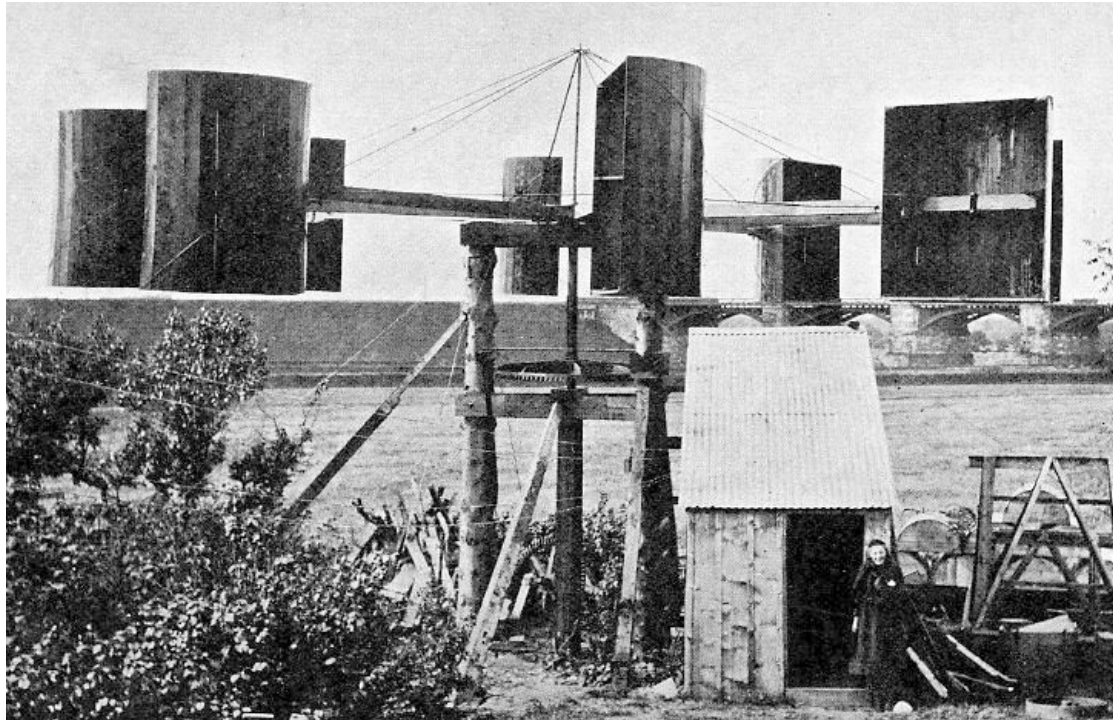


# **Wind Power: the story so far**

Dr Peter Musgrove  
First BWEA Chairman

## In the beginning....



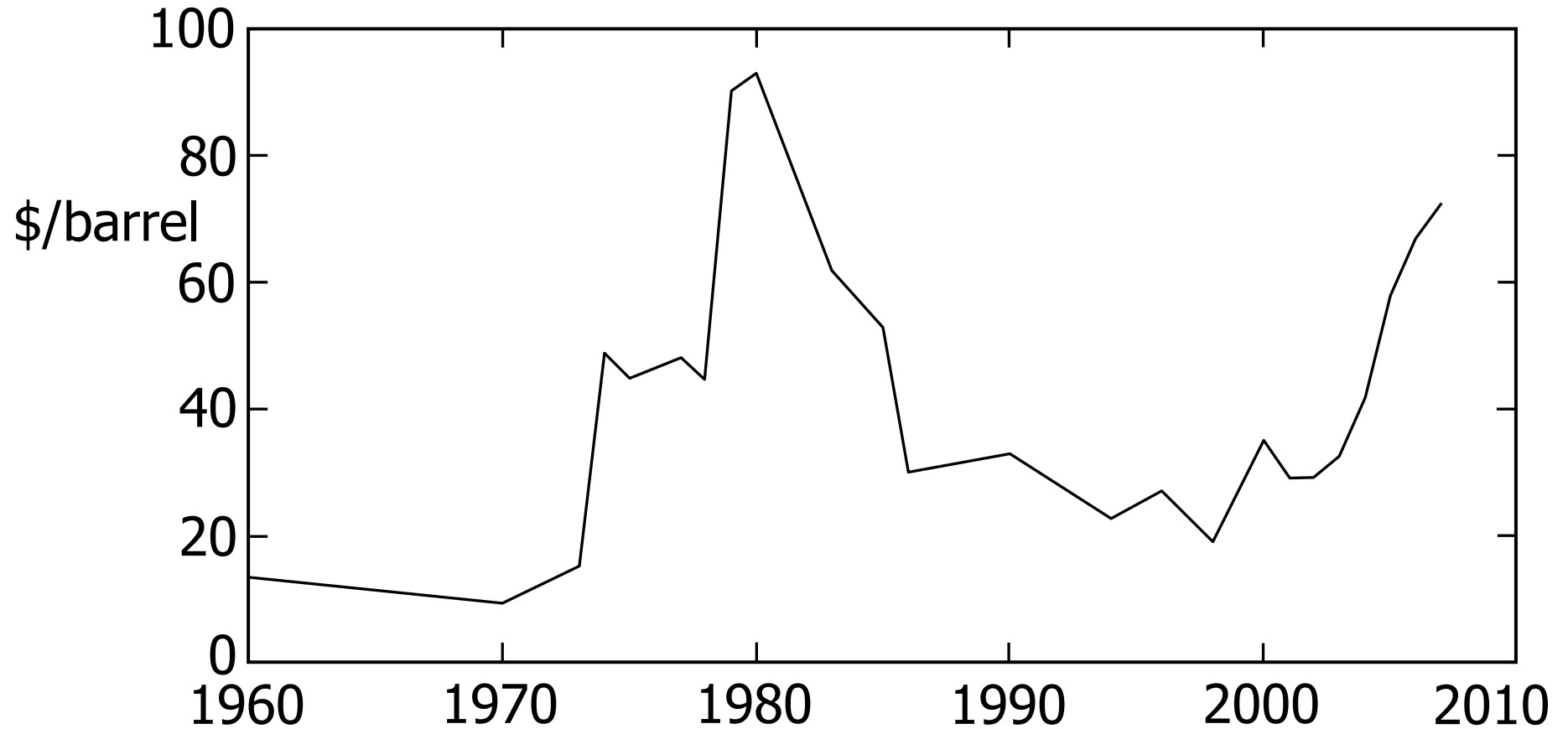
- Prof. James Blyth, Anderson's College, Glasgow, was first – in 1887 – to generate electricity from the wind.
- Photo shows his 1891 machine, at Marykirk (near Dundee).
- Power used to light his holiday home.

## **Smith-Putnam, 1941, 53 m dia., 1.25 MW.**



- Built at Grandpa's Knob, Vermont, New England.
- Two variable pitch steel blades, downwind.
- Grid-connected via synchronous generator.
- Succession of problems, never ran unattended.
- Dismantled 1945 after blade failure.
- Putnam's book reported it as very nearly successful.

# Oil price: inflation adjusted to 2007

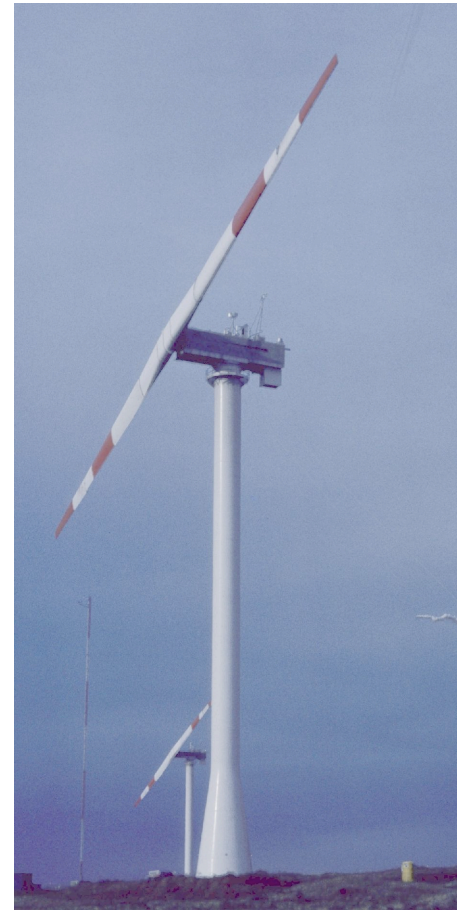


Data from BP Statistical Review 2008

## Post-1973; Focus was on Large Wind Turbines



GE Mod-1, 1979  
2 MW, 61 m dia.



Boeing Mod-2, 1982  
2.5 MW, 91 m dia.

## But in Denmark...



Riijsager, 1977 30  
kW, 10 m dia.



Bonus, 1982  
55 kW, 15 m dia.

## Then in California, in the early 1980s, came the wind boom.



- From 1981 thousands of small wind turbines installed.
- Initially all US made, but many failures.
- US Windpower most successful.
- Photo shows USW machines, 100 kW, 17 m dia., downwind rotor.
- 4000 in Altamont Pass, east of San Francisco.

## And Danish wind turbines went to California in their thousands.



- Danish wind turbines were more robust and reliable.
- 1985 peak year, 400 MW installed; half was Danish.
- 1986: oil price slumped, tax credits ended.
- Many manufacturers went bankrupt.
- Photo shows Micon, 65 kW, 16 m dia. machines, also in Altamont Pass

## Status at the end of 1990

- 1500 MW from 15,000 turbines operational in US (California); half were Danish.
- 340 MW in Denmark; 140 MW in rest of the world.
- **Reliable machines available from several manufacturers; mostly Danish.**
- Drive to reduce energy cost led to slow growth in turbine size.
- By 1990 typically about 35 m dia. and 300 kW rated.
- Danish three-bladed upwind rotor configuration dominant.
- Mostly fixed pitch machines with induction generators.

## **In the UK, to 1990**

- Early 1970s; initial focus was on wave power.
- Wind seen as least promising option, until offshore wind potential recognised.
- **BWEA formed 1978.**
- 1979 election won by Margaret Thatcher; 15,000 MW nuclear build programme started.
- Punitive property taxes (Rates) for wind turbines; deterred all except utilities.
- Just 8 MW wind by 1990, including 3 MW Orkney machine.
- 1990: Electricity industry privatised; NFFO introduced.

## From 1990 to 2000



- Oil price low, but growing concern over global warming.
- Global capacity grew rapidly; from 2 GW to 18 GW.
- Drive to reduce energy cost led to larger turbines.
- Basic rotor configuration unchanged.
- Photo shows 1996 turbines; 600 kW, 44 m dia., Bonus.

## From 2000 to 2007

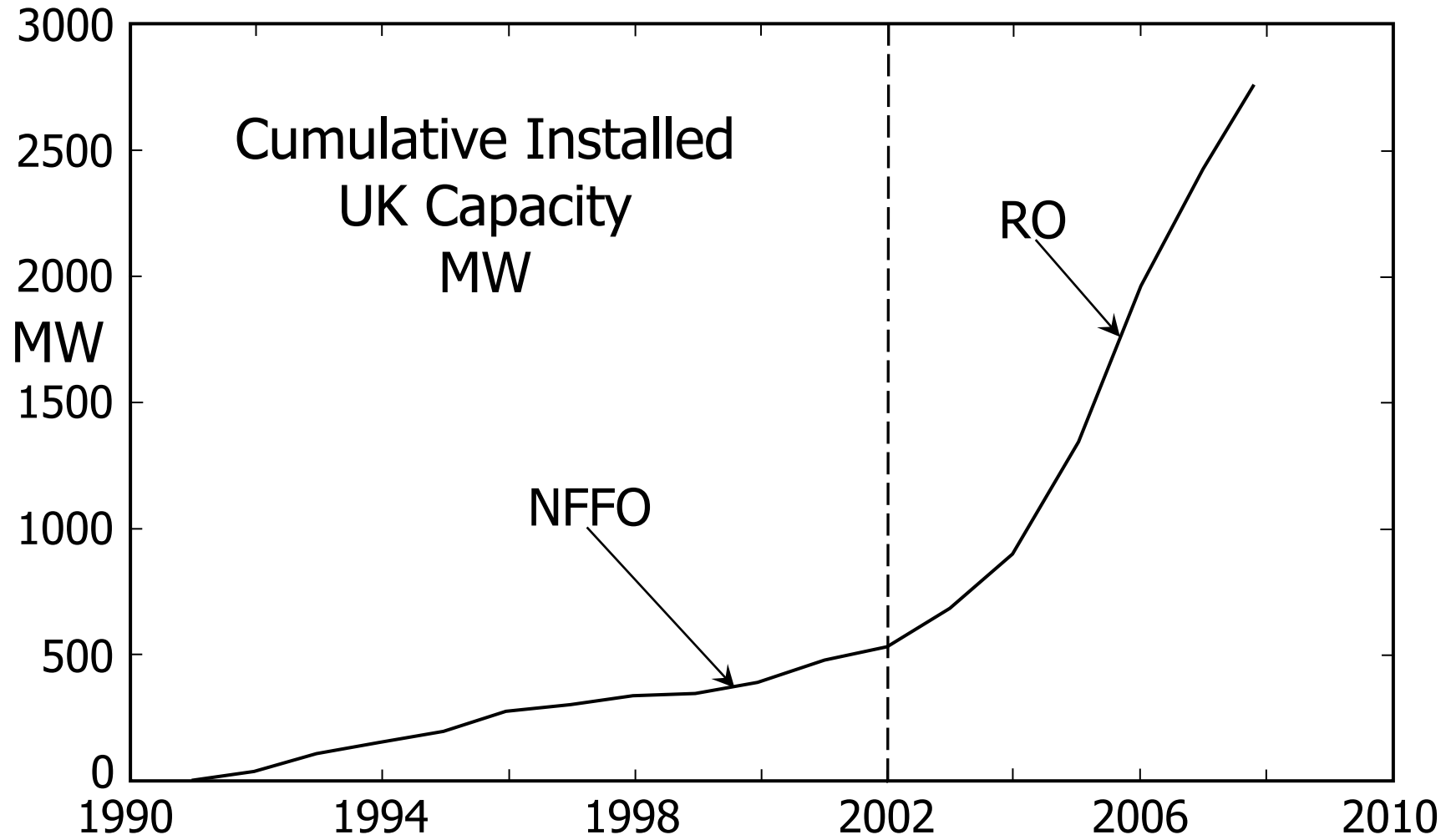


- Rapid growth continued; 94 GW by end of 2007.
- Annual growth rate 27% - despite turbine shortages.
- Most turbines now have variable blade pitch and variable speed.
- Offshore deployment commencing.
- Turbine size still increasing.
- Photo shows 2003 turbine; 2 MW, 80 m dia., Vestas.

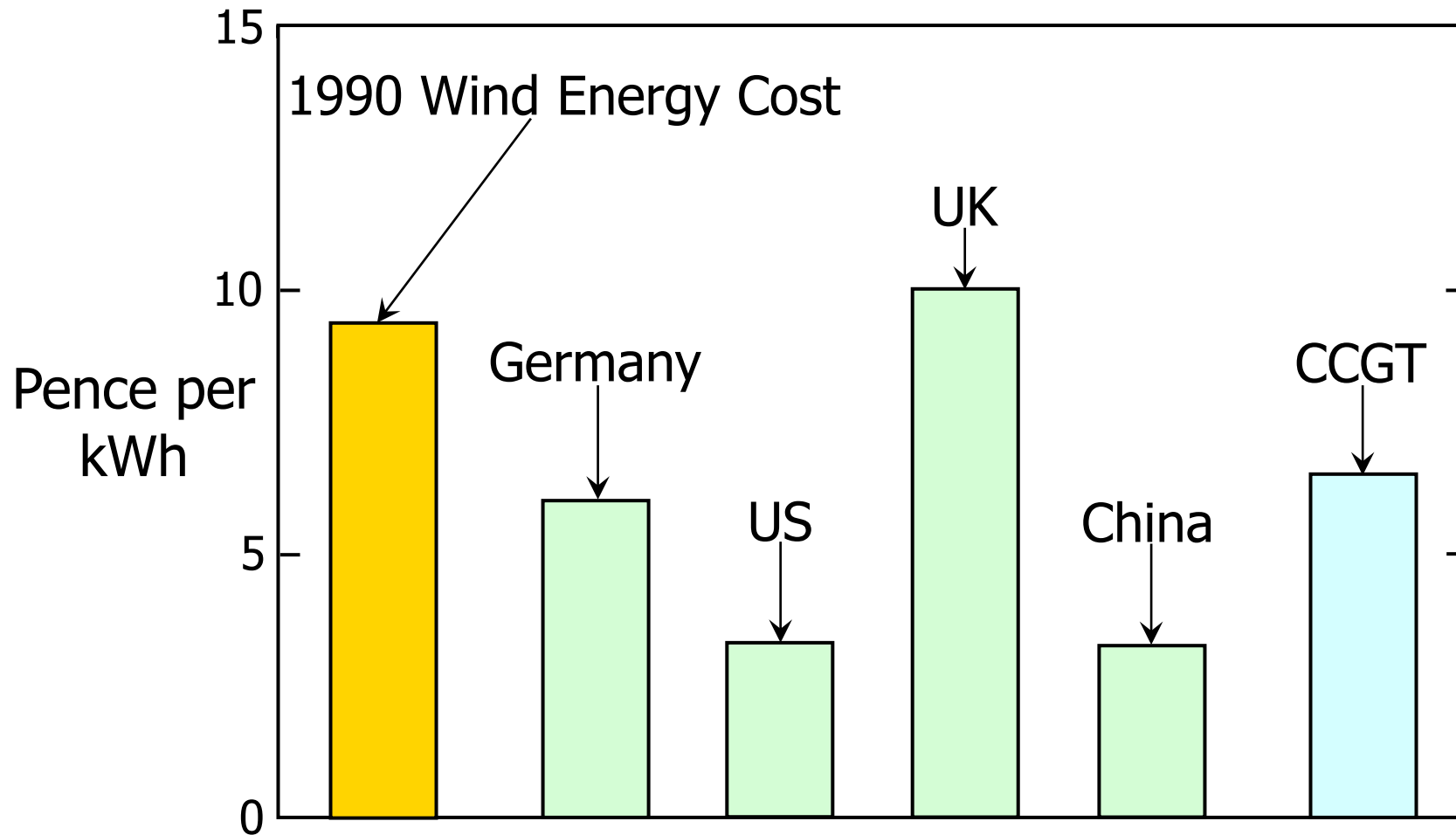
## Leading Countries at end 2007

Country	Capacity (MW)		Land Area 1000 km <sup>2</sup>	Power density kW/km <sup>2</sup>
	Total	In 2007		
Germany	<b>22,200</b>	1,630	349	64
US	17,000	<b>5,270</b>	9,160	2
Spain	15,100	3,530	500	30
India	7,800	1,570	2,970	3
China	5,900	3,310	9,330	0.6
Denmark	3,120	0	42	<b>74</b>
Italy	2,730	600	294	9
UK	2,490	530	242	10

# UK Capacity Growth

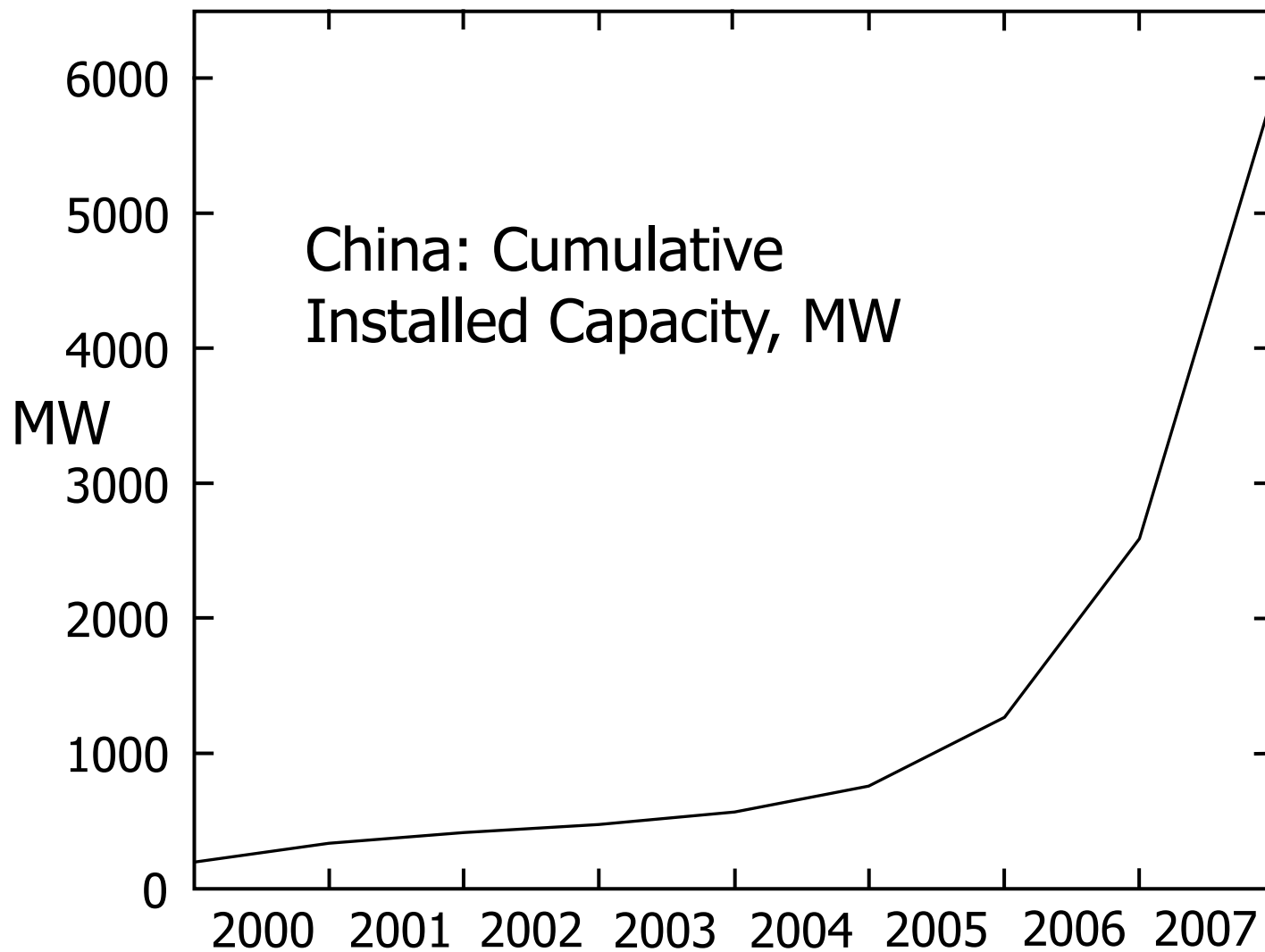


# Wind Energy Costs 2007/8



CCGT Energy Cost assumes gas at 75 p/therm (Oil at \$100/bbl)

# CHINA: Capacity Growth



# Global Cumulative Capacity Growth and percentage of global electricity

