

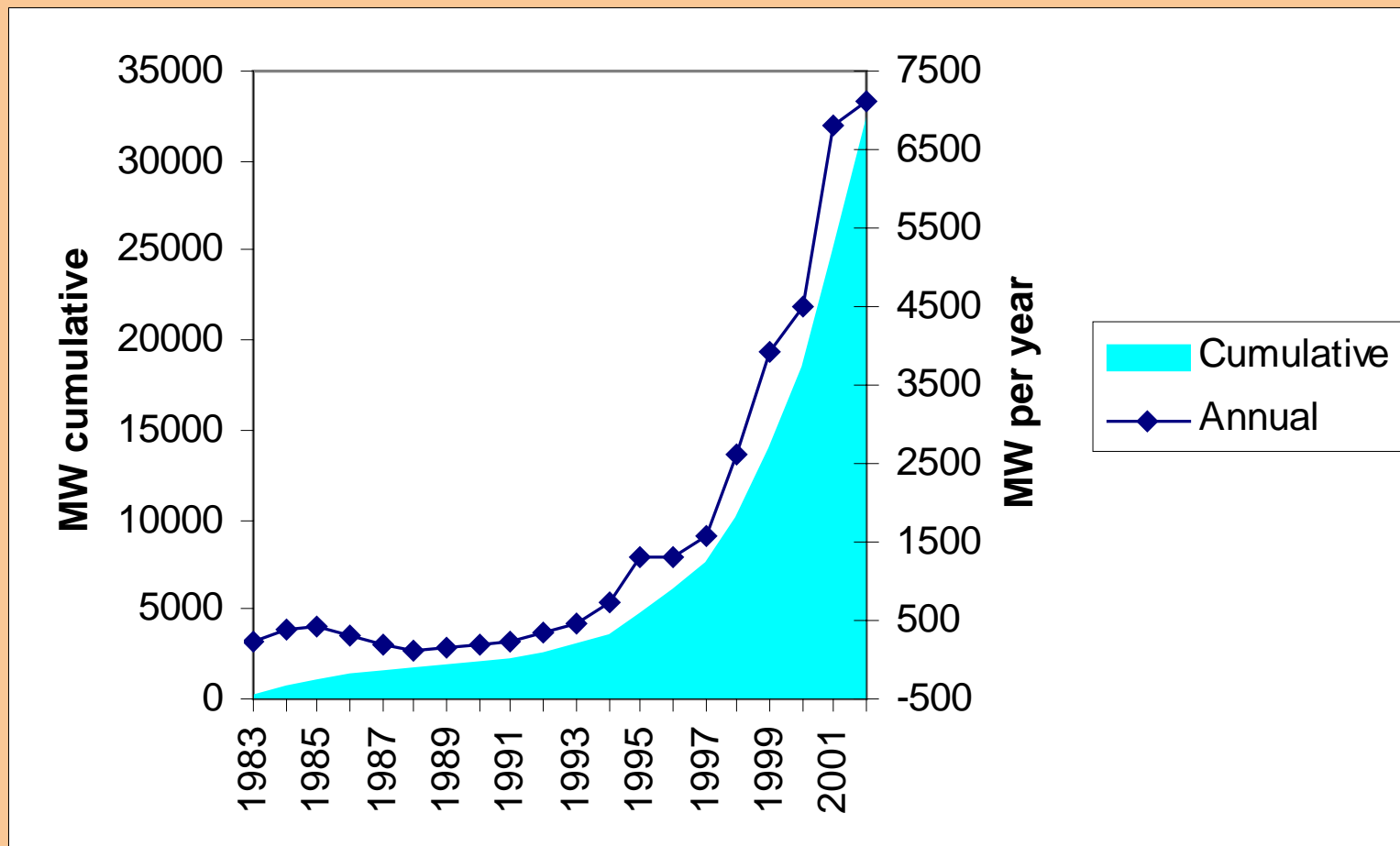
Economics of Wind power

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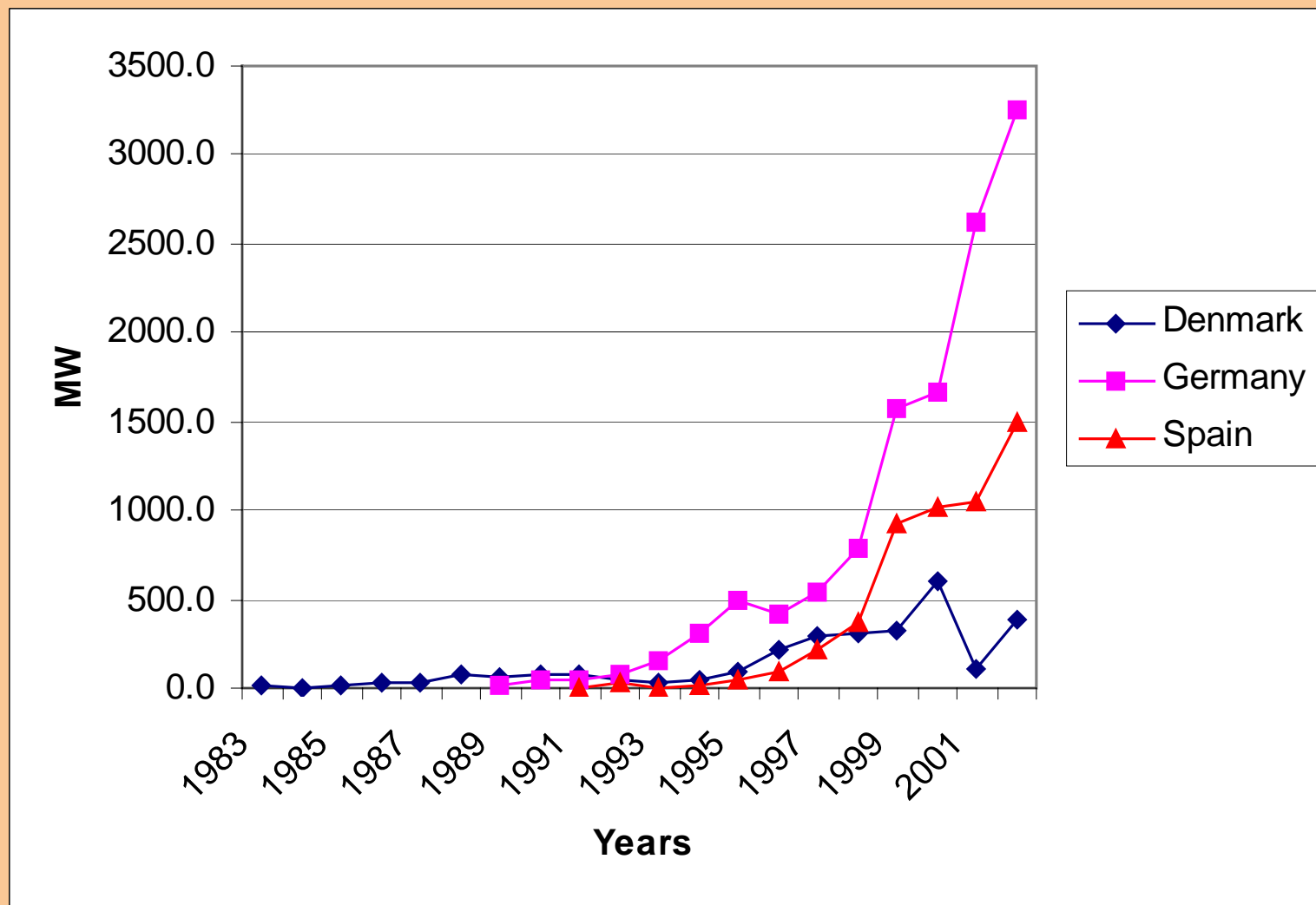
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Global development of wind power

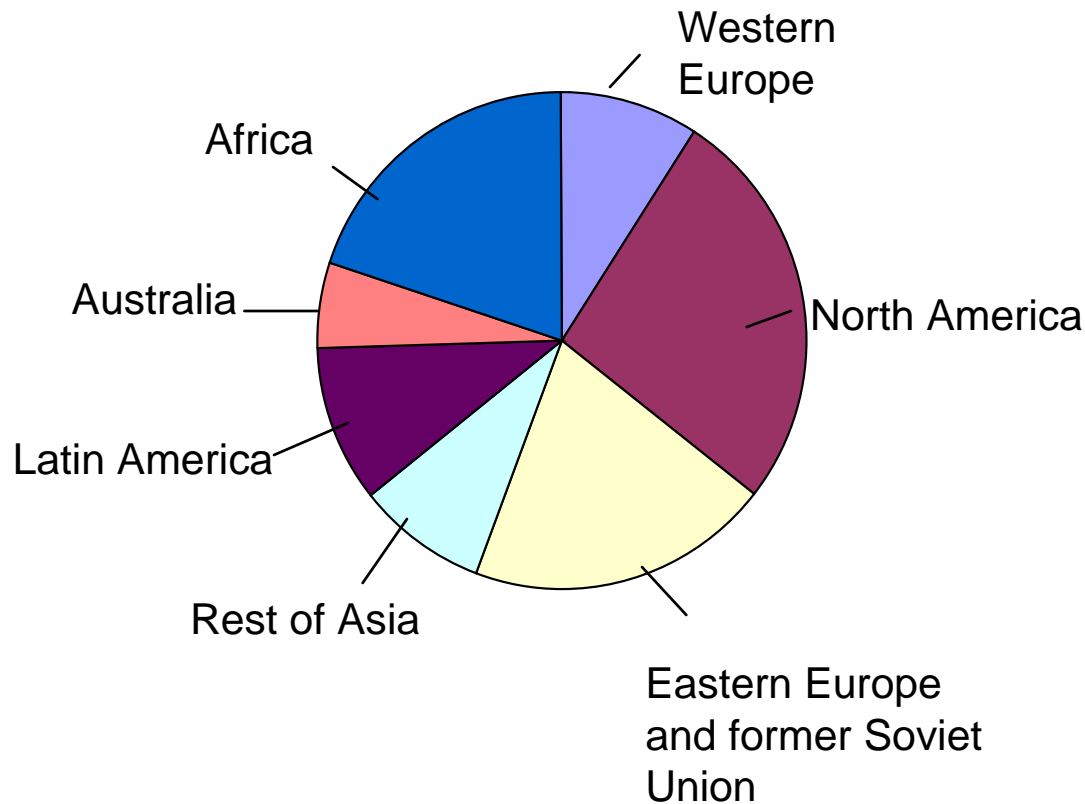


Three countries dominating in Europe



Wind resource potentials

World total = 53,000 TWh

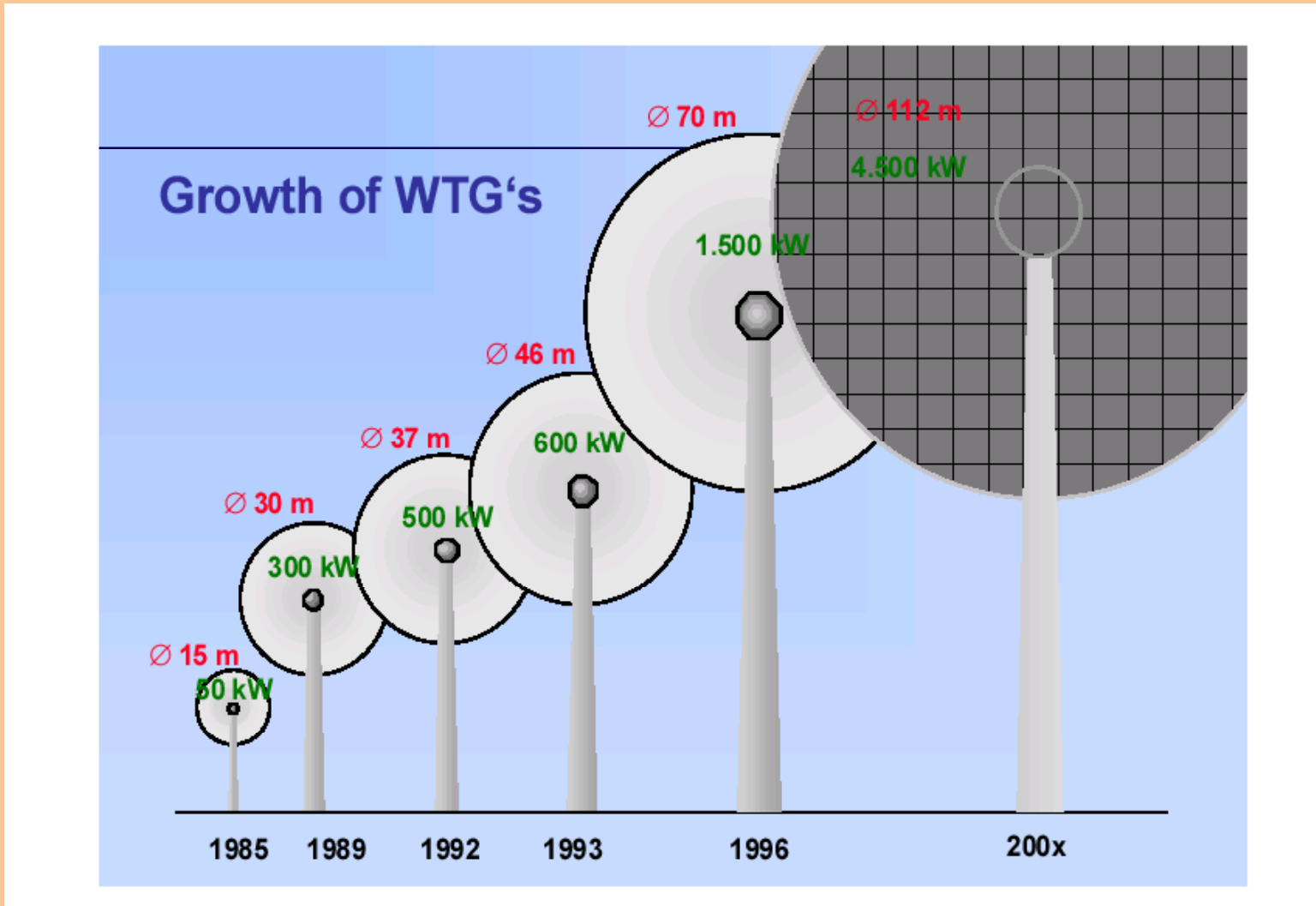


World electricity demand

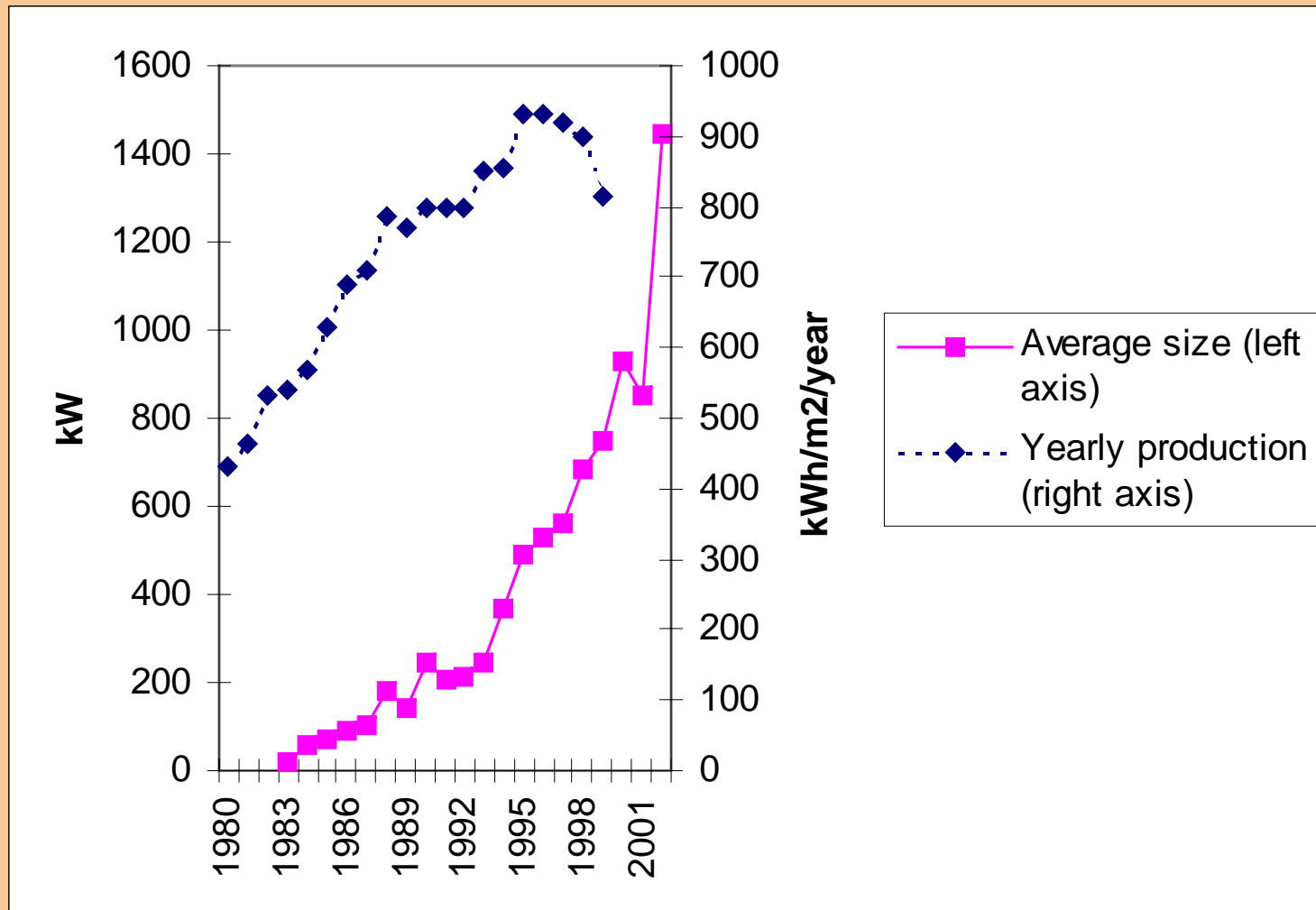
1998
14,000
TWh

2020
27,000
TWh

Turbine size



Size and efficiency



The main economic parameters

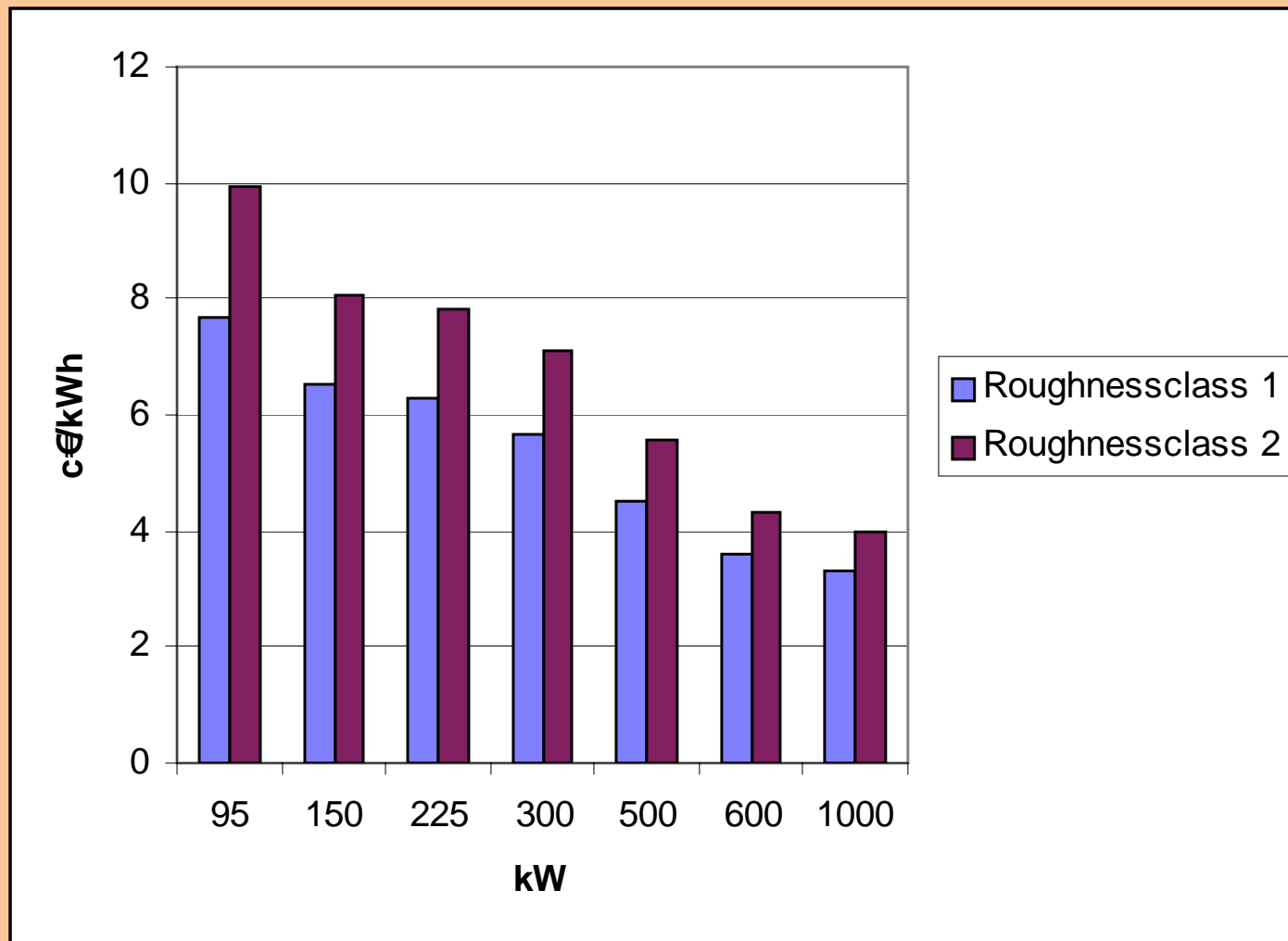
The main parameters governing wind power economics include the following:

- 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

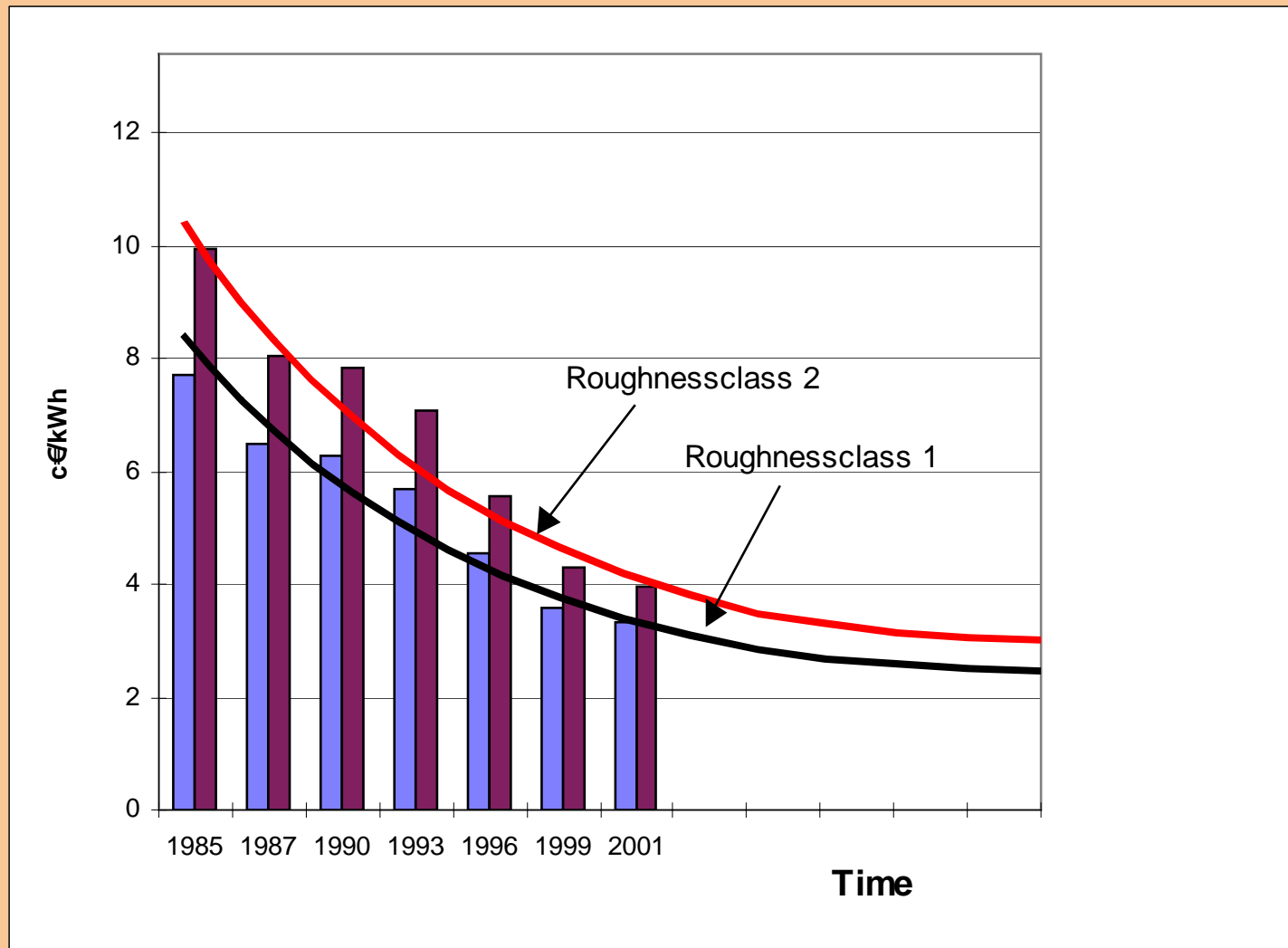
Investments in a 1 MW turbine

	Investment (1000 €)	Share (%)
Turbine (ex works)	748	81.9
Foundation	44	4.8
Electric installation	10	1.1
Grid-connection	60	6.6
Control systems	2	0.2
Consultancy	8	0.9
Land	27	2.9
Financial costs	8	0.9
Road	7	0.7
Total	914	100.0

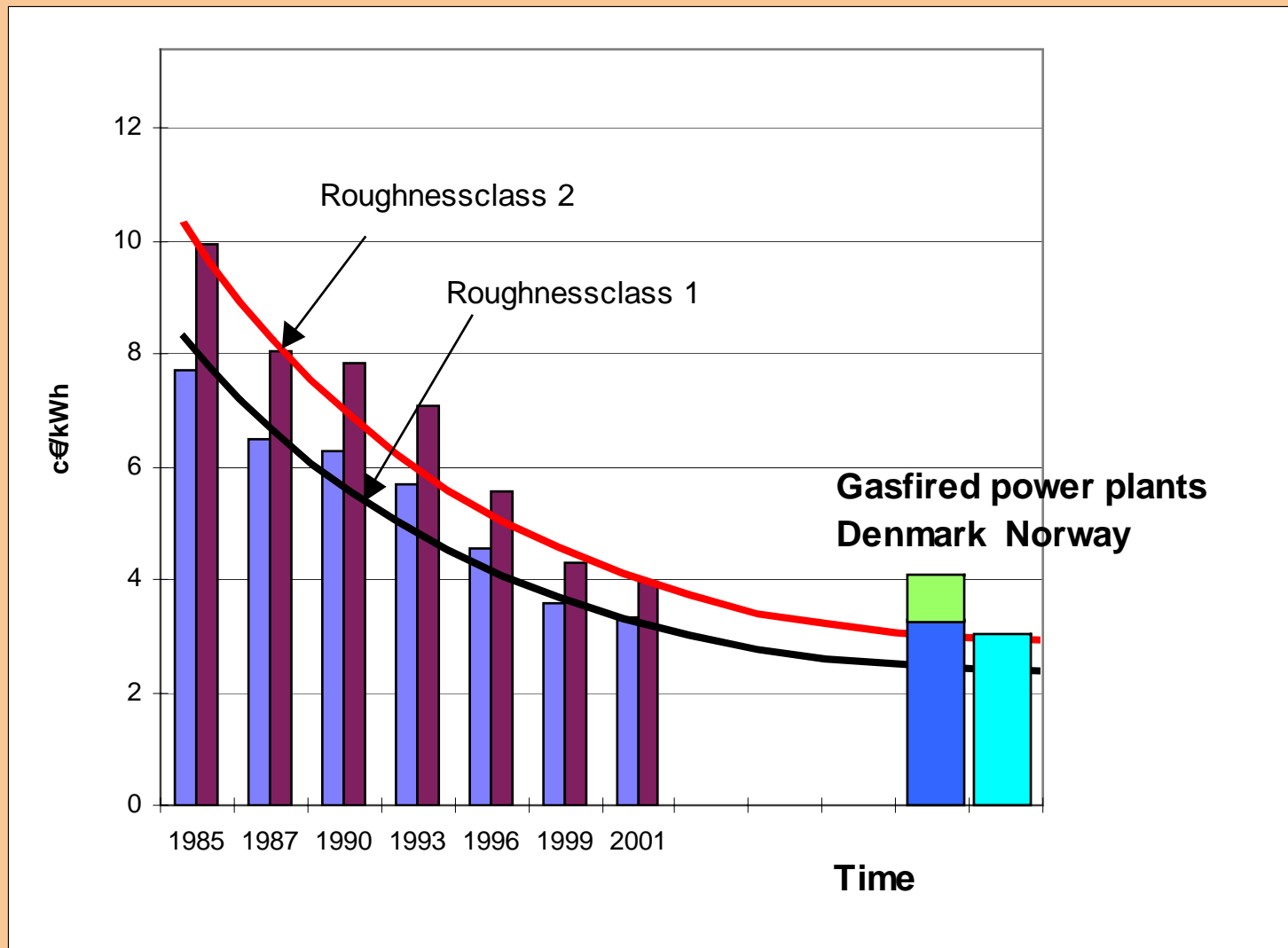
Cost of wind power



Future cost - experience curve analysis



Future cost - compared to conventional power production



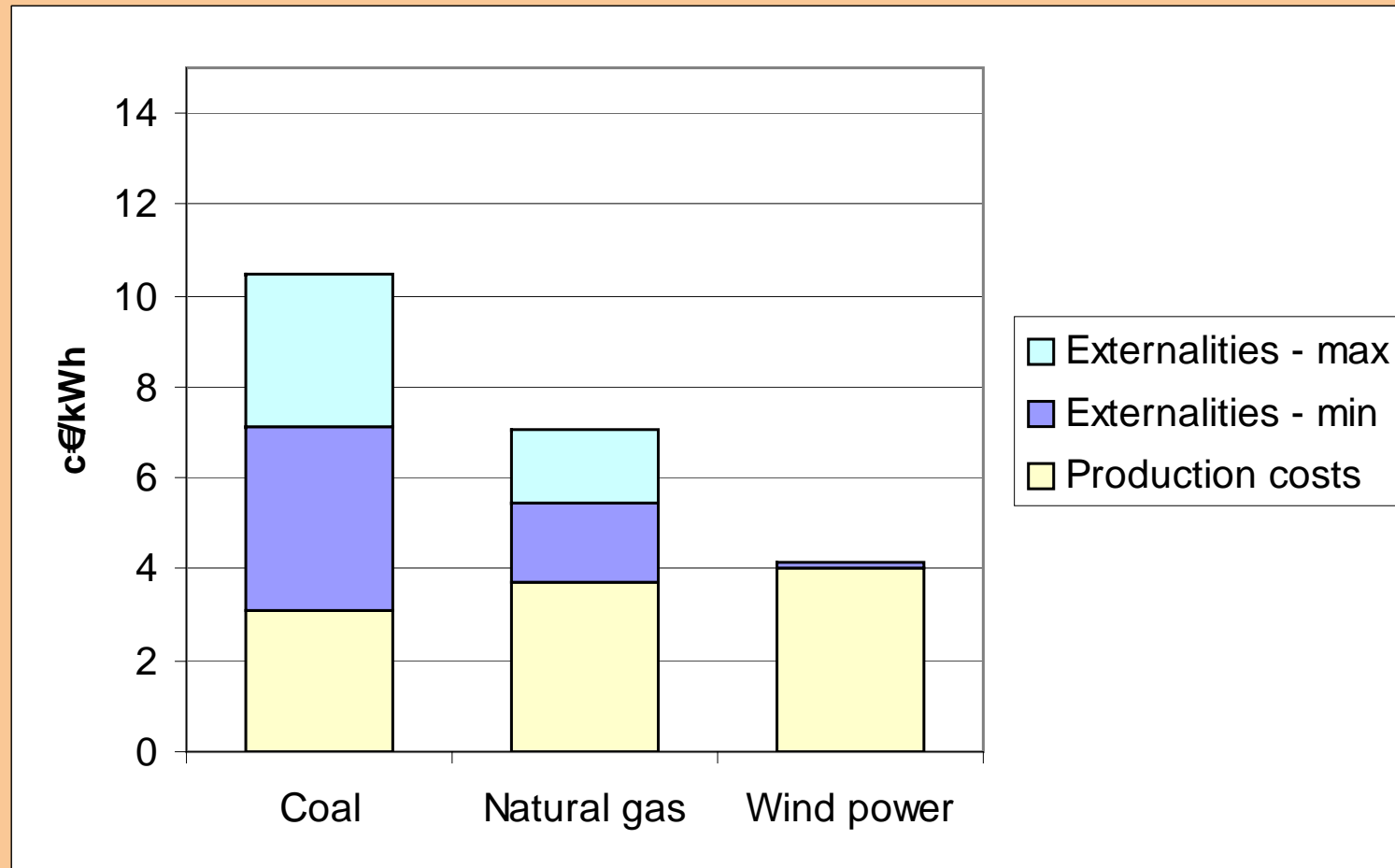
Externalities - what is that?

Impacts from the energy production that is not included in the price of energy today

- Environmental emissions - CO₂, NO_x, SO₂
- Noise
- Visual impacts

- ExternE
 - Large EU-project
 - All the way from the impact to the damage is quantified - and monetised
 - Enormous uncertainties

Production costs plus externalities for wind power and conventional plants



Offshore development in Denmark

Existing in total approx. 250 MW

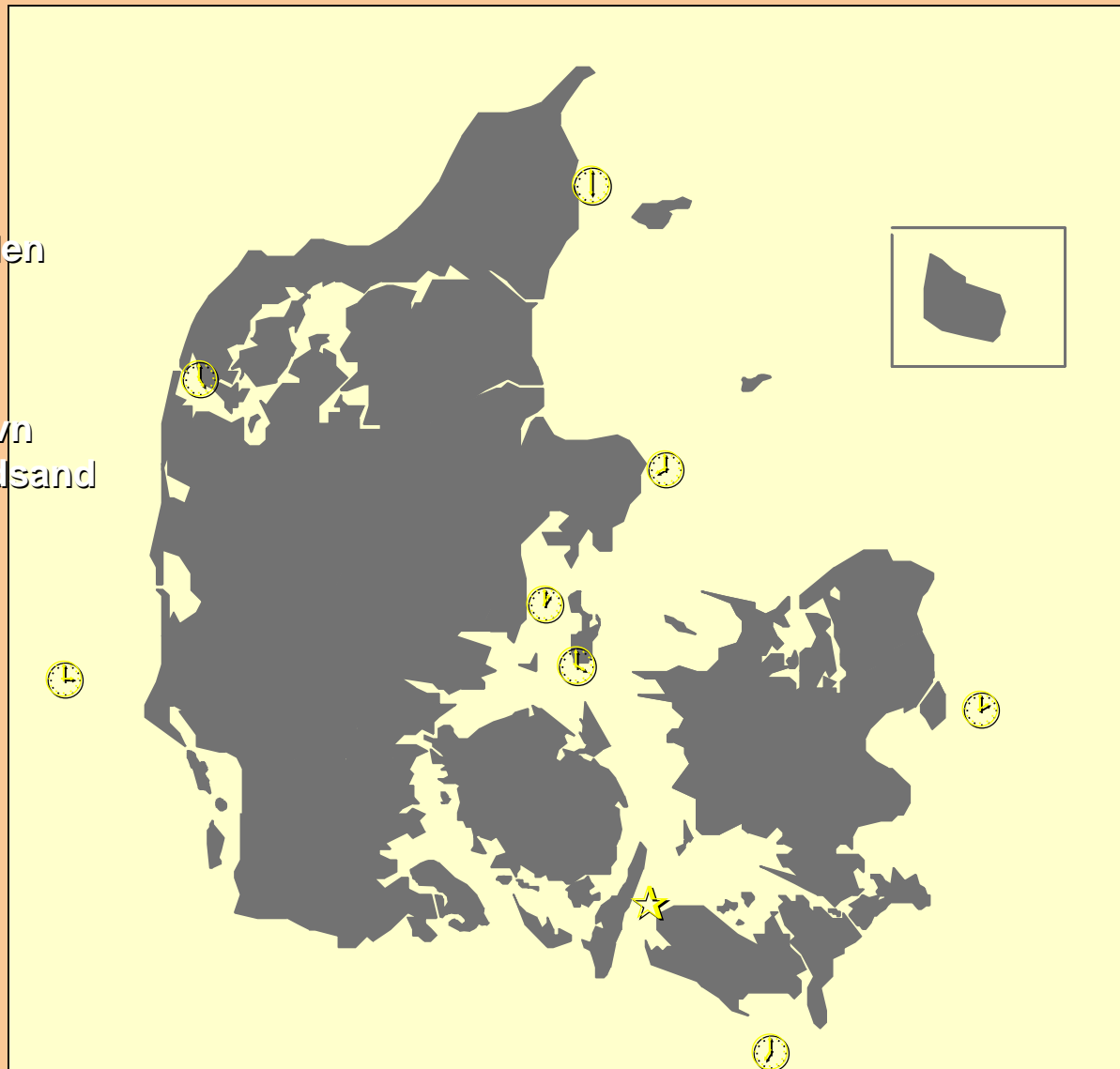
- Horns Reef $80 \times 2 \text{ MW} = 160 \text{ MW}$
- Middelgrunden $20 \times 2 \text{ MW} = 40 \text{ MW}$
- Samsø offshore farm $10 \times 2,3 \text{ MW} = 23 \text{ MW}$
- Rønland $4 \times 2 \text{ MW} + 4 \times 2,3 \text{ MW} = 17,2 \text{ MW}$
- Tunø Knop and Vindeby approx. 10 MW

Planned

- Nysted (Rødsand) $72 \times 2,3 \text{ MW}$ approx. 160 MW
- Frederikshavn and Grenaa

Offshore sites in Denmark

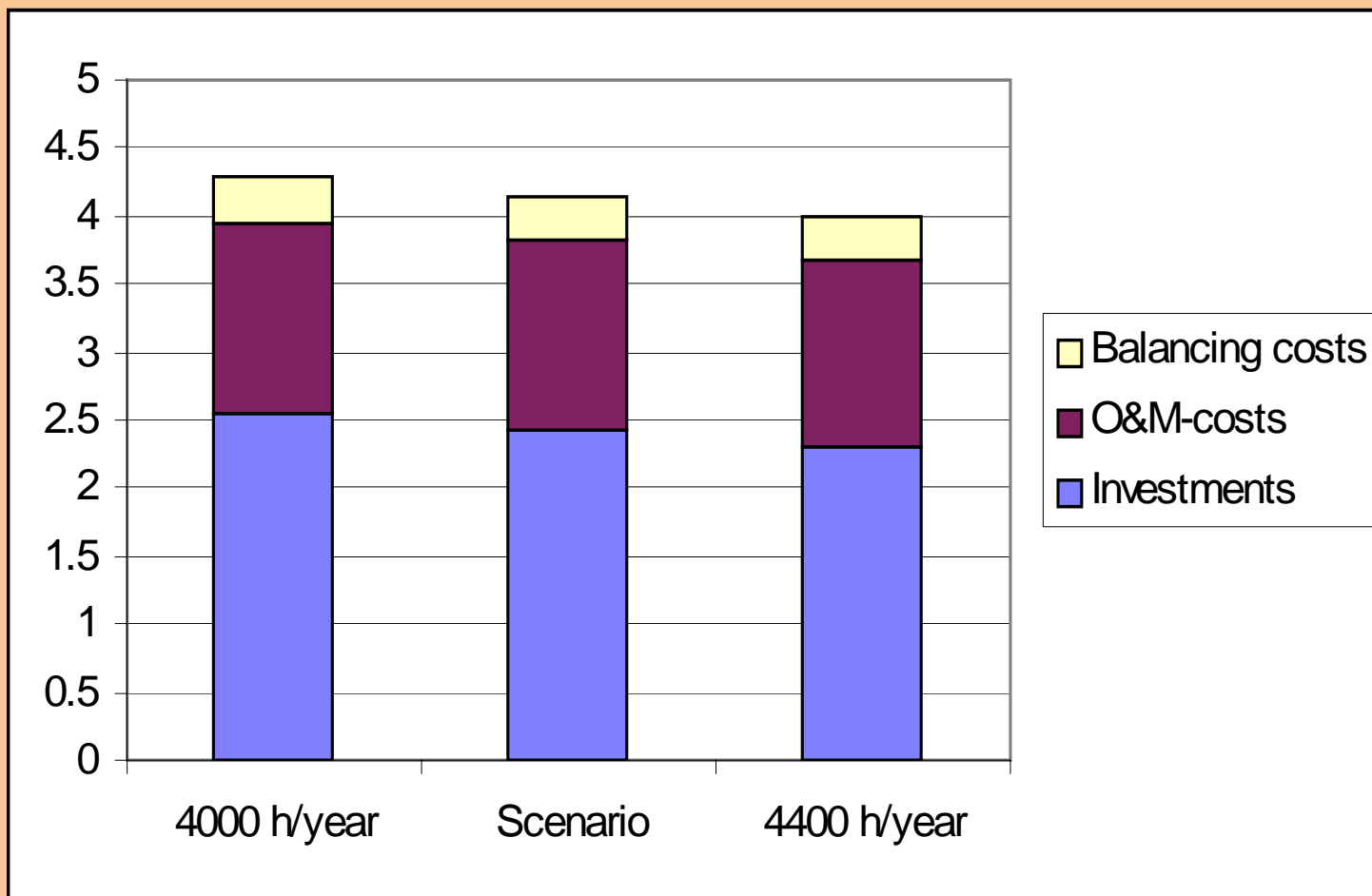
- ★ Vindeby
- 🕒 Tunø Knob
- 🕒 Middelgrunden
- 🕒 Horns Reef
- 🕒 Samsøe
- 🕒 Roenland
- 🕒 Frederikshavn
- 🕒 Nysted-Roedsand
- 🕒 Grenå



Horns Reef - 80 turbines 160 MW



The cost of an offshore wind farm equipped with 3 MW turbines



Conclusions

- On a global scale wind power is developing rapidly
 - Installed capacity increases by approx. 30% p.a.
 - Average size is continuously increasing - largest turbine is more than 3 MW
- Taking externalities into account wind power is highly economic competitive today
- Within 5-7 years wind power is expected to be fully economic competitive compared to conventional power plants
- Offshore wind power is getting an increasingly important role in the development