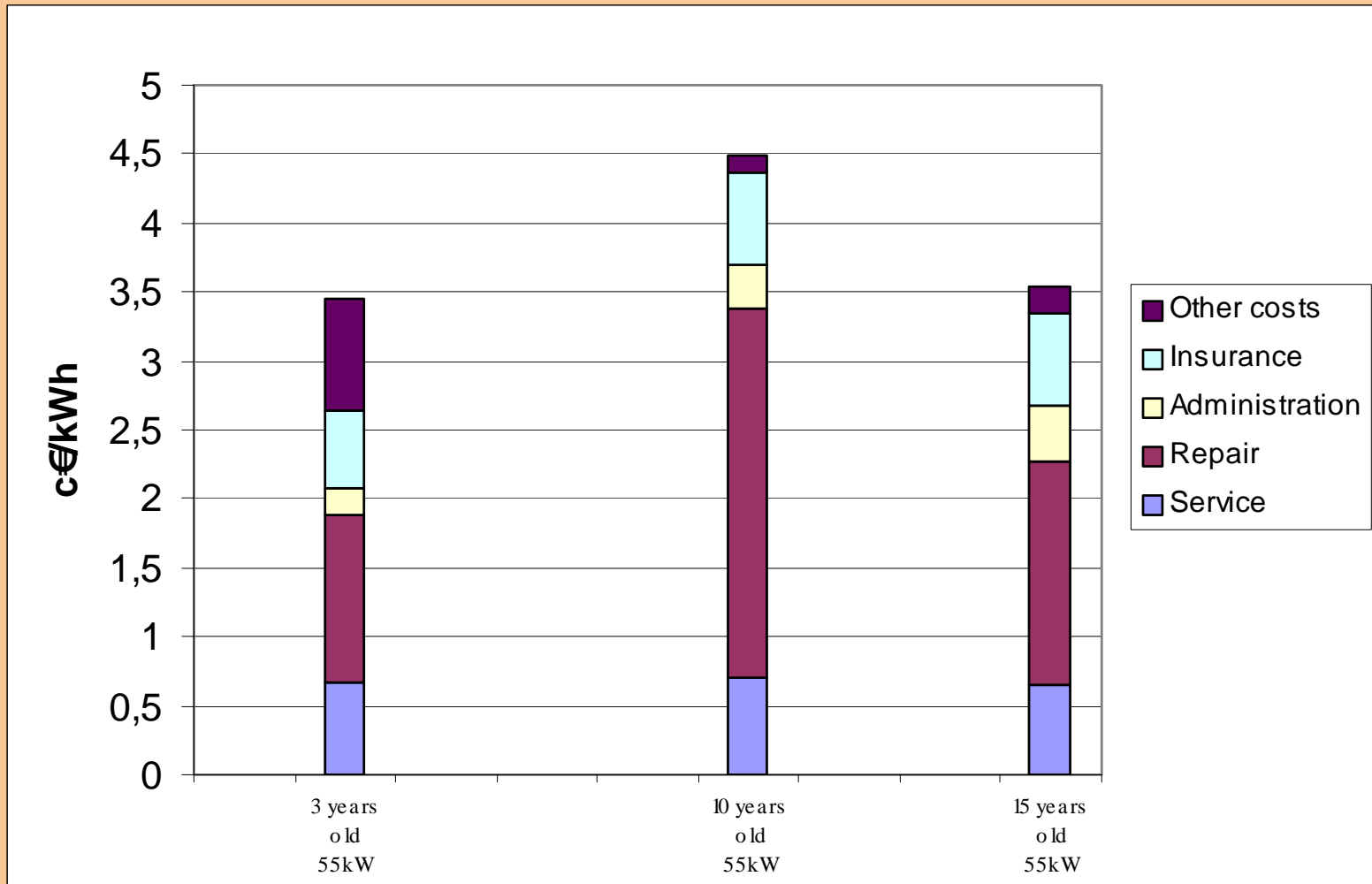
Investment Costs per kW



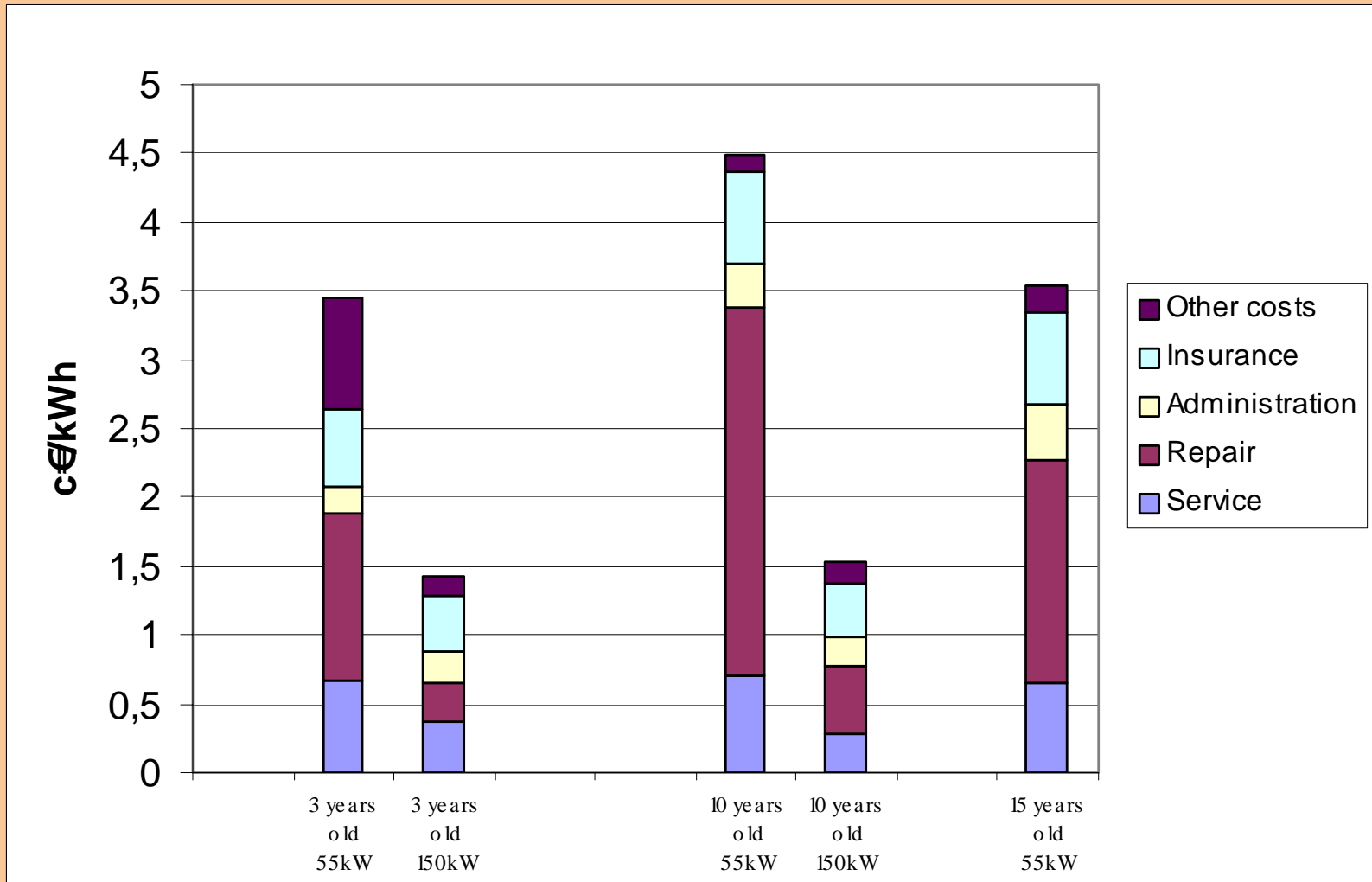
O&M-costs



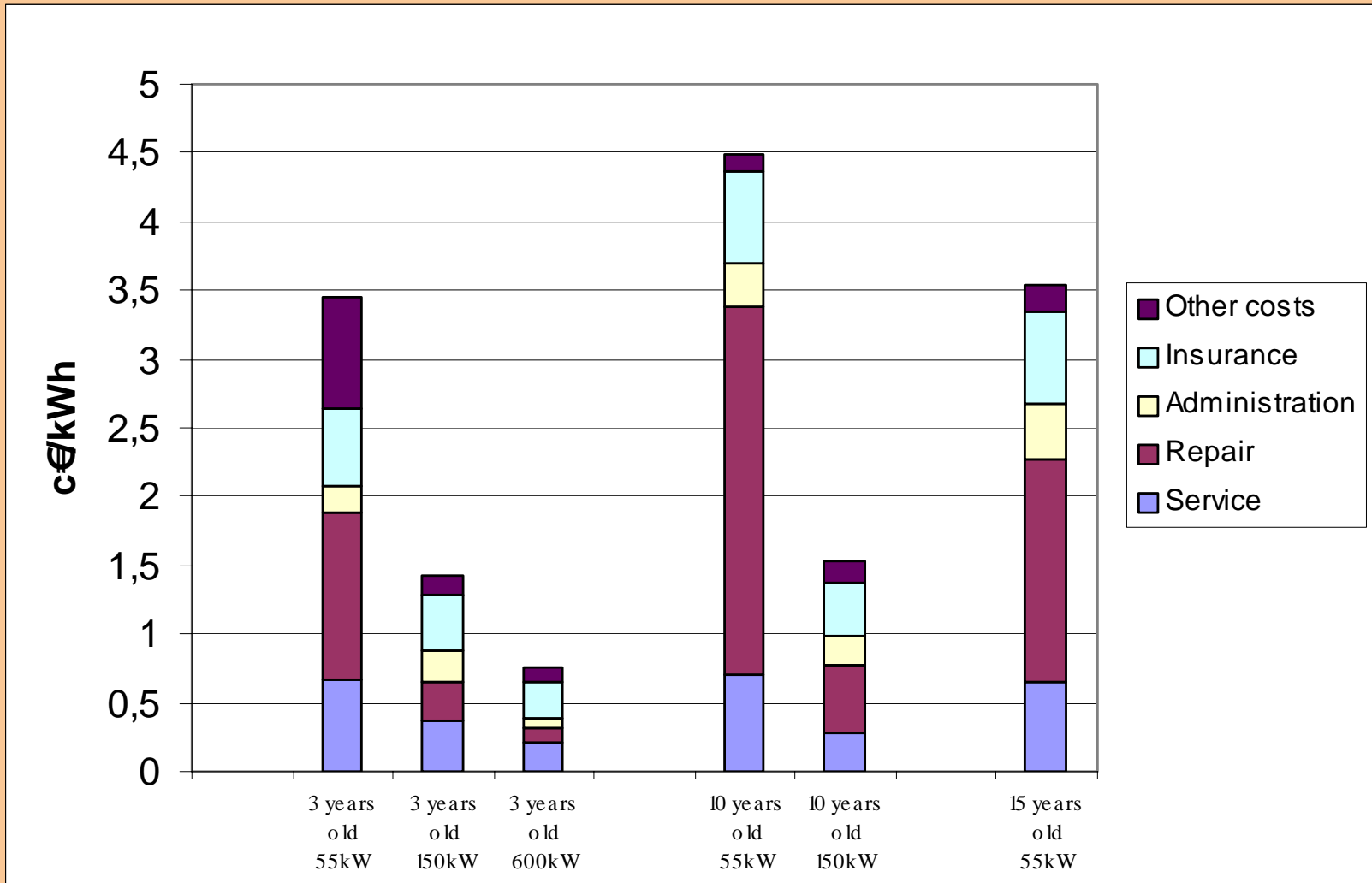
O&M costs 55 kW



O&M costs 55 kW and 150 kW



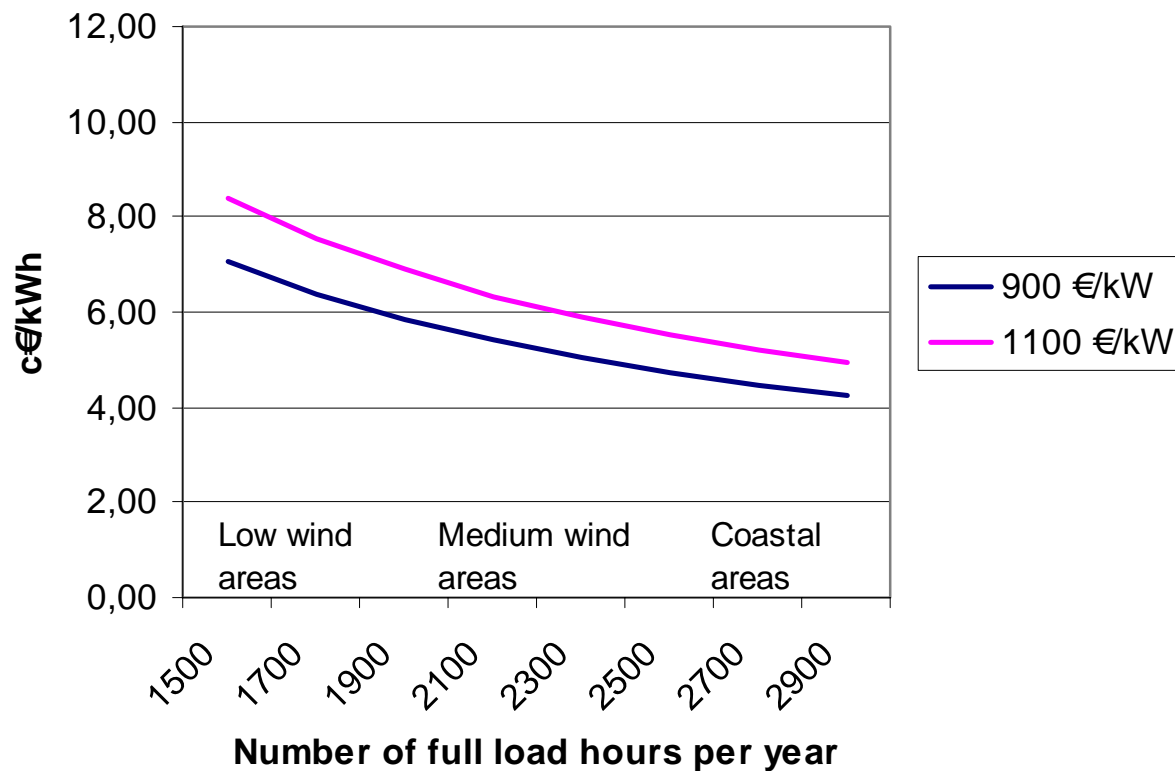
Comparison of O&M-costs



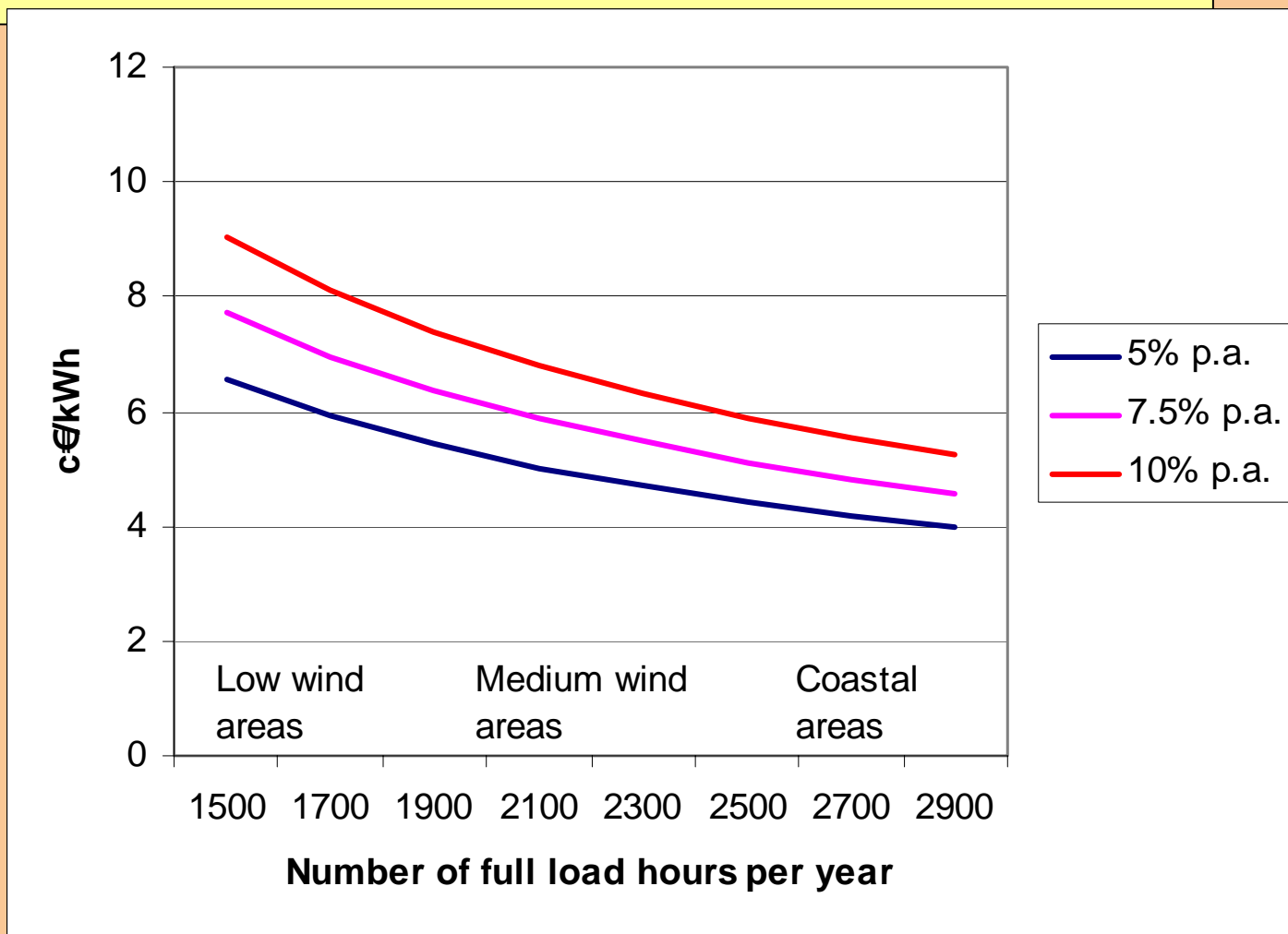
Production Costs Depending on the Wind Regime

Assumptions:

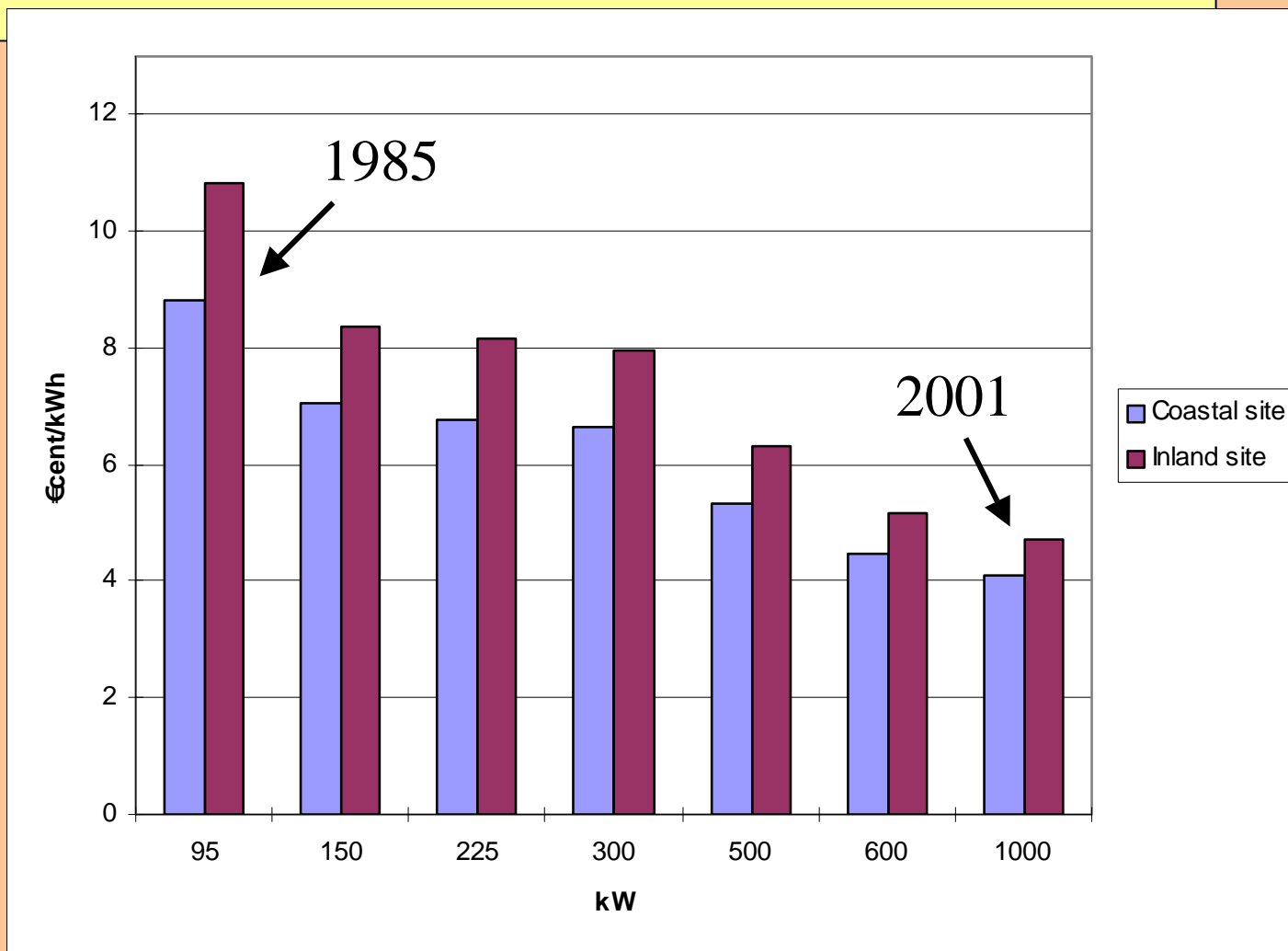
- Simple economic analysis – no taxes, depreciation, risk premium etc.
- O&M of 1.2 c€/kWh
- Lifetime 20 Years
- Discount rate 7.5% p.a.



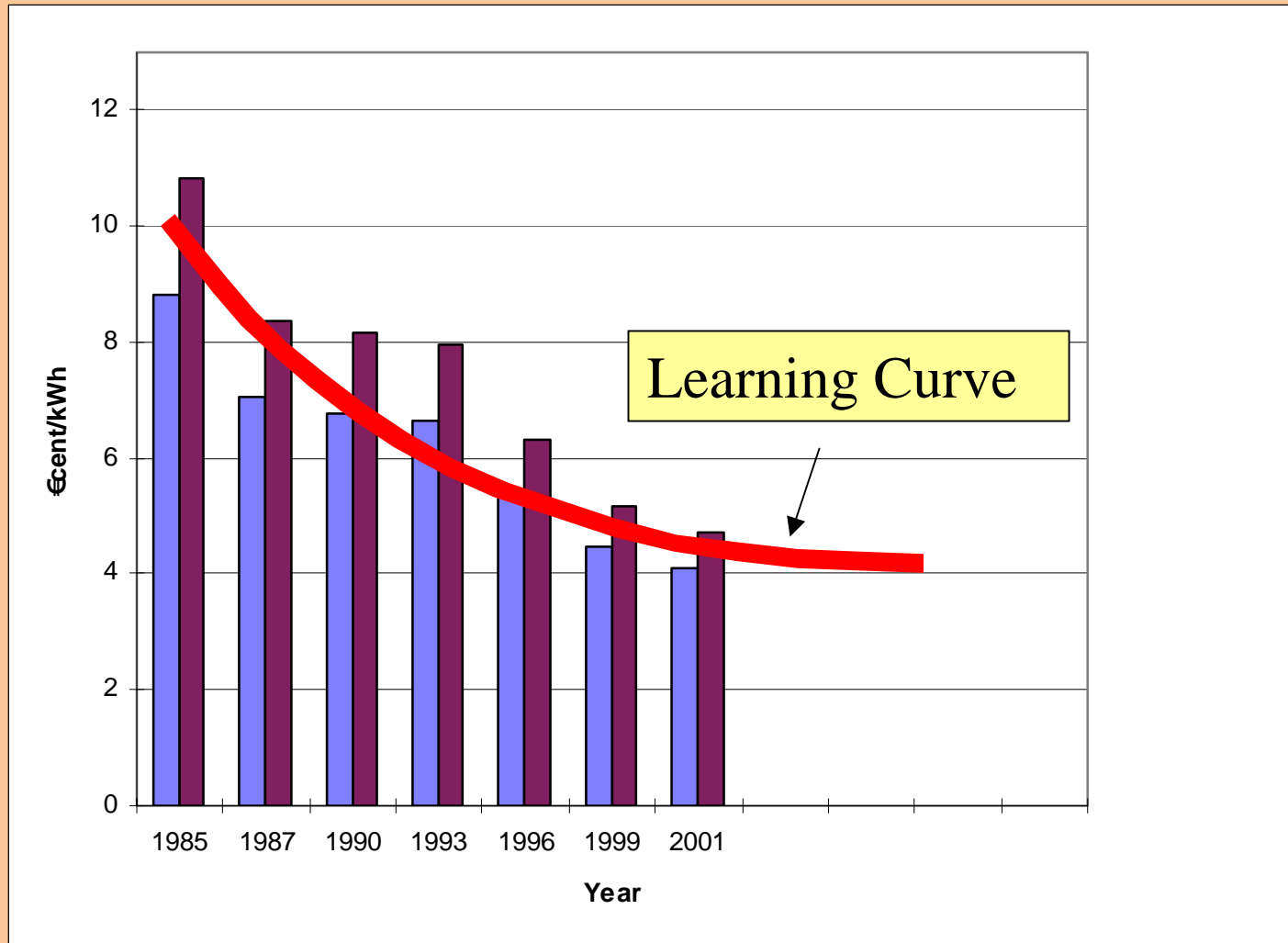
Production Costs – Sensitivity of Discount Rate



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



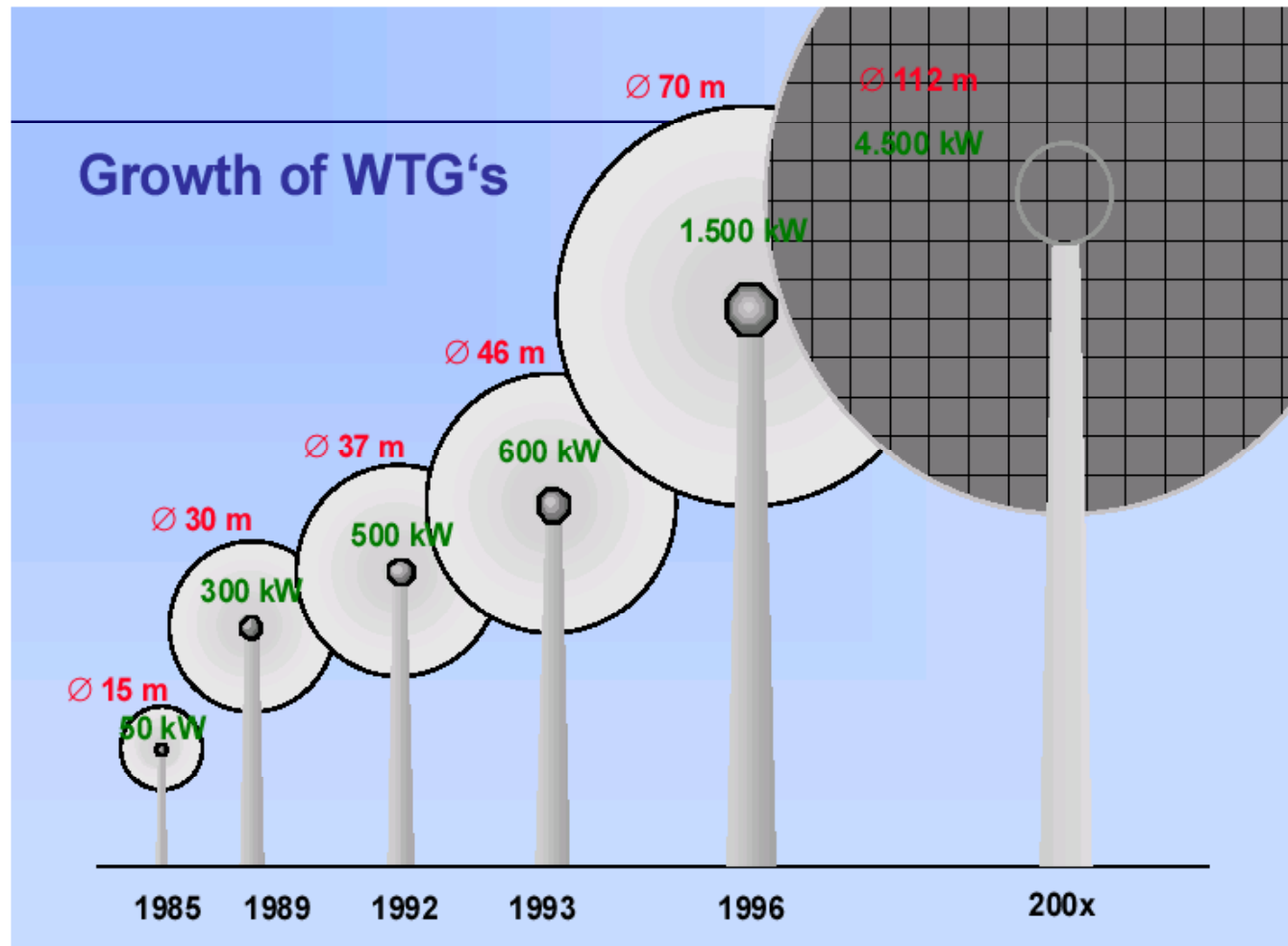
Learning Rate for Wind Power



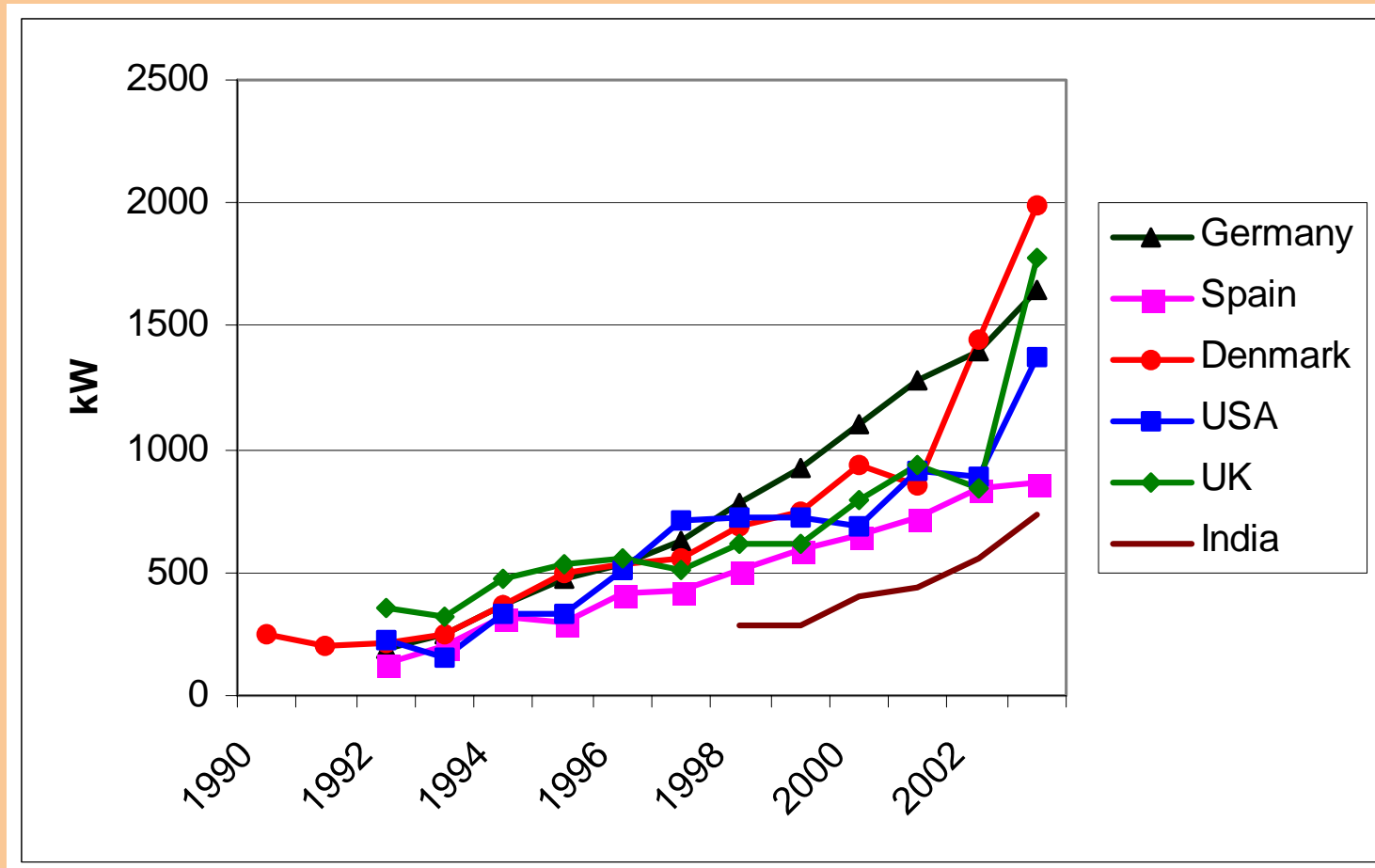
Learning Curve Approach

- 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



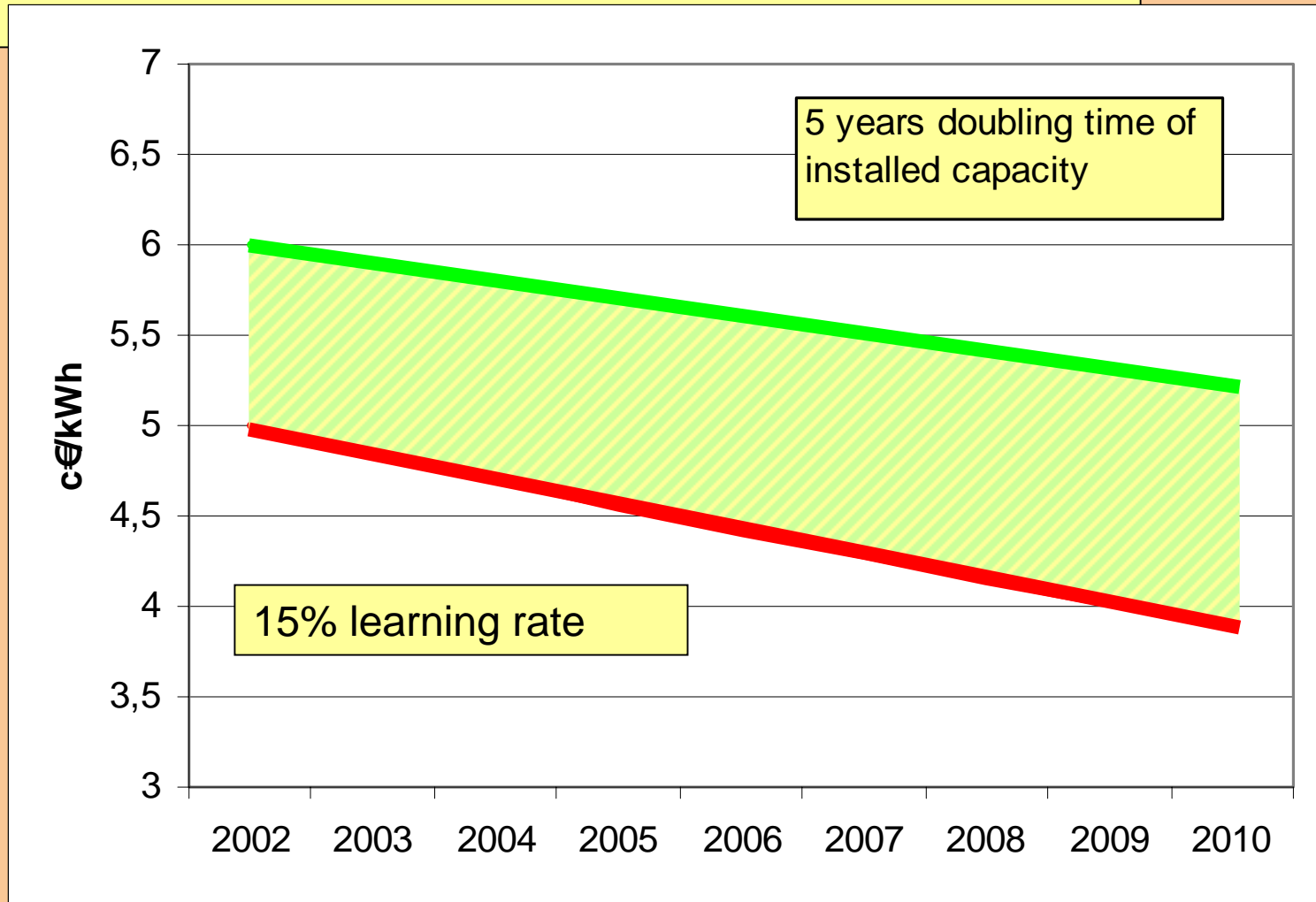
Will up-scaling of turbines continue?

- 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

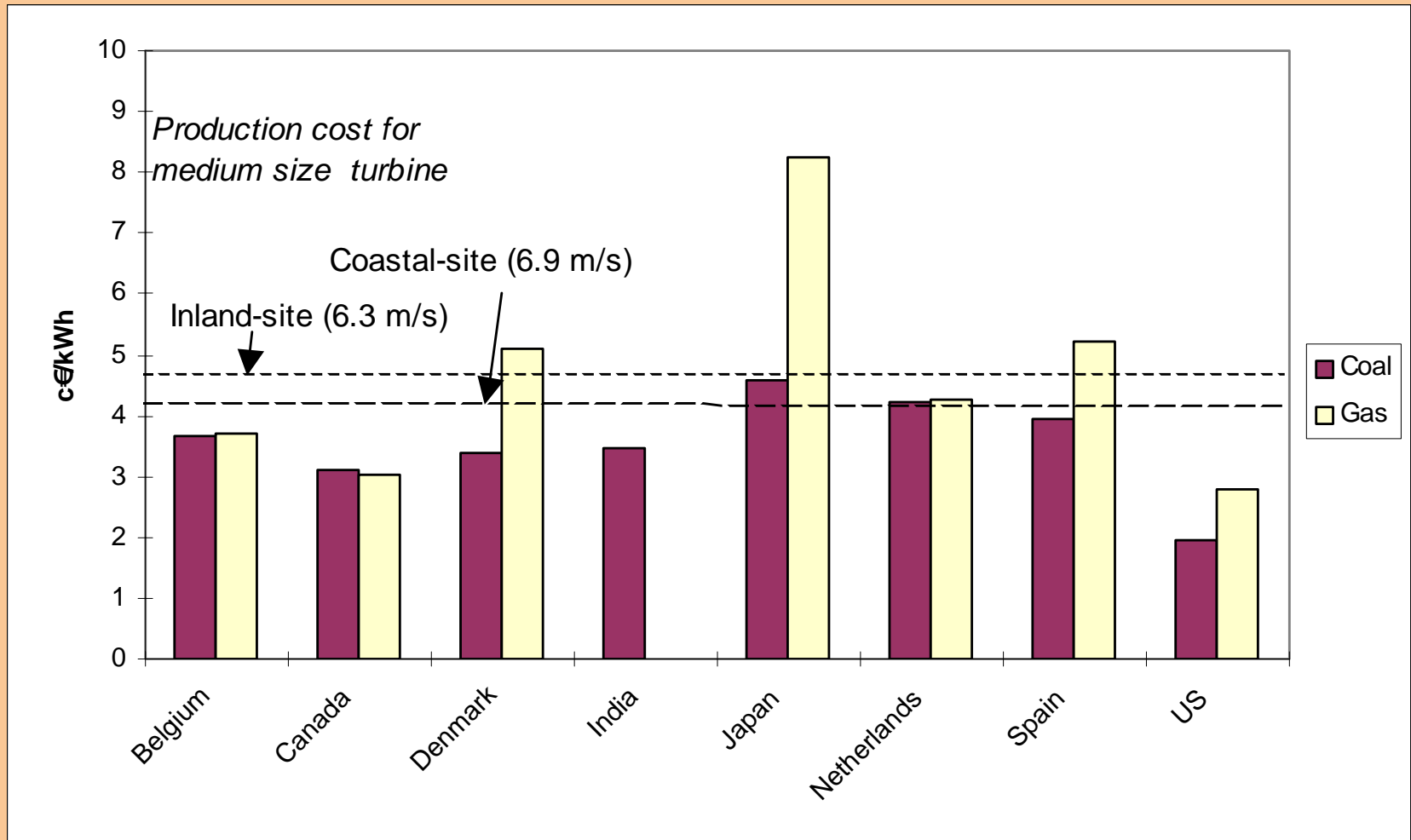
Significant cost reductions achieved through continued up-scaling

- 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.