The Economics of Wind Power

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Status and Perspectives

Photos:

DONGEnergy A/S

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The main Socio-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 €/MW)	Share (%)
Turbine (ex works)	928	75.6
Foundation	80	6.5
Electric installation	18	1.5
Grid-connection	109	8.9
Control systems	4	0.3
Consultancy	15	1.2
Land	48	3.9
Financial costs	15	1.2
Road	11	0.9
Total	1227	100

Turbine Investment Cost in different Countries
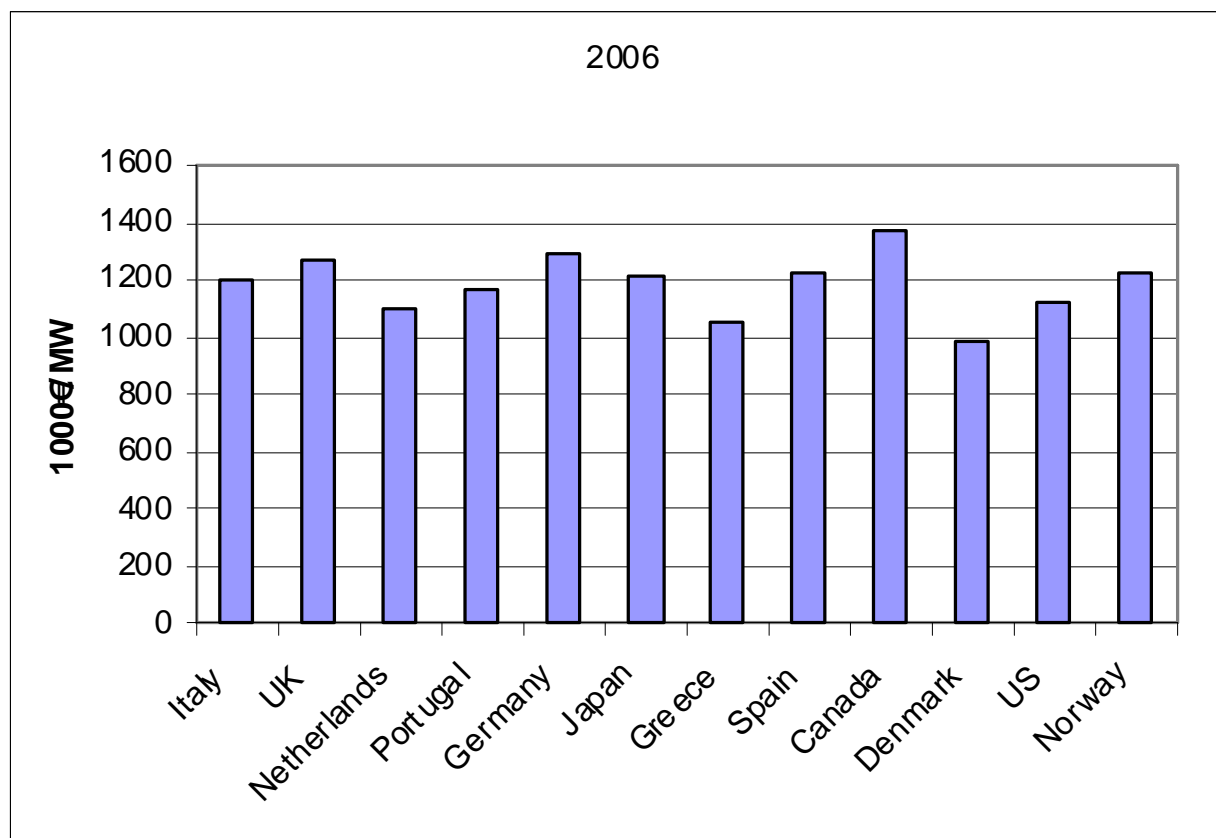
Development of Turbine Size in different Countries
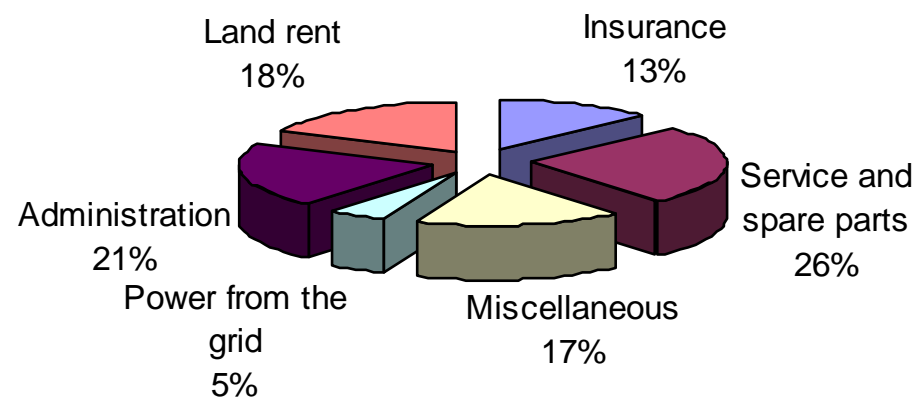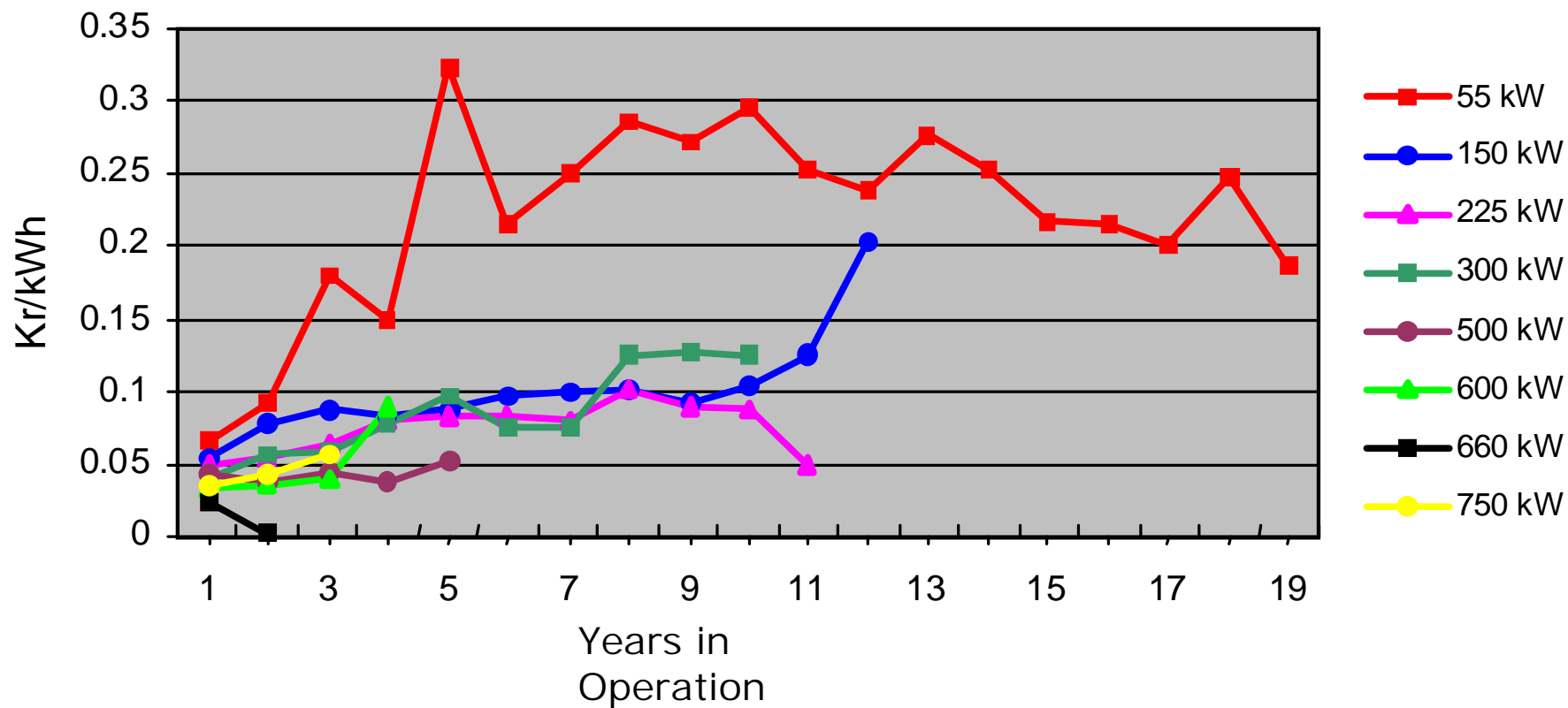

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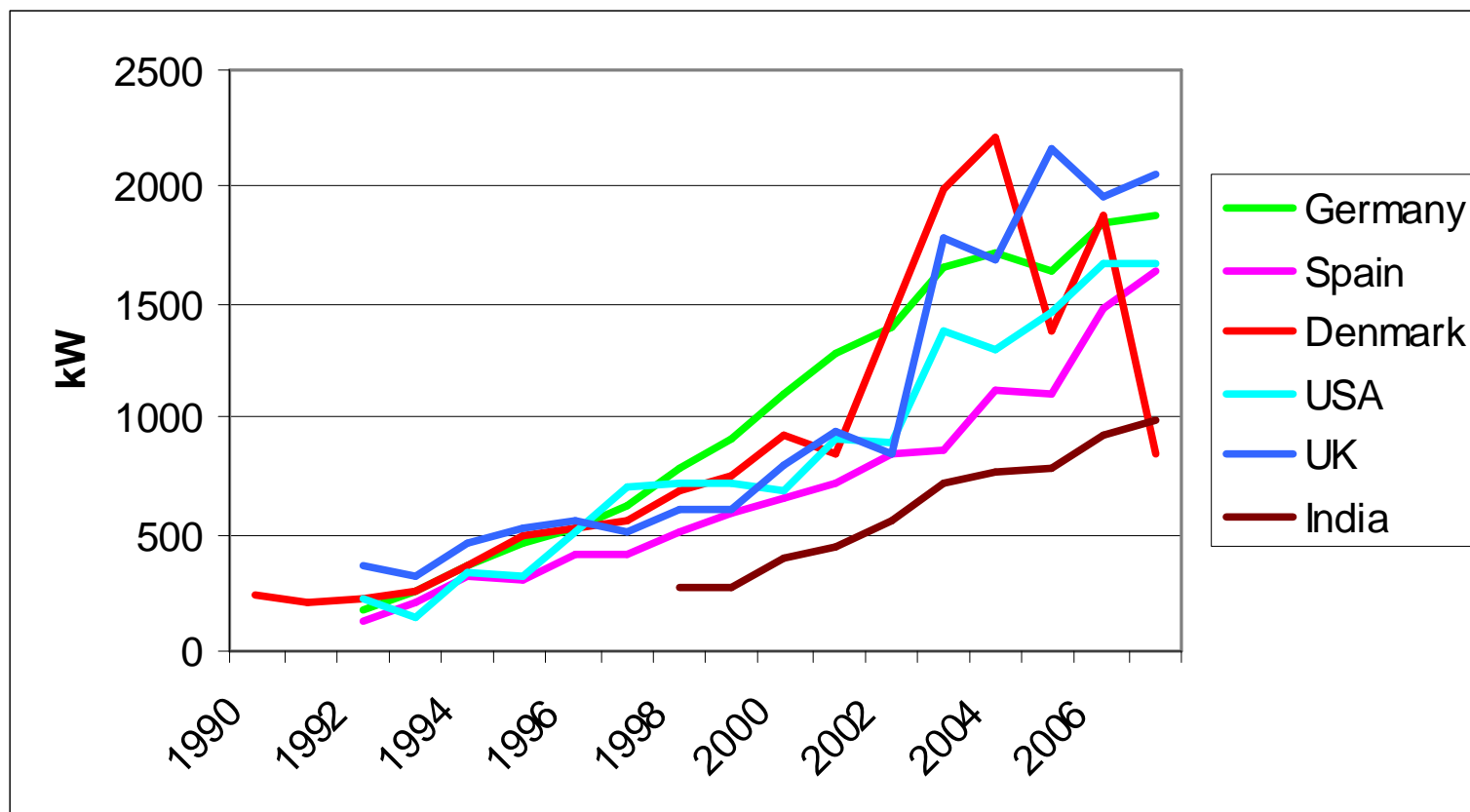
Operation and Maintenance

- O&M costs: Approx. 1.5 c€/kWh

O&M components

- Insurance
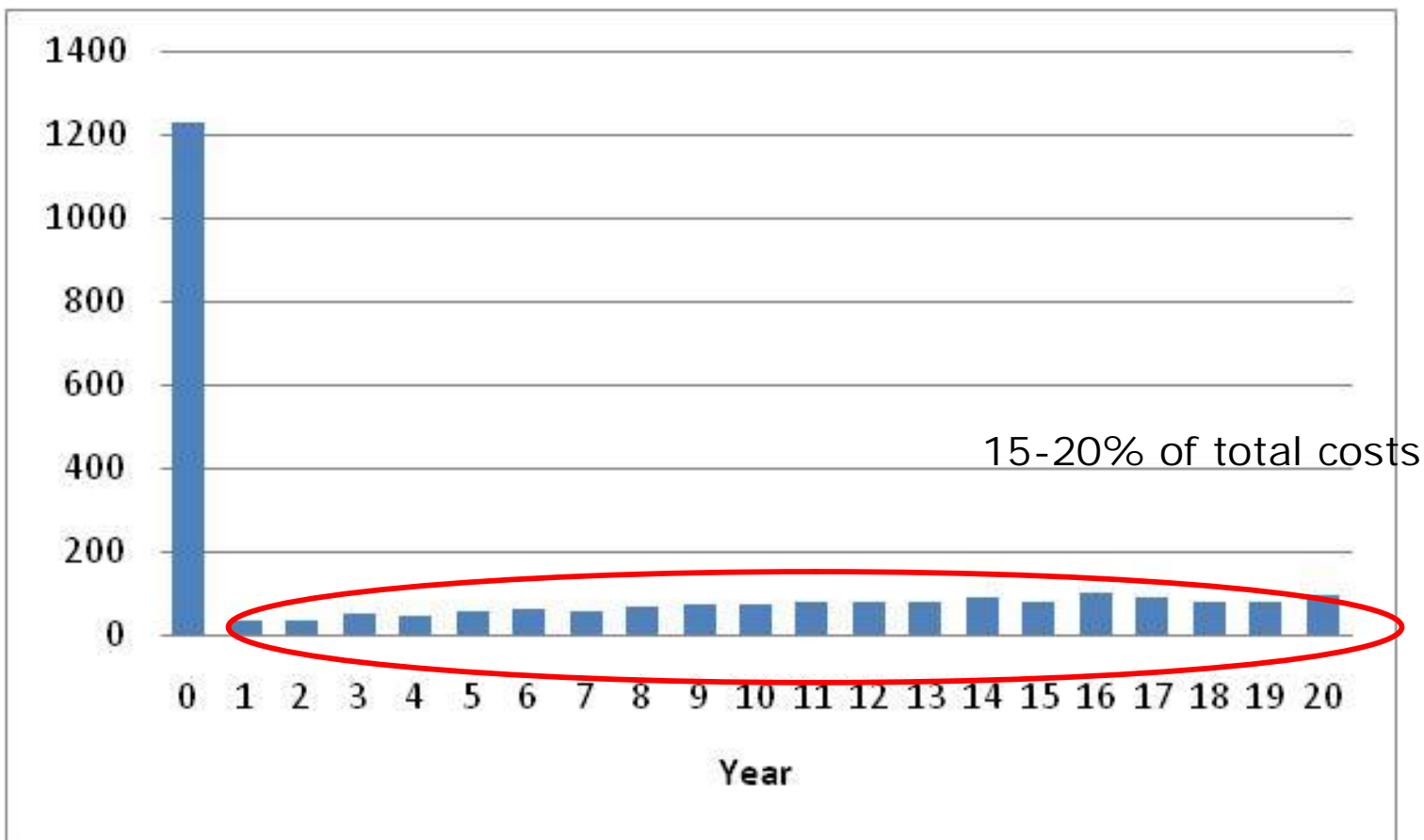- Regular maintenance
- Repair
- Spare parts
- Administration

Land rent
18%

Insurance
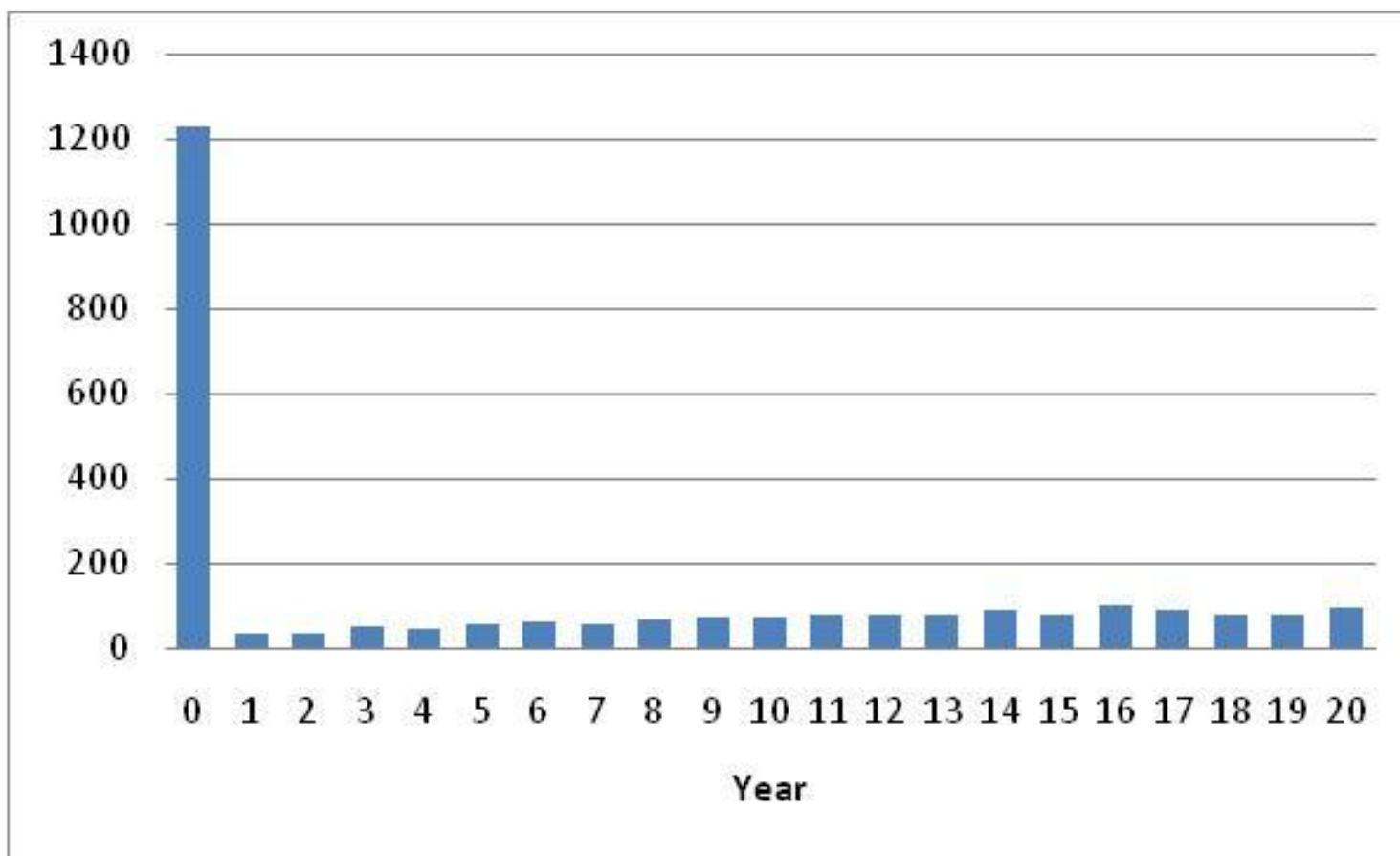13%

Administration
21%

Service and
spare parts
26%

Power from the
grid
5%

Miscellaneous
17%

Operation and Maintenance

Cash flow for Wind Power plant

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Cash flow for Wind Power plant

15-20% of total costs
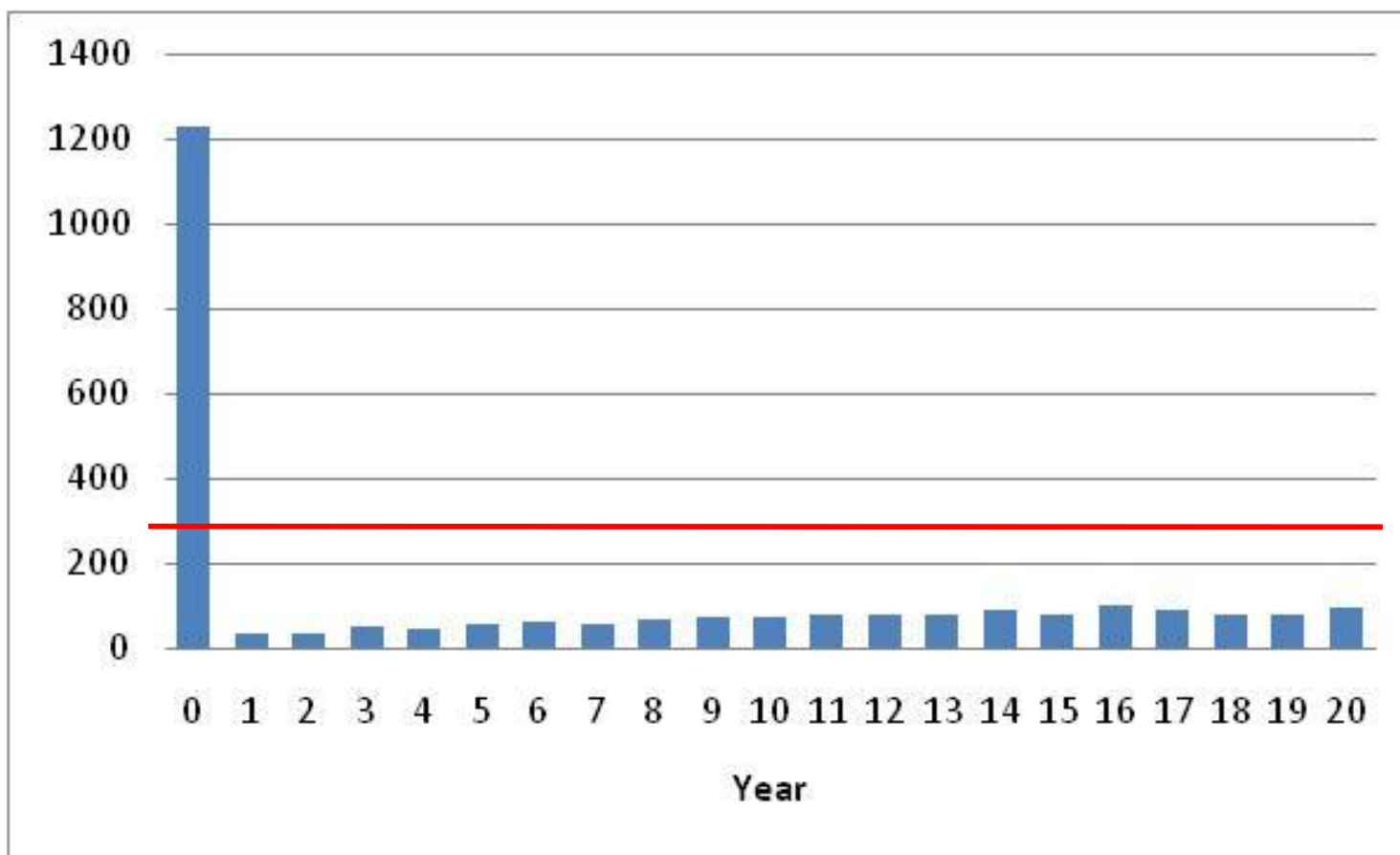
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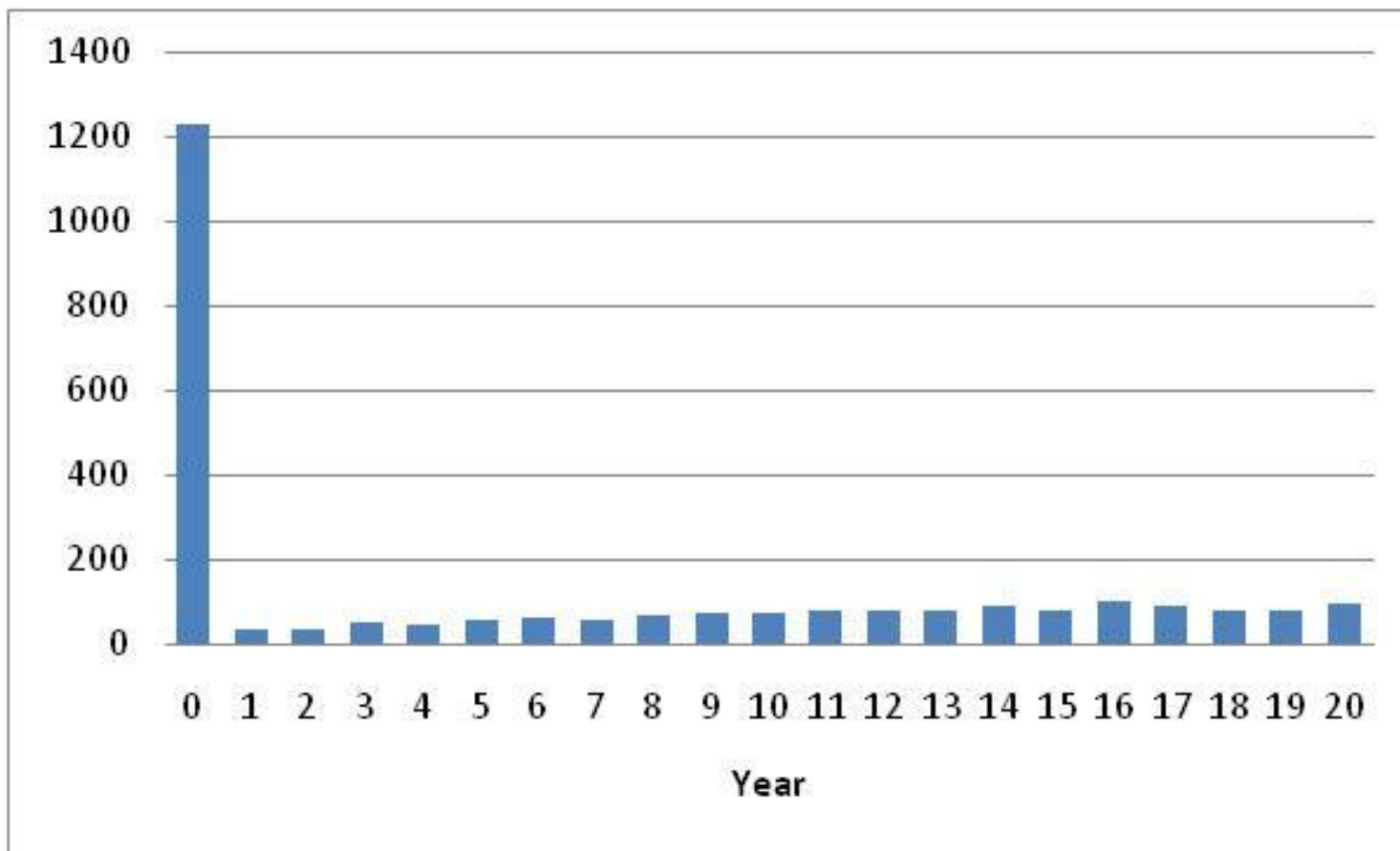
Cash flow for Wind Power plant

$$NPC = I/(1+i)^0 + C_1/(1+i)^1 + C_2/(1+i)^2 + \ldots + C_{20}/(1+i)^{20}$$
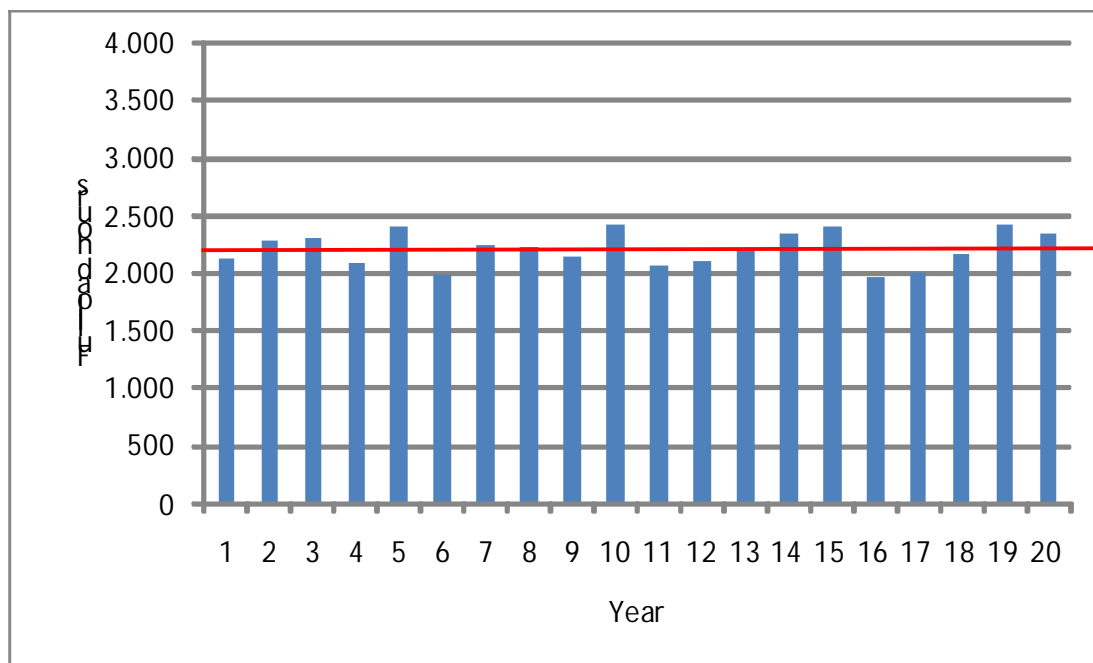
Cash flow for Wind Power plant

$$NPV = I/(1+i)^0 + C_1/(1+i)^1 + C_2/(1+i)^2 + \ldots + C_{20}/(1+i)^{20}$$

Average cost over the lifetime = Levellised cost (PMT)

Calculation of Unit Cost

Number of full load hours:

The number of hours the turbine has to run at maximum capacity to produce the total annual production

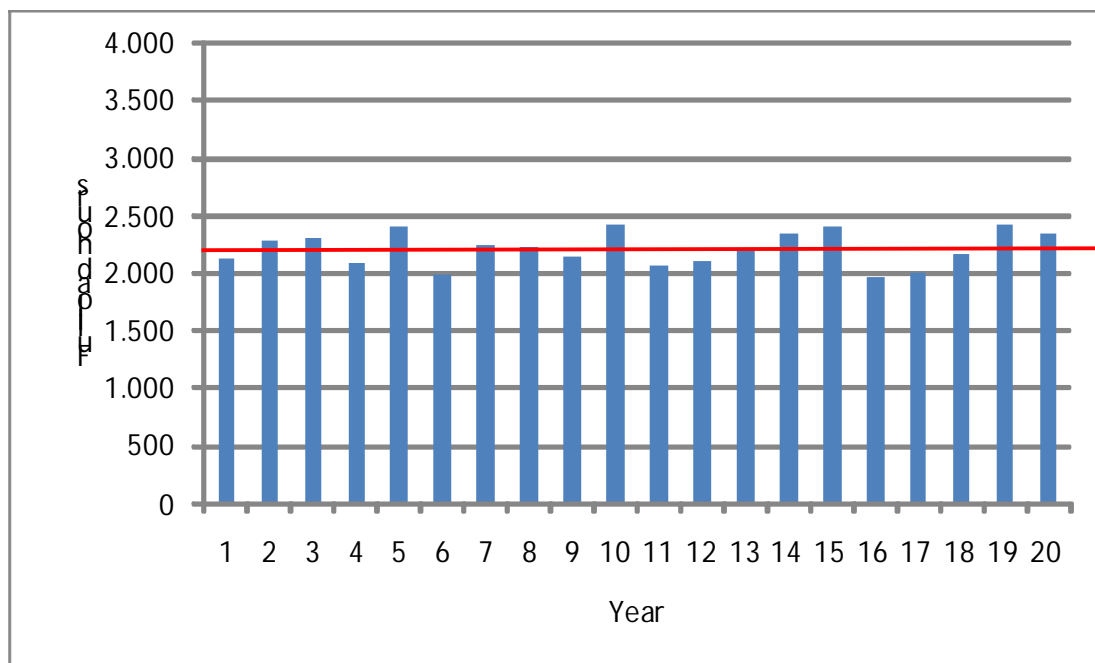Poul Erik Morthorst   15/3/2009

Calculation of Unit Cost

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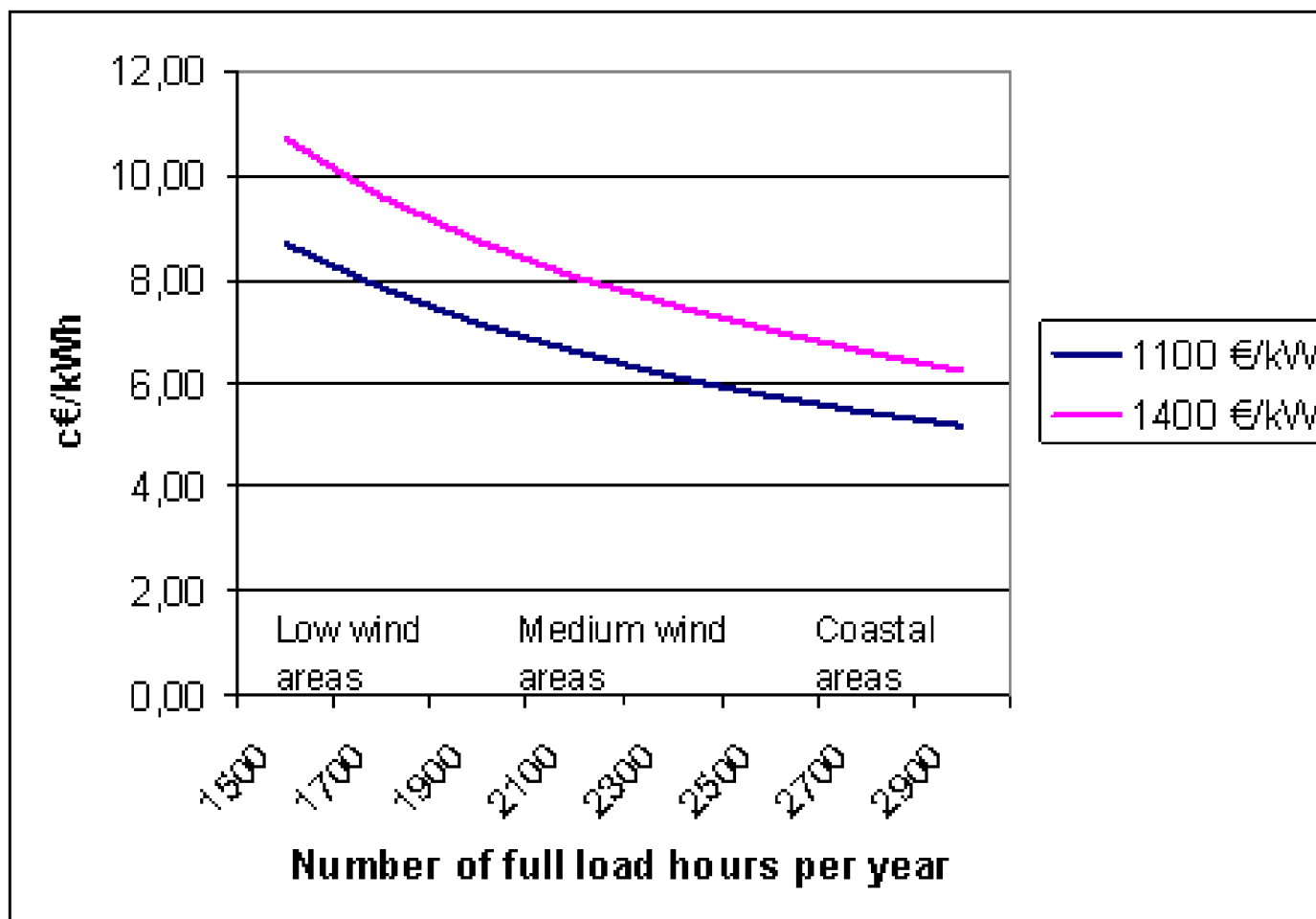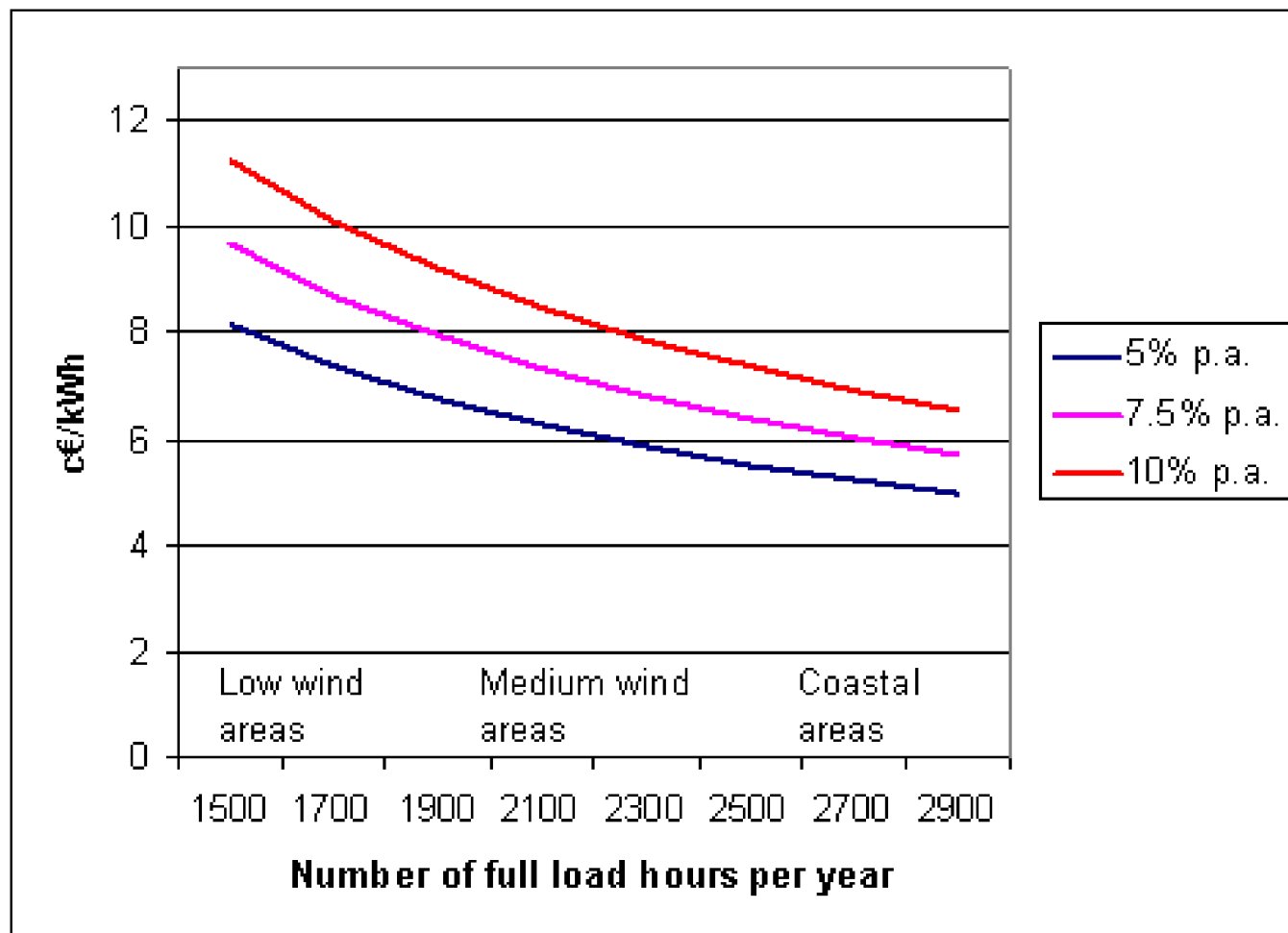
Unit cost = Levellised costs / Average Annual Production

=   c€/kWh (approx. 6-7 c€/kWh)

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Production costs

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Importance of discount rate

Socio-Economics vs. Business Economics
Basic conditions

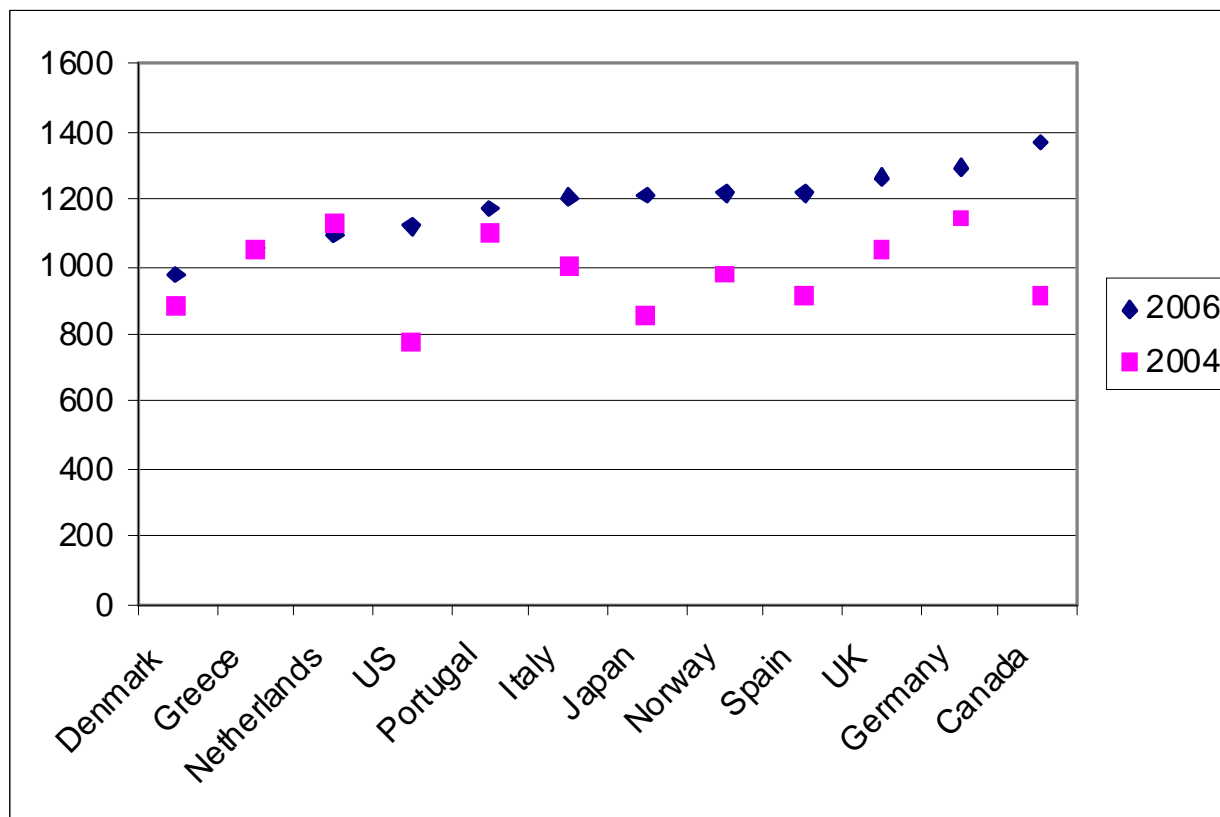|	Socio-Economics	Business Economics
Prices	Real terms (no inflation)	Nominal prices (including inflation)
Discount rate	Socio determined Real terms Typically 5-8% p.a.	Market determined Nominal terms Including risk premium
Revenues	Normally only costs	Payment schedules important
Conditions	Excluding taxes etc.	Including taxes, depreciation rules etc.
Lifetime	Technical lifetime (20 years)	Economic lifetime (< 20 years)

A real Socio-Economic analysis also includes...

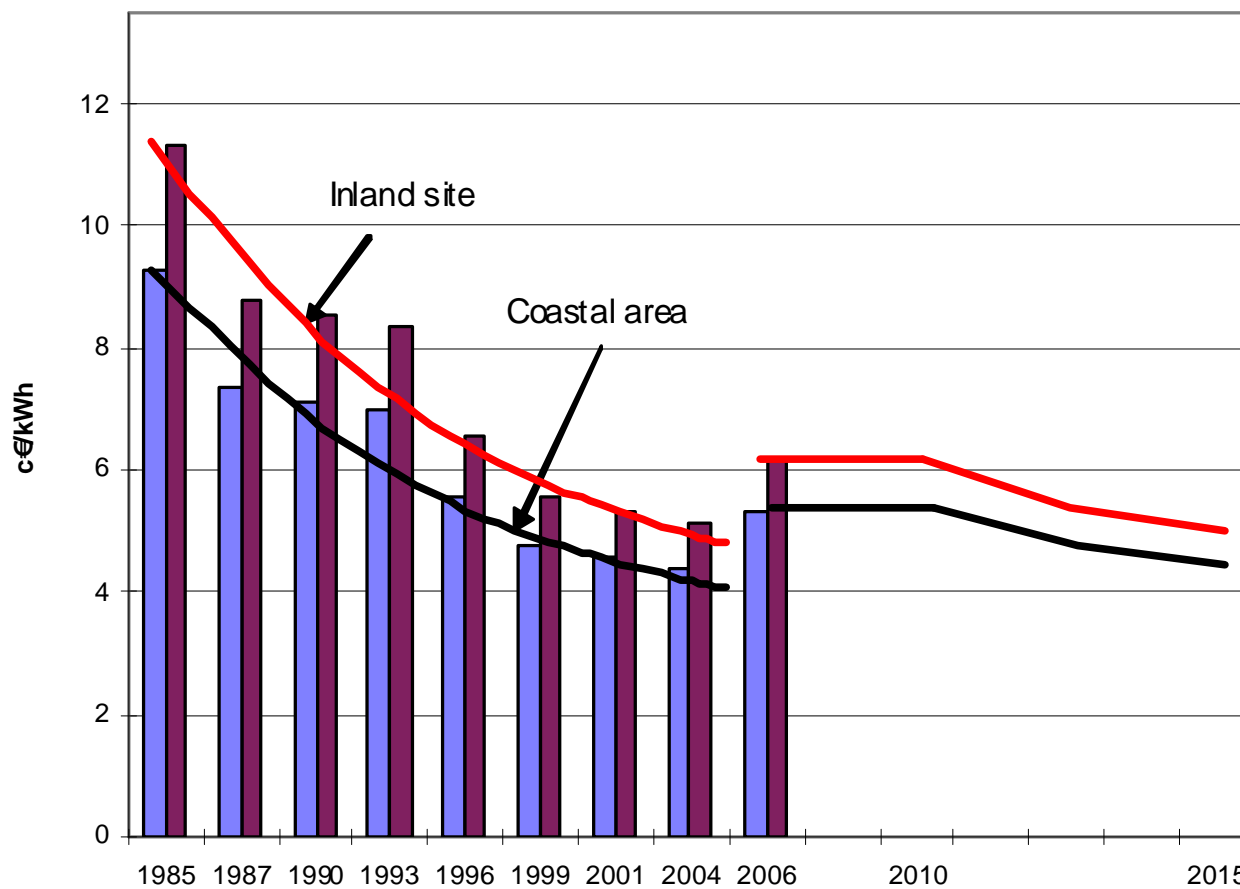|	Socio-Economics	Business Economics
Adjustment factor	Investment is substituting alternative use	Not considered
Externalities	Issues not included in prices and costs	Not considered

Development of Unit Cost

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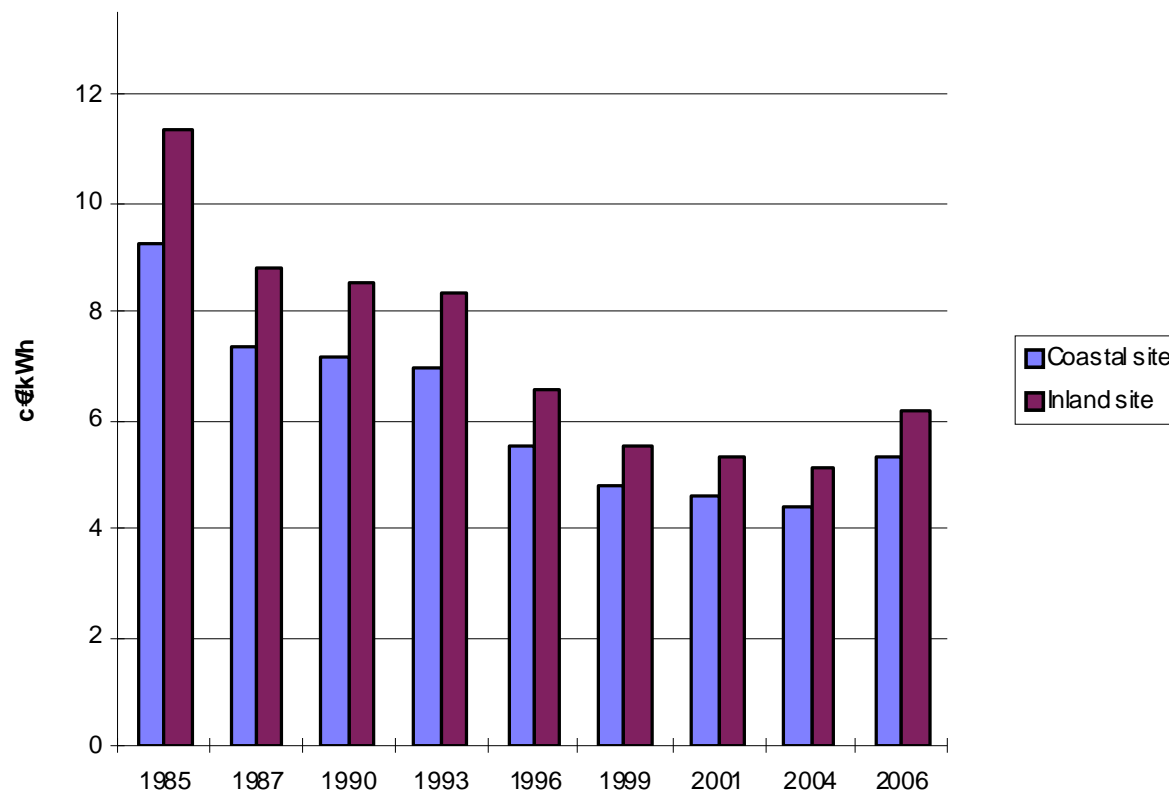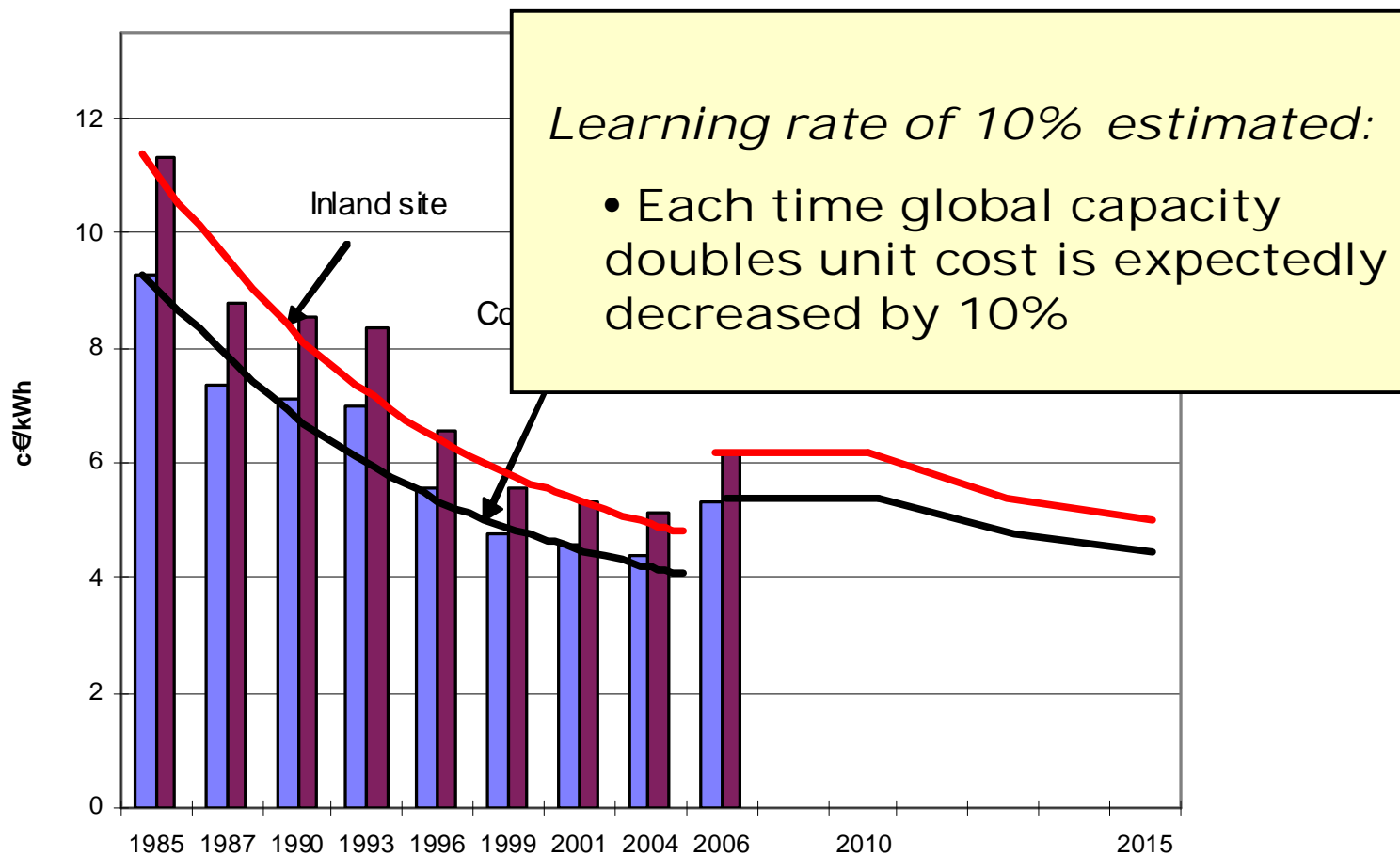
Increase in Turbine Price in different Countries

Experience Curve for Wind Power Unit Cost

Experience Curve for Wind Power Unit Cost

Inland site

c€/kWh

Learning rate of 10% estimated:

- Each time global capacity doubles unit cost is expectedly decreased by 10%

Wind Power Unit Cost by 2015
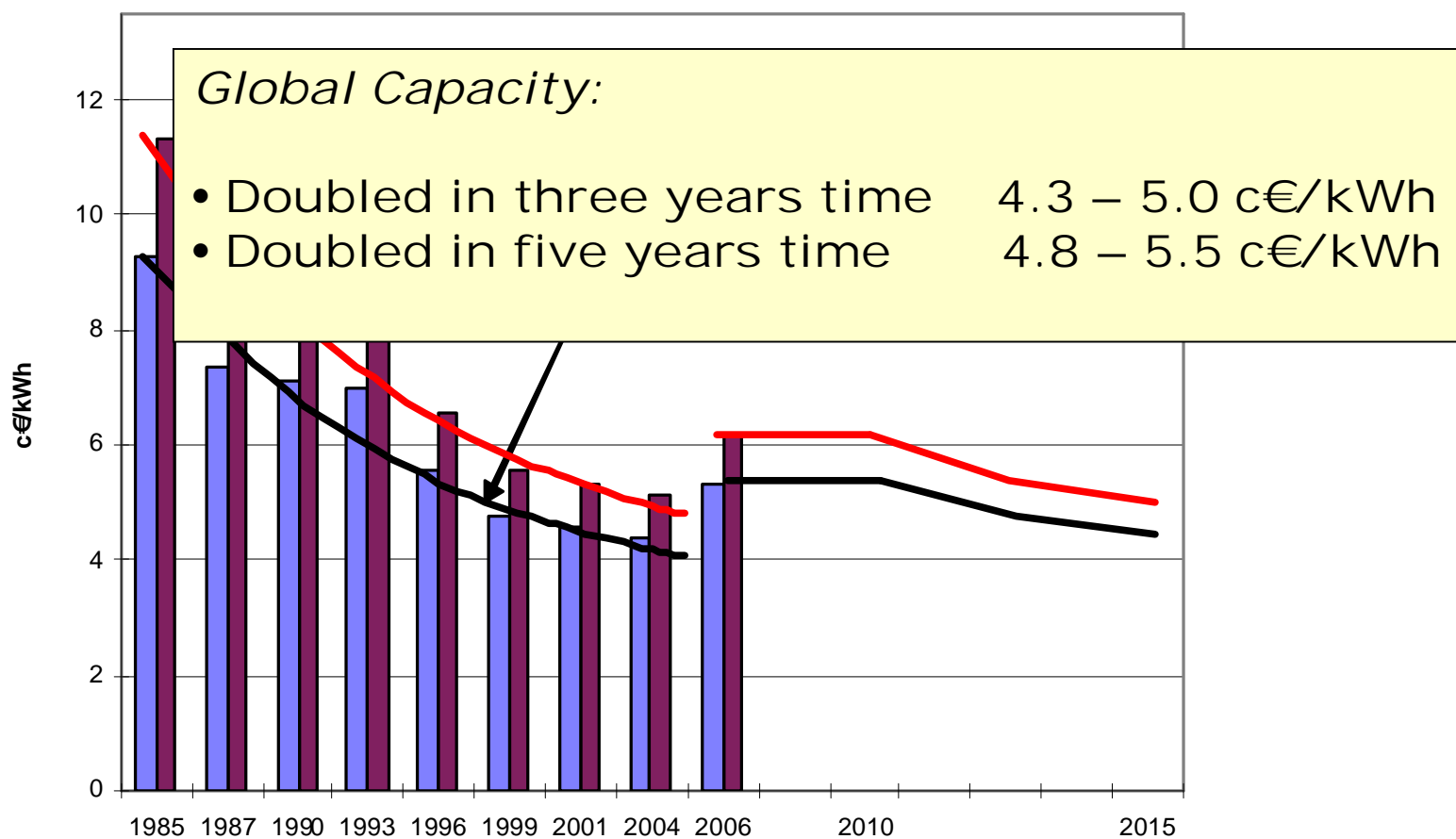
# Wind Power compared to Conventional Plants

Displaced or partly displaced cost components:

- Fuel costs

- Cost of CO_2-emissions (as given by the European Trading System for CO_2, ETS)

- Operation and maintenance costs

- Capital cost, including planning and site work

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Wind Power Compared to Natural Gas Power Plant – changing fuel costs
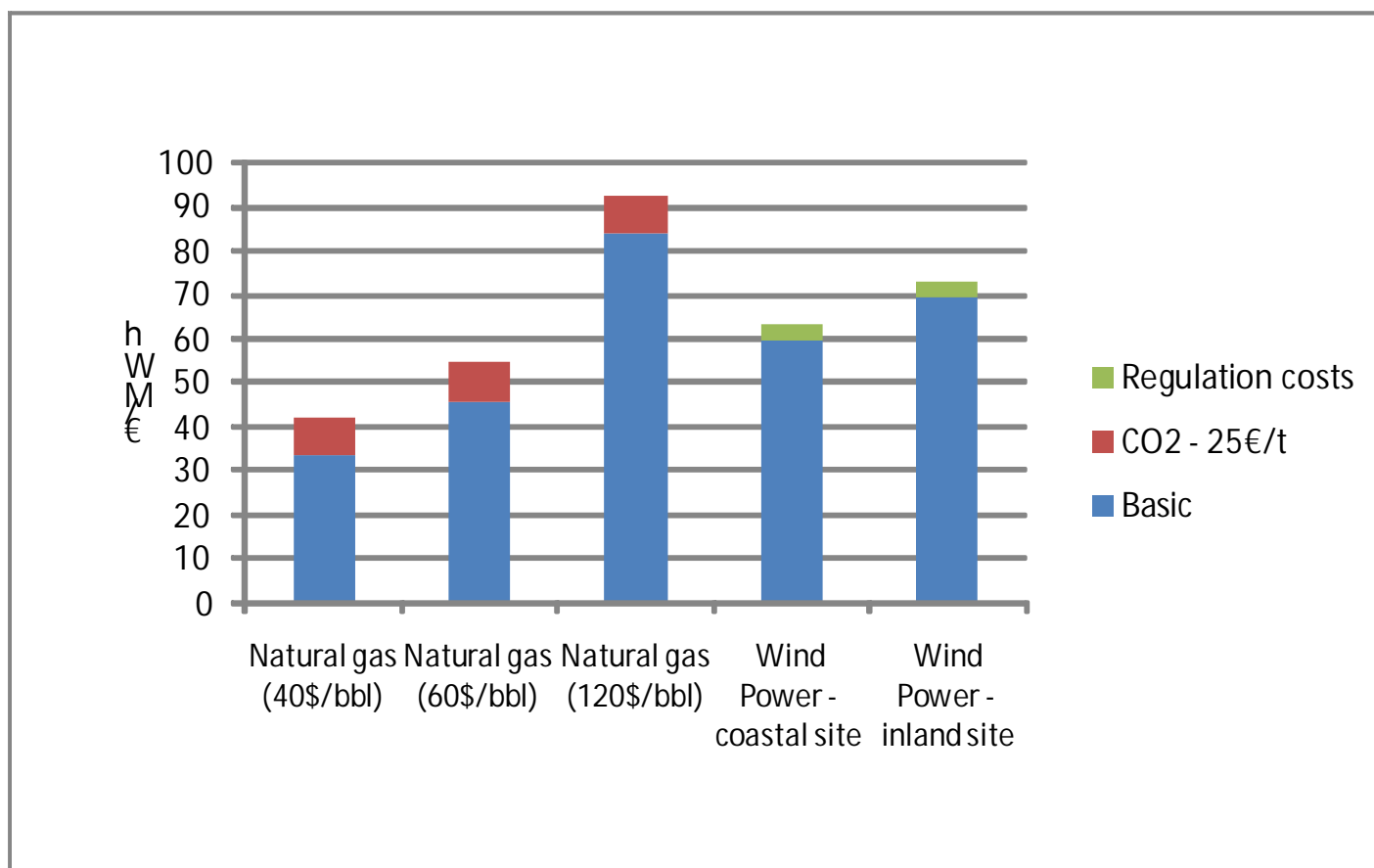
Wind Power Compared to Coal Fired Power Plant – changing costs of CO_2

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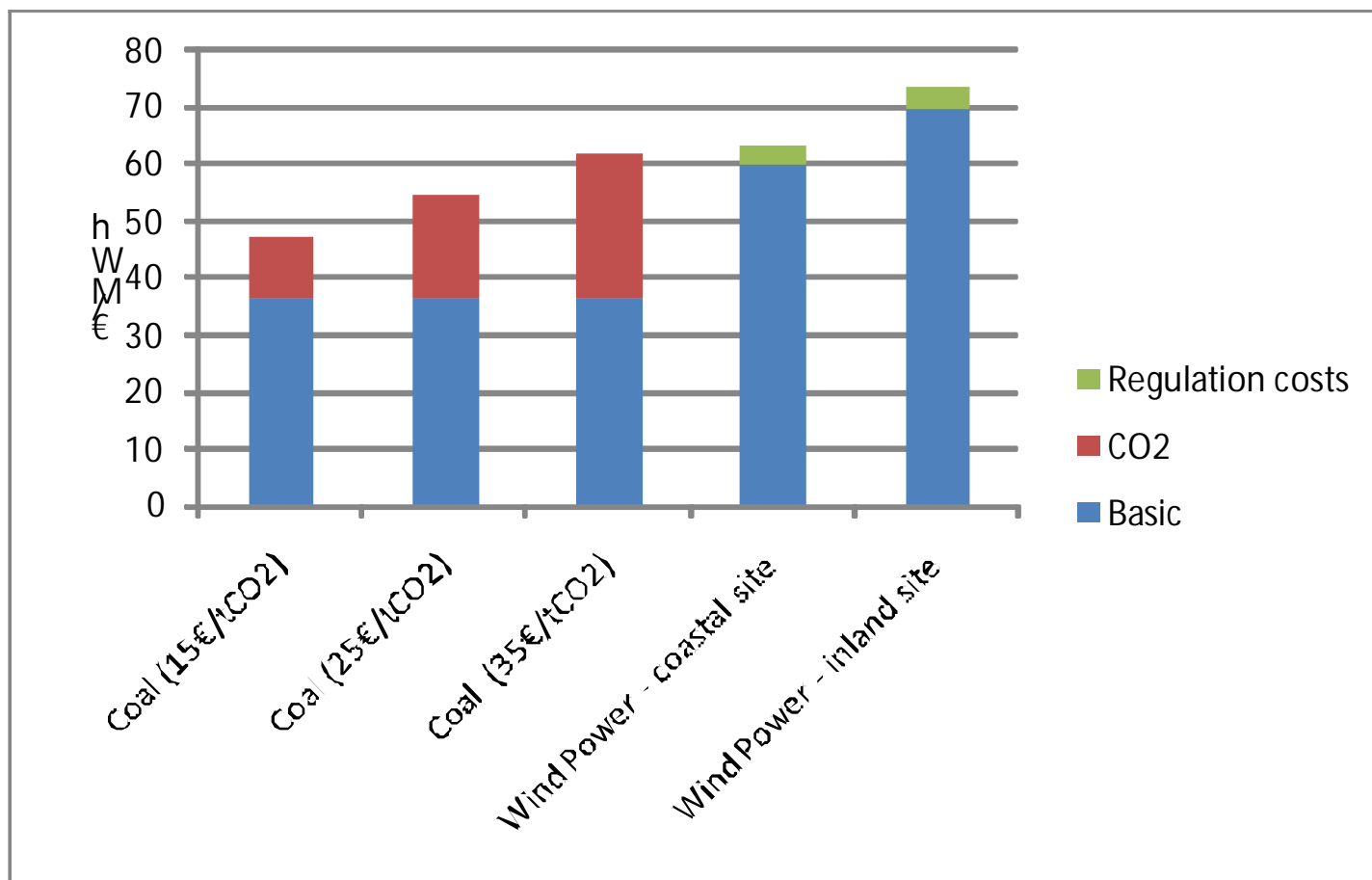
Conclusions

- Wind Power Economics are fairly simple with only a few important parameters
  - The annual wind-generated power production is tantamount

- Operation and Maintenance Costs are getting increasingly important
  - Improved reliability of turbine and fewer service visits

- Wind power has experienced a learning rate of 10% p.a.
  - Disrupted in 2004 by a price increase of more than 20%

- Increasing fuel prices needed to make wind power economic competitive to conventional plants
  - The European Emission Trading scheme on CO_2 will not do the job alone