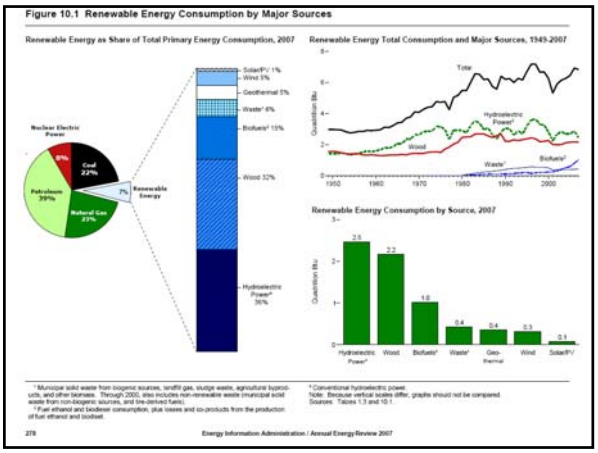
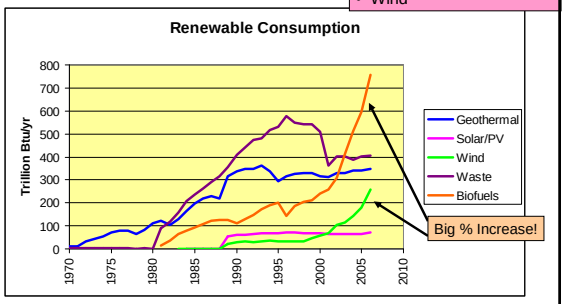
Class 16

Renewables (cont)
Wind Energy



Non-continuous sources:
- Solar (day/night cycle)
- Wind



- Both wind and alcohol have increased by 200-500 trillion Btu/yr over the last 5 years!
- This is still only 1 out of 100 quads of U.S. annual energy consumption!
- Let's call it a good baby step!

Wind Power

- Land vs ocean wind farms
- Costs
- Efficiency vs type of windmill
- Optimal locations
- Pluses & minuses

Costs of 50 MW Wind Farm

50 MW Windmill farm	$ 50,000,000	92.1%
10 miles transmission	$ 2,860,000	5.3%
Substation	$ 1,080,000	2.0%
Connection to Grid	$ 360,000	0.7%
Total	$ 54,300,000	

Total extras	$ 4,300,000.00
	7.9%

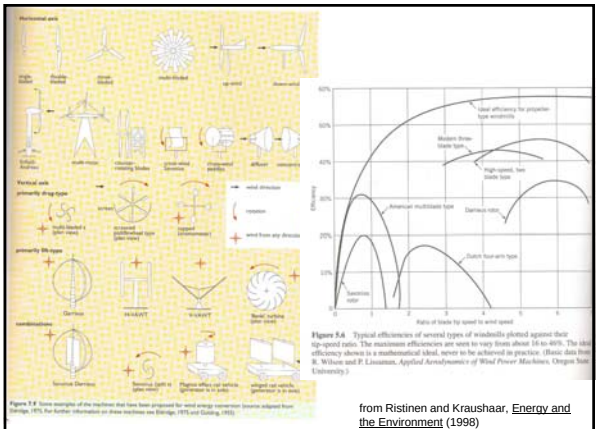
Installation Costs ($/kW)

Nuclear	$ 1,404
Coal	$ 971
Gas	$ 560
Wind	$ 1,086

Electricity Costs (¢/kWh)

Nuclear	3.75
Coal	3.25
Gas	>5.75
Wind	>5

Notes:
- These wind costs do not include the current government subsidy of 1.5¢/kWh for the first 10 years
- Electricity costs published by California wind energy people (1996) show coal at 4.8-5.5 ¢/kWh, nuclear at 11.1-14.5 ¢/kWh, gas at 3.9-4.4 ¢/kWh, and biomass at 5.8-11.6 ¢/kWh



from Boyle, Renewable Energy (2004)

from Ristinen and Kraushaar, Energy and the Environment (1998)

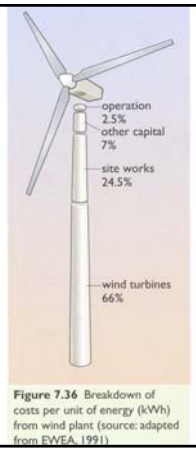
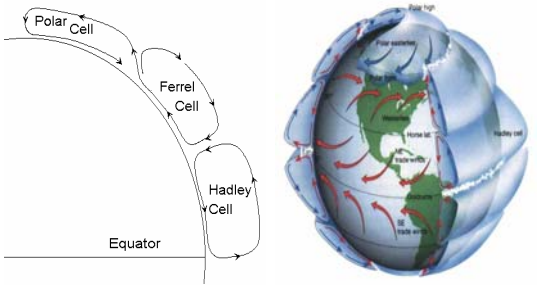
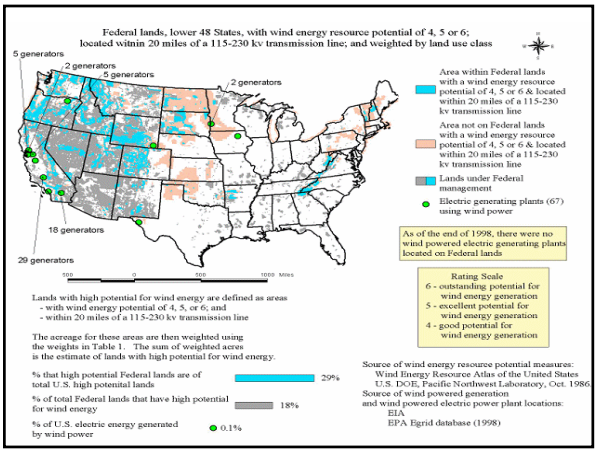


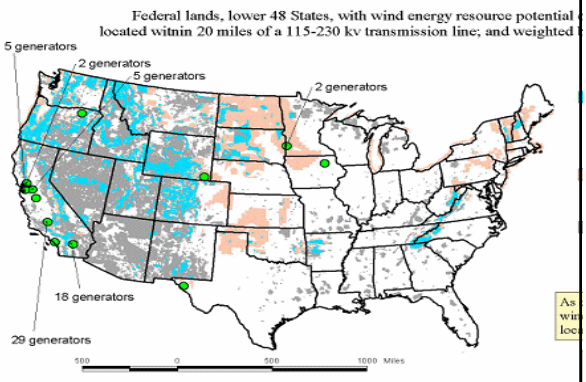
Figure 7.36 Breakdown of costs per unit of energy (kWh) from wind plant (source: adapted from EWEA, 1991)

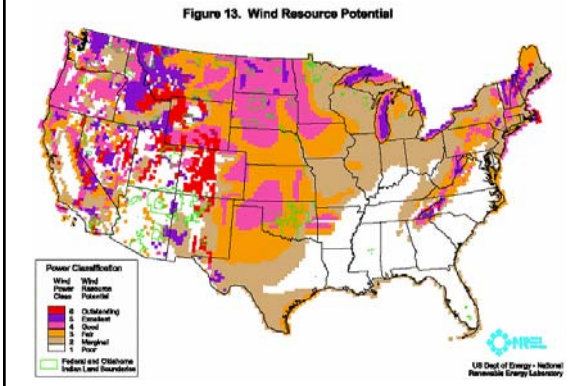
from Boyle, Renewable Energy (2004)

Global Wind Patterns

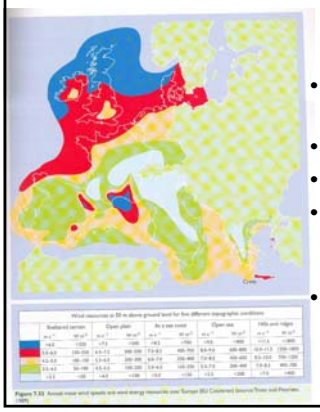








http://www.eia.doe.gov/cneaf/solar.renewables/ilands/fig13.html



Wind Energy in Europe

- Wind speed at 50 m elevation
- Blue is > 6 m/s
- North Sea (obvious)
- Southeast France
  - Squeezed between Pyrenees and Alps
- Valley on west side of Pyrenees

from Boyle, Renewable Energy (2004)

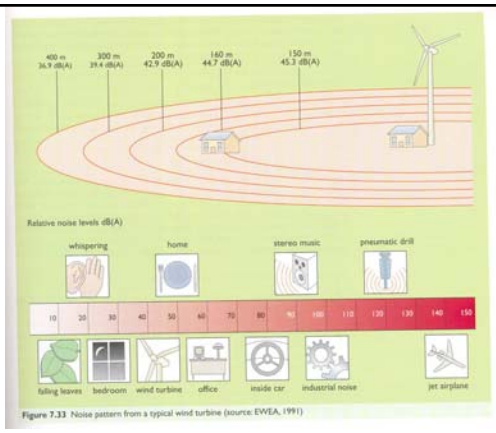


Figure 7.33 Noise pattern from a typical wind turbine (source: EWEA, 1991)

from Boyle, Renewable Energy (2004)

Wind Power

Advantages	Disadvantages
• Prime fuel is free • Infinitely renewable • Non-polluting • In UK seasonal variation matches demand • Big generators can be located on remote sites • Saves conventional fuels • Saves construction of conventional generation • Diversity of power generation methods	• Risk of blade failure (total destruction of installation) • Suitable small generators not available • Unsuitable for urban areas • Cost of storage battery or mains converter station • Acoustic noise of gearbox and rotor blades • Construction costs of tower and access roads • Electromagnetic interference if metal rotor used • Environmental objections

Source: Shepherd and Shepherd, Energy Studies (2003)

Final Thoughts (on Wind)

- Costs have come down considerably
- Problems if too much wind power
  - Non-continuous source
  - Electricity need on demand
  - Too expensive to have a power plant on idle when the wind does not blow
  - Higher temperatures when the wind does not blow
- Environmental problems
  - Unsightly
  - Noise, radio interference
  - Must be near power lines

Obama vs McCain on Energy

http://money.cnn.com/2008/06/09/news/economy/candidates_energy/index.htm?section=money_latest

http://www.scribd.com/doc/6007835/Obama-vs-McCain-on-Energy