

Wind Power

100% clean, 100% possible



Wind power technology



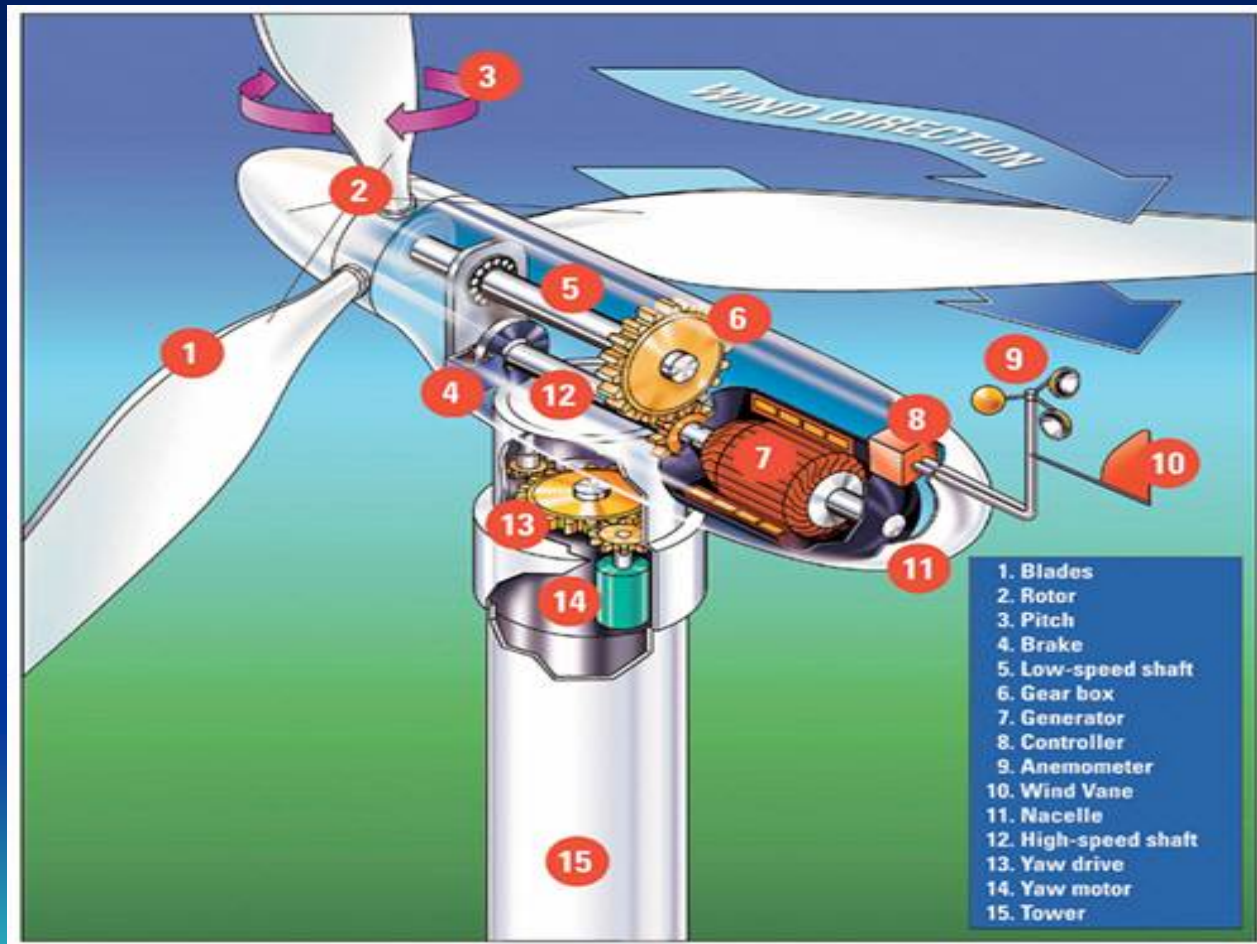
$$P = \frac{1}{2} \times \text{efficiency} \times \text{air density} \times \text{swept rotor area} \times (\text{wind speed})^3$$

20 Years of Wind Technology Development

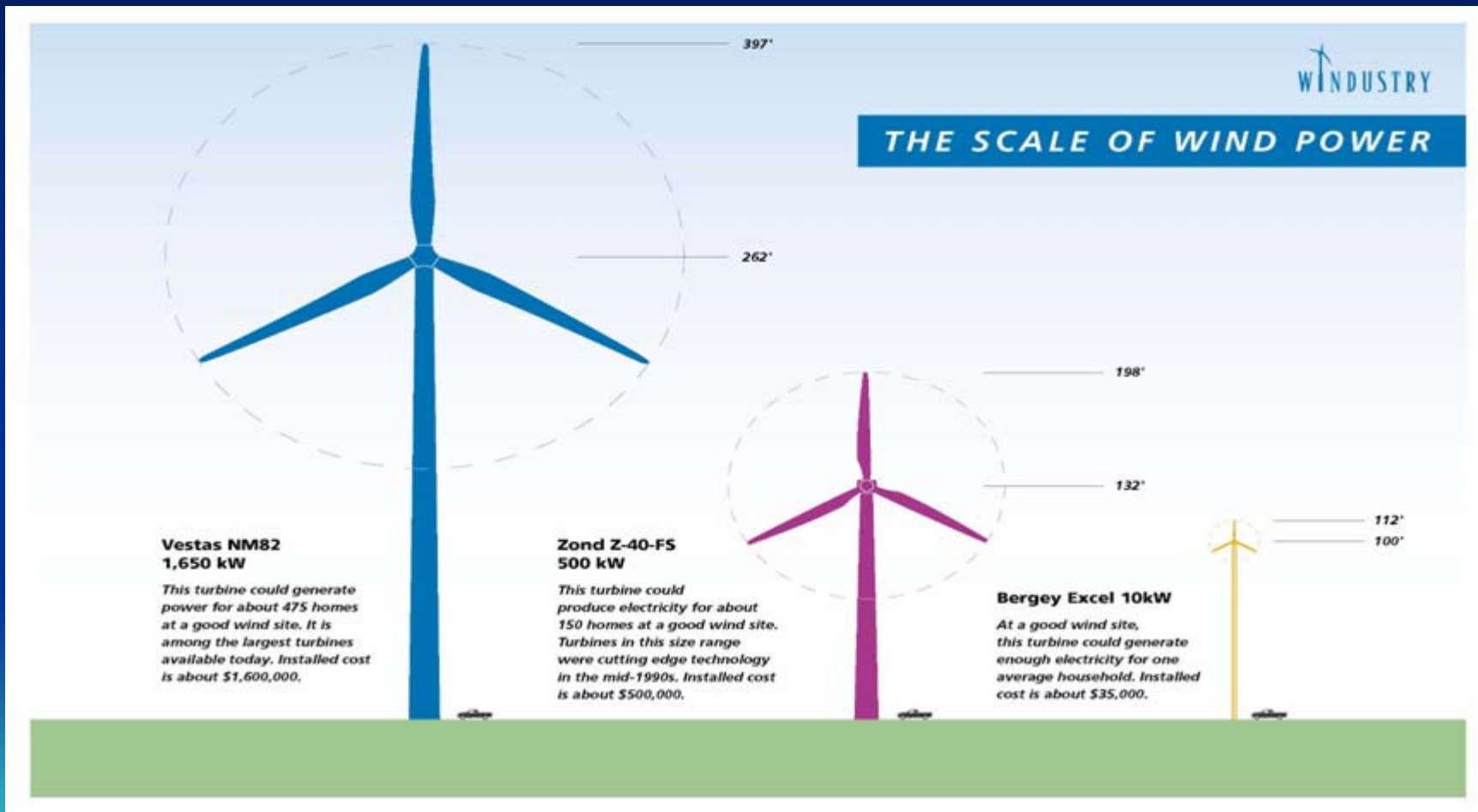


	<u>1981</u>	<u>1985</u>	<u>1990</u>	<u>1996</u>	<u>1999</u>	<u>2000</u>
Rotor (Meter)	10	17	27	40	50	71
KW	25	100	225	550	750	1,650
Total Cost, k	\$65	\$165	\$300	\$580	\$730	\$1,300
Cost/kW	\$2,600	\$1,650	\$1,333	\$1,050	\$950	\$790
MWh	45	220	550	1,480	2,200	5,600

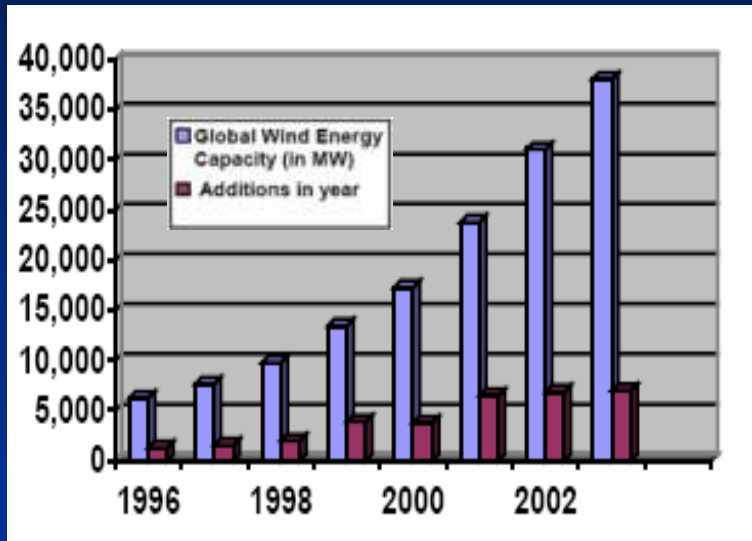
The turbine



The bigger the better



Worldwide Wind Capacity



- Europe in the lead
- US first out of gates, now third in national capacity (behind Germany and the Netherlands).

Costs of electricity generation

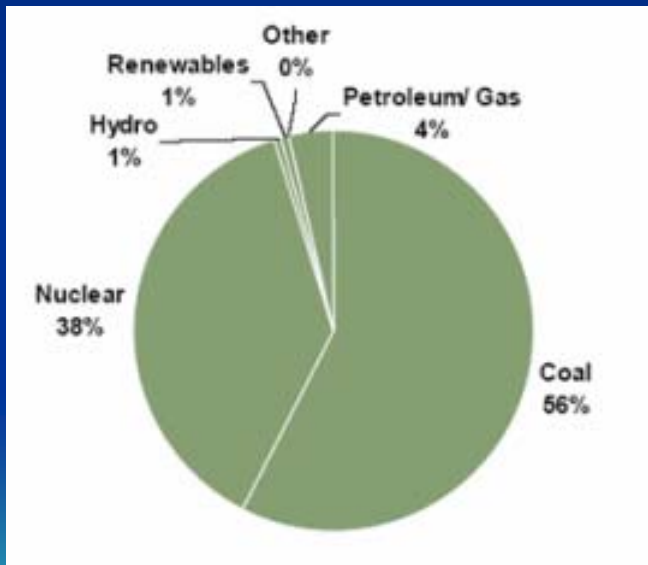
Energy Source	Levelized Costs
<i>Coal</i>	4.8 - 5.5
<i>Gas</i>	3.9 - 4.4
<i>Hydro</i>	5.1 - 11.3
<i>Biomass</i>	5.8 - 11.6
<i>Nuclear</i>	11.1 - 14.5
<i>Wind</i>	4.0 - 6.0

- Levelized cost of wind power down almost 90% over last 20 years.
- Competitive with other energy sources, especially with the PTC factored in.



Current energy mix in PA


- Most of energy from coal (56%)
- Next largest slice from nuclear (38%)



Under these conditions, in order to keep up with demand, we have to pollute more

Source: Black & Veatch (2004). *Economic impact of renewable energy in Pennsylvania*

Pollution in PA

- PA ranks second in SO₂ emissions
 - Sixth in NO_x emissions
 - Fifth in CO₂ emissions.
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- Also, electrical plants are the biggest source of mercury pollution across the US

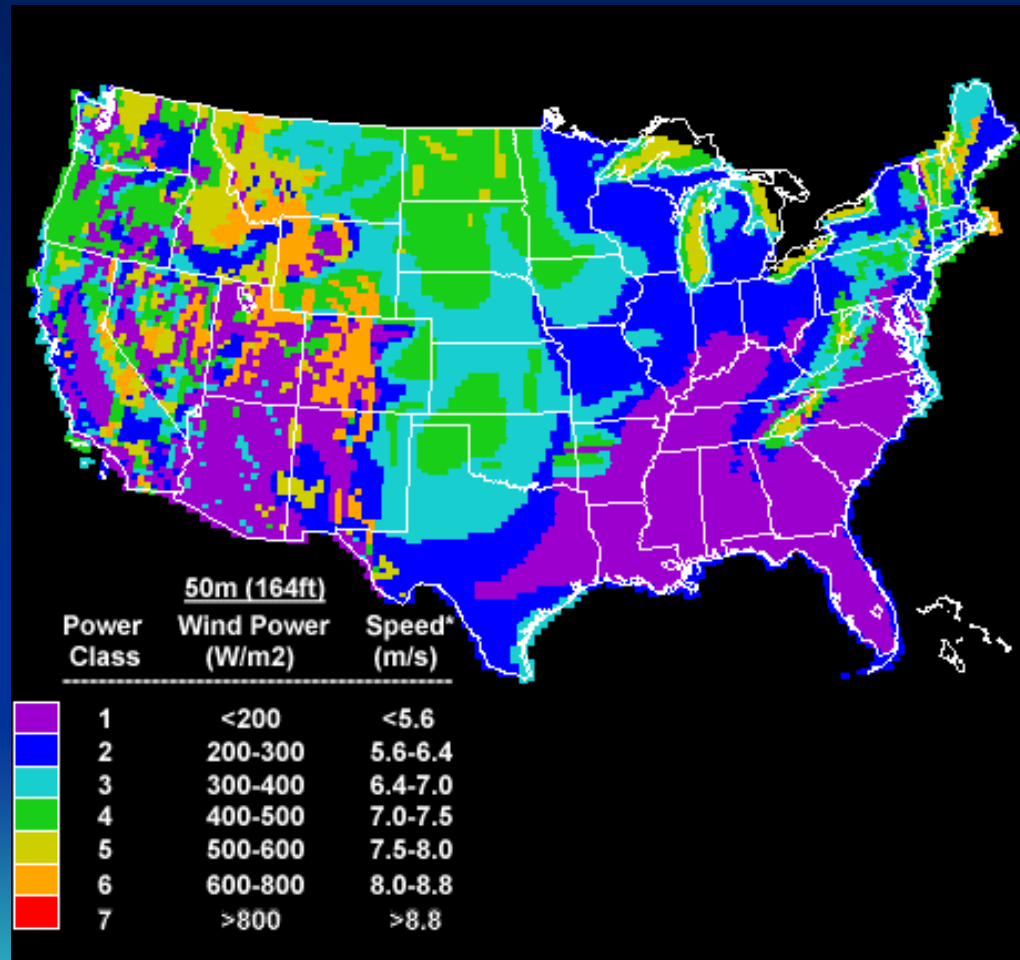
Wind, a breath of fresh air...

- No pollution
- Economically feasible
- Technologically efficient

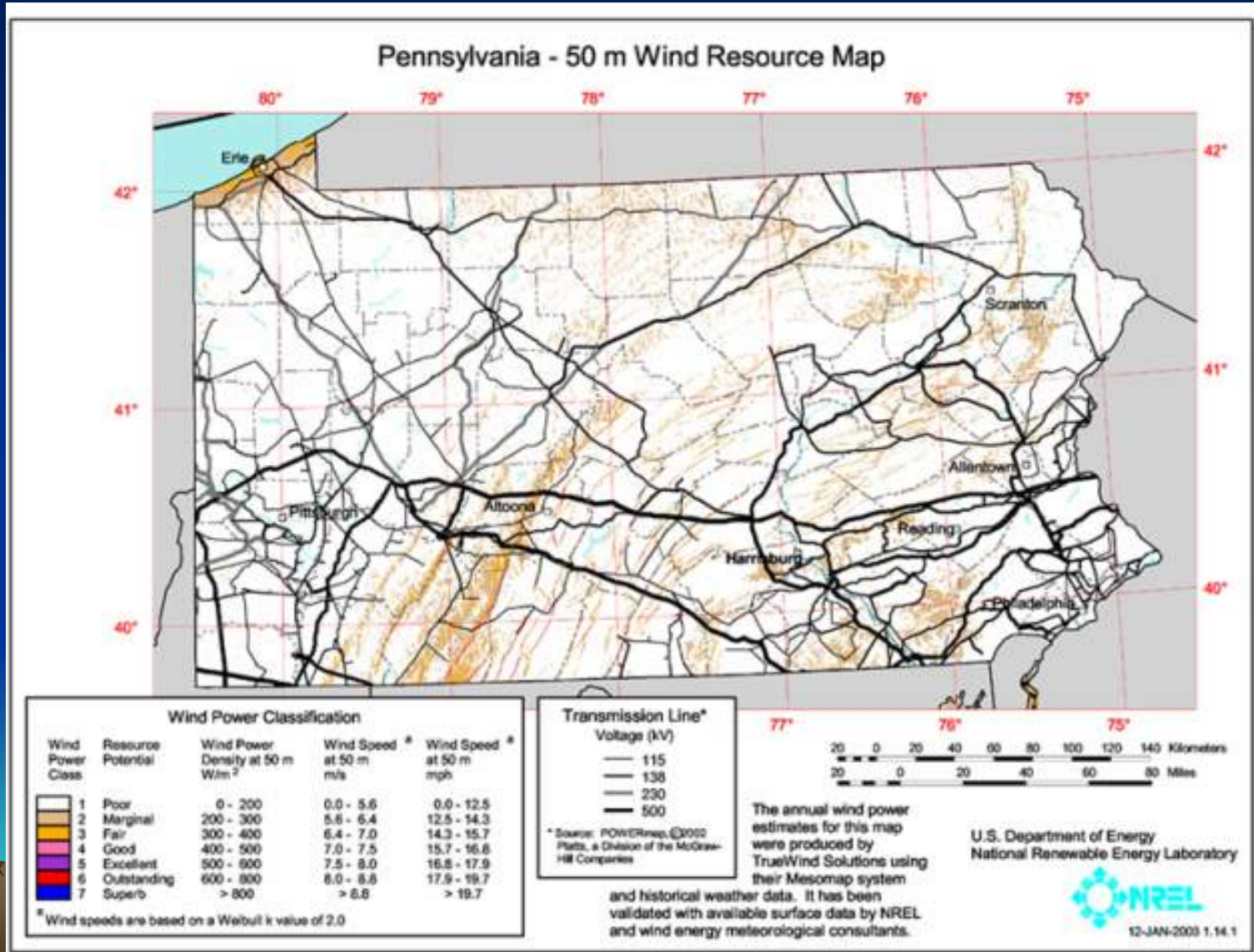
Only thing left is figuring out *where* to put turbines...



US wind potential




PA wind potential



Is it enough?

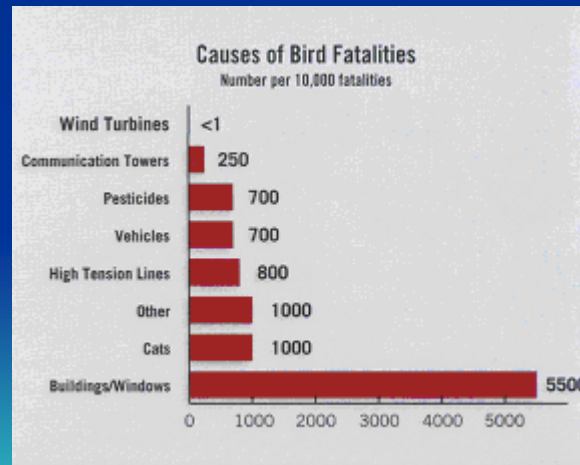
- Could produce almost 44,000 GWh of electricity per year
- 21% of PA's 2002 total electricity production.

Where would it go?

- Would only require 0.14% of the land area.
 - After construction, typical industrial scale turbine only takes up $\frac{1}{4}$ acre; can be farmed around
- 

What about the birds?

- Often cited concern by opponents is the threat to bird populations
- Only problem with poorly sited wind farms (such as the infamous Altamont wind farm)



Source: www.awea.org

NIMBY

- Not In My BackYard
- High profile cases → Nantucket Sound
- Requires “reframing”
- Most social studies suggest NIMBY effect is often exaggerated



Legislation in PA

- Utilities deregulation → opened of electricity markets to competition → consumer demand
- Advanced Energy Portfolio Standard (AEPS)
 - Tier 1: solar PV, wind power, low-impact hydropower, geothermal, biologically-derived methane gas, fuel cells, biomass, and coal mine methane
 - 8% by 2020
 - Tier 2: waste coal, distributed generation systems, demand-side management, large-scale hydropower, municipal solid waste, by-products of the pulping process, and integrated combined coal gasification technology
 - 10% by 2020



AEPS cont...

Good step in right direction, but seriously flawed...

- Tier 1 only 8%
- Use of fossil fuels
- Waste coal???
- “Force majeure”



Wind power's next steps

- Build it and they will come
 - 129 MW capacity now, with more than 200 MW in planning/construction
- Make the PTC permanent
- Continue to advertise
- Win the PR game

