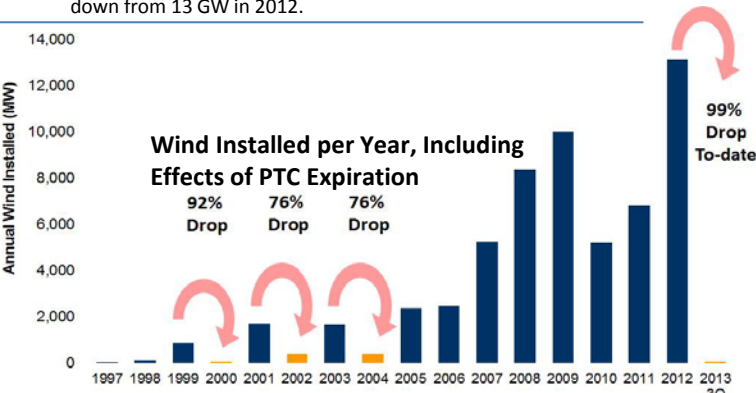
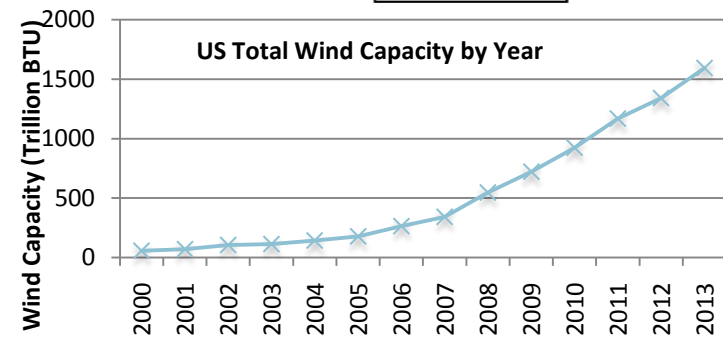
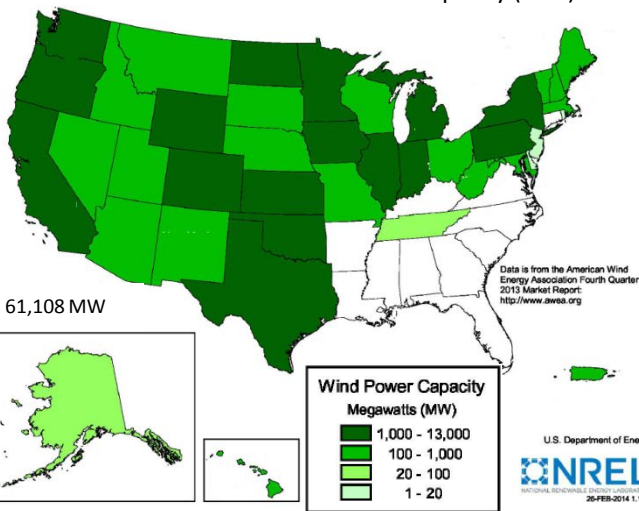


State of the Industry

- Total Installed Wind Capacity at end of 2013 is 61,108 MW
- 87,000 wind-related jobs at end of 2012
- Wind energy is economical, with prices at 4-6 cents per kWh
- Wind energy provides 35% of all new power capacity since 2008
- Production Tax Credit is vital to generating more wind capacity. It expired in 2013 and the industry installed less than 1 GW that year, down from 13 GW in 2012.



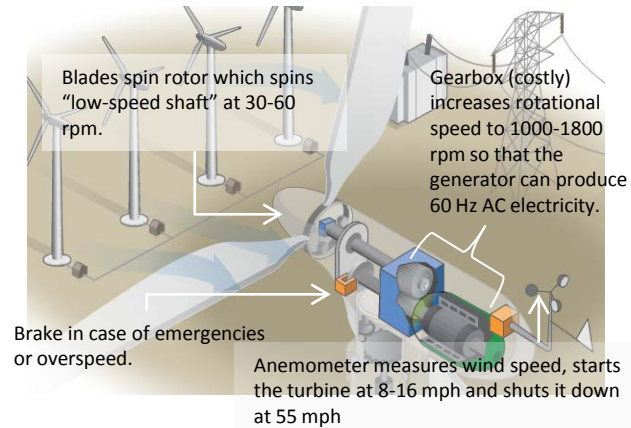
2013 Year End Wind Power Capacity (MW)



Common Areas of Concern

- Variability of wind conditions: Utility Wind Integration Group concluded that cost increases due to variability and uncertainty sum to less than 10% of value of energy generated.
- Wildlife safety: AWEA reports wind turbines account for only 0.0003% of human-caused avian fatalities.
- Sound: 40 dB at 400 meters, & homes are no closer than 300m.
- Property values: Study of 50,000 homes across 9 states near 67 wind facilities shows no depreciation of property value.

Technology



Timeline of Technological Advancements

- 1990: New Materials for Components for manufacturability
- 1991: Advanced blade designs produce 30% more energy
- 1995: First-in-industry systems demonstrated
- 2003: NuMAD software allows for computational analysis of blades, which leads to more efficient blades
- 2004: 1.5 MW permanent magnet drive train reduces cost of production by 12.8%
- 2005: STAR curved blade tips debuts, increasing efficiency
- 2007: GE 1.5 MW commercialized and wind resource maps available
- 2008: 20% wind energy by 2030 report released

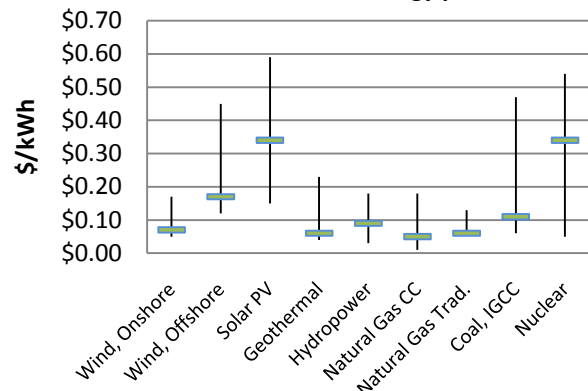
Compare to other Energy Sources

The US Department of Energy (DOE) Wind Program set a goal in 2008 to power 20% of the nation through wind energy.

This means:

- 300,000 MW total capacity by wind, and therefore:
- ✓ 409,200,000 tons coal offset per year
- ✓ 450,000,000 gallons water offset per year
- ✓ 6,360,000,000 cubic feet natural gas consumption offset per year
- ✓ 825,000,000 metric tons of CO₂ avoided cumulatively by 2030

Levelized Cost of Energy per kWh



Q: How much CO₂ can one 1.5 MW Wind Turbine displace in a year?

Assume 38% capacity factor, the 2013 average.

1.5 MW for 8760 hours in a year = 1.314×10^7 kWh x 38% = 4.9932×10^6 kWh produced

Compare to NGCC at 55% efficiency and 54.5 HHV

4.9932×10^6 kWh * 3.6 MJ/kWh = 1.798×10^7 MJ produced / 55% efficient = 3.268×10^7 MJ needed

3.268×10^7 MJ / 54.5 [MJ/kg] = 599684 kg NG * 0.74% C = 443766 kgC * 3.667 = 1.62729×10^6 kgCO₂

A: 1,627.29 Metric Tonnes of CO₂ displaced by one wind turbine per year.



State of the Industry

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Compare to other Energy Sources

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