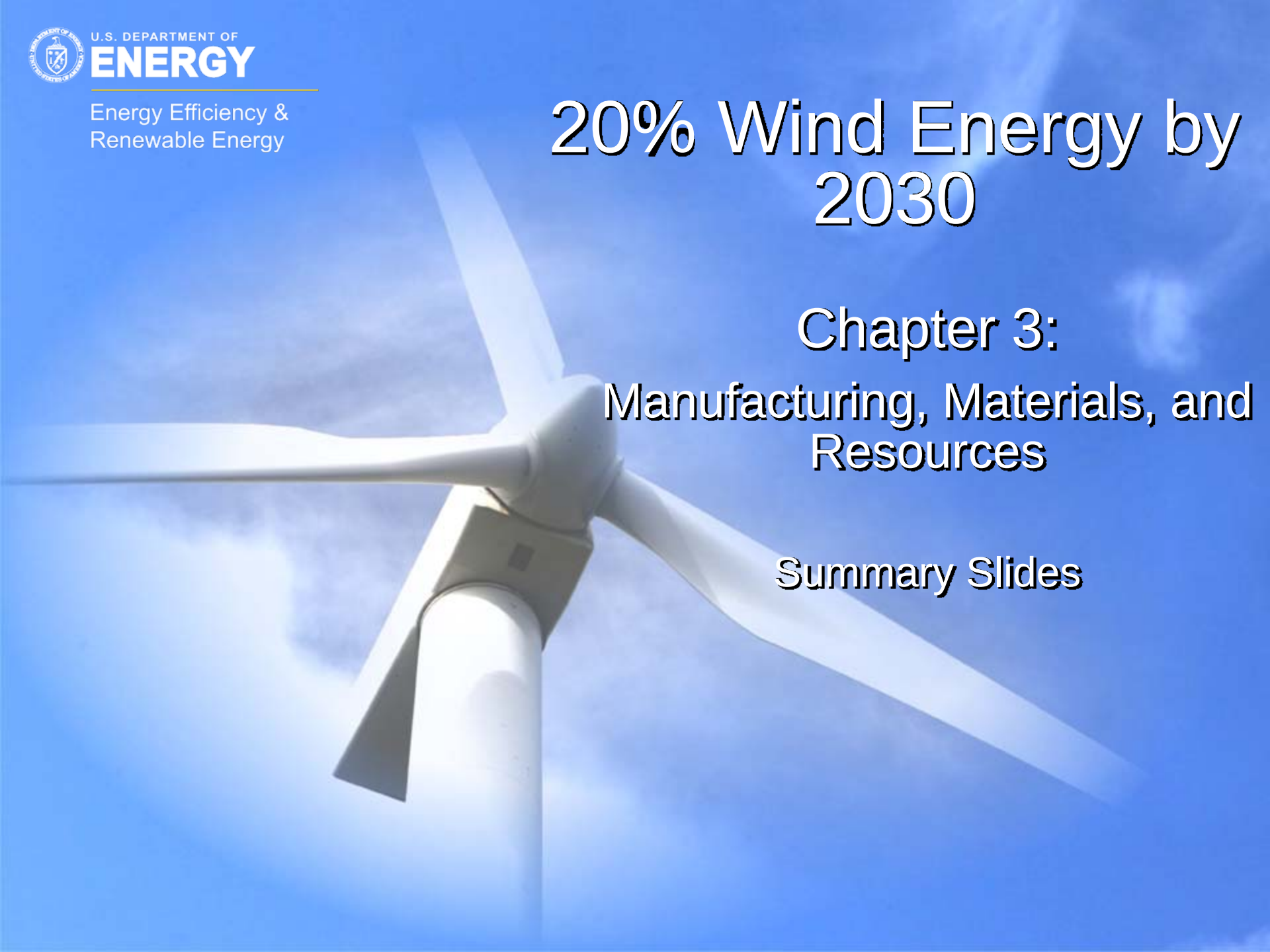


20% Wind Energy by 2030

Chapter 3:

Manufacturing, Materials, and Resources

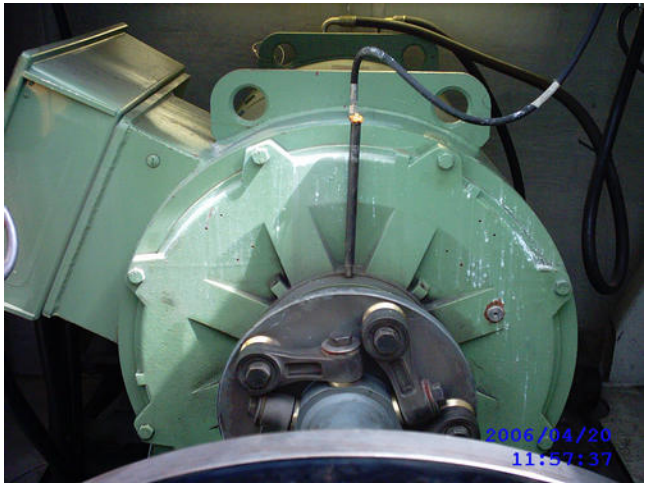
Summary Slides

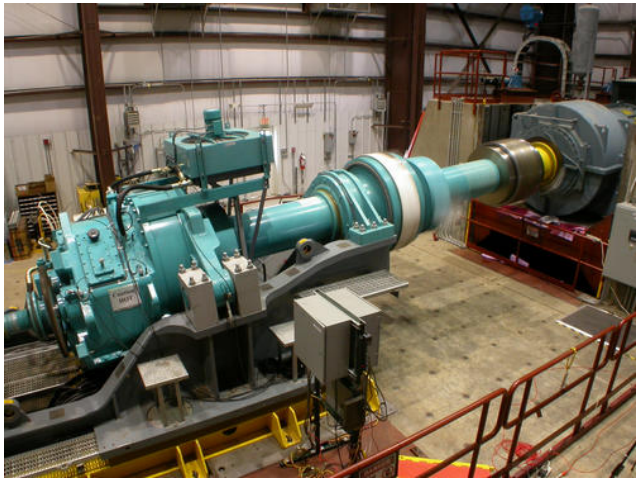
Manufacturing, materials, and resource challenges

- Materials
  - Demand for steel will increase significantly
  - Improved availability of critical materials needed: fiberglass, resins and permanent magnets could be a constraint
- Manufacturing
  - The 20% Wind Scenario would require a 20% annual growth in installations for nearly a decade and then require maintaining that installation level through 2030
- Education and workforce
  - The decreasing availability of a qualified work force continues to be a challenge

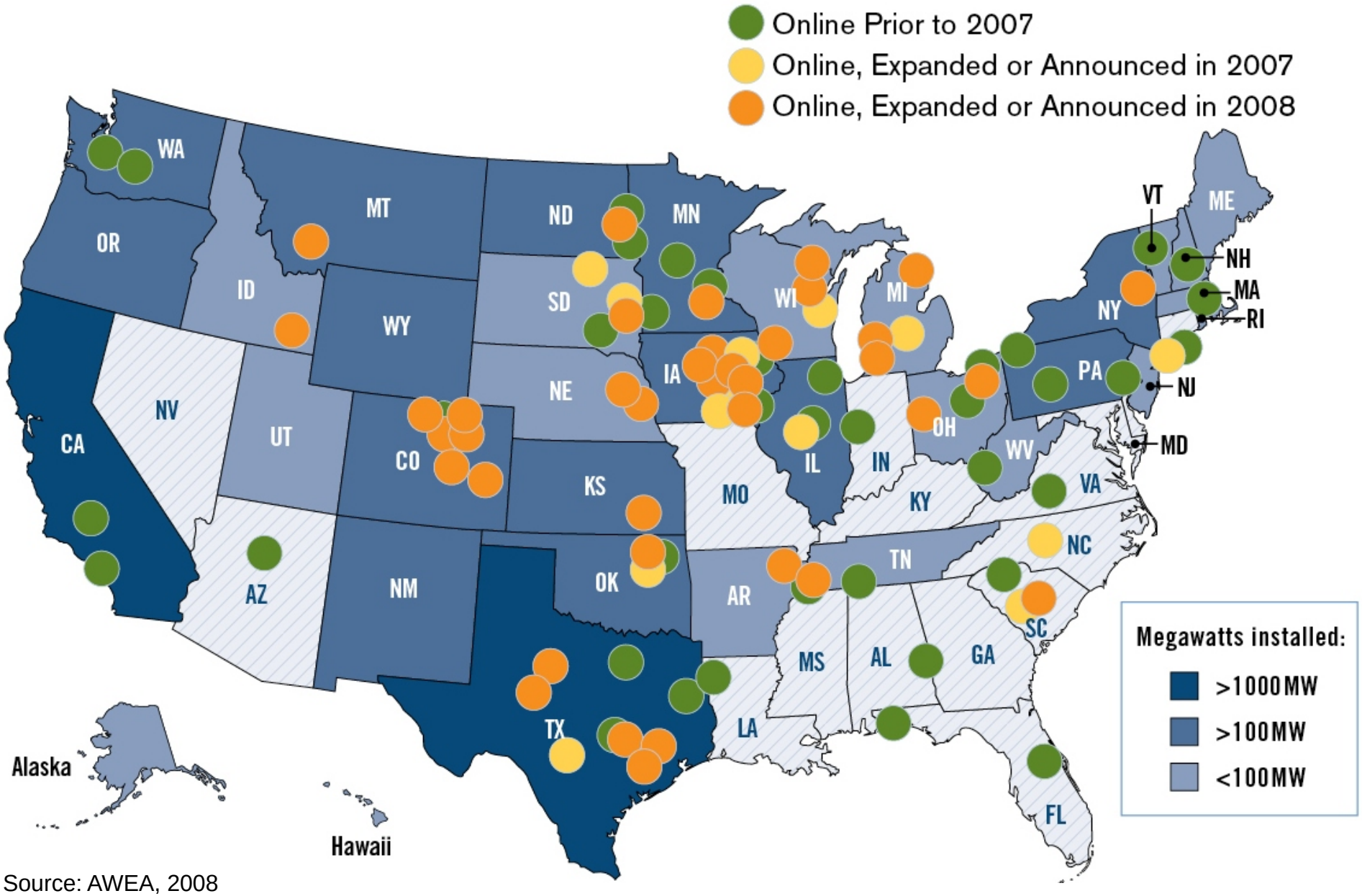
Major challenges and opportunities in raw materials and components include:

- Increasing demand for core materials, including carbon fiber
- Increasing costs of resins and adhesives
- Introducing aluminum and lightweight composites
- Simplifying nacelle machinery, which may reduce raw material costs and increase reliability
- Continuing to use glass fiber-reinforced plastic (GRP) in blades; using carbon fiber could reduce weight and cost
- Increasing the need for magnetic materials (such as rare-earth permanent magnets) in permanent magnet generators



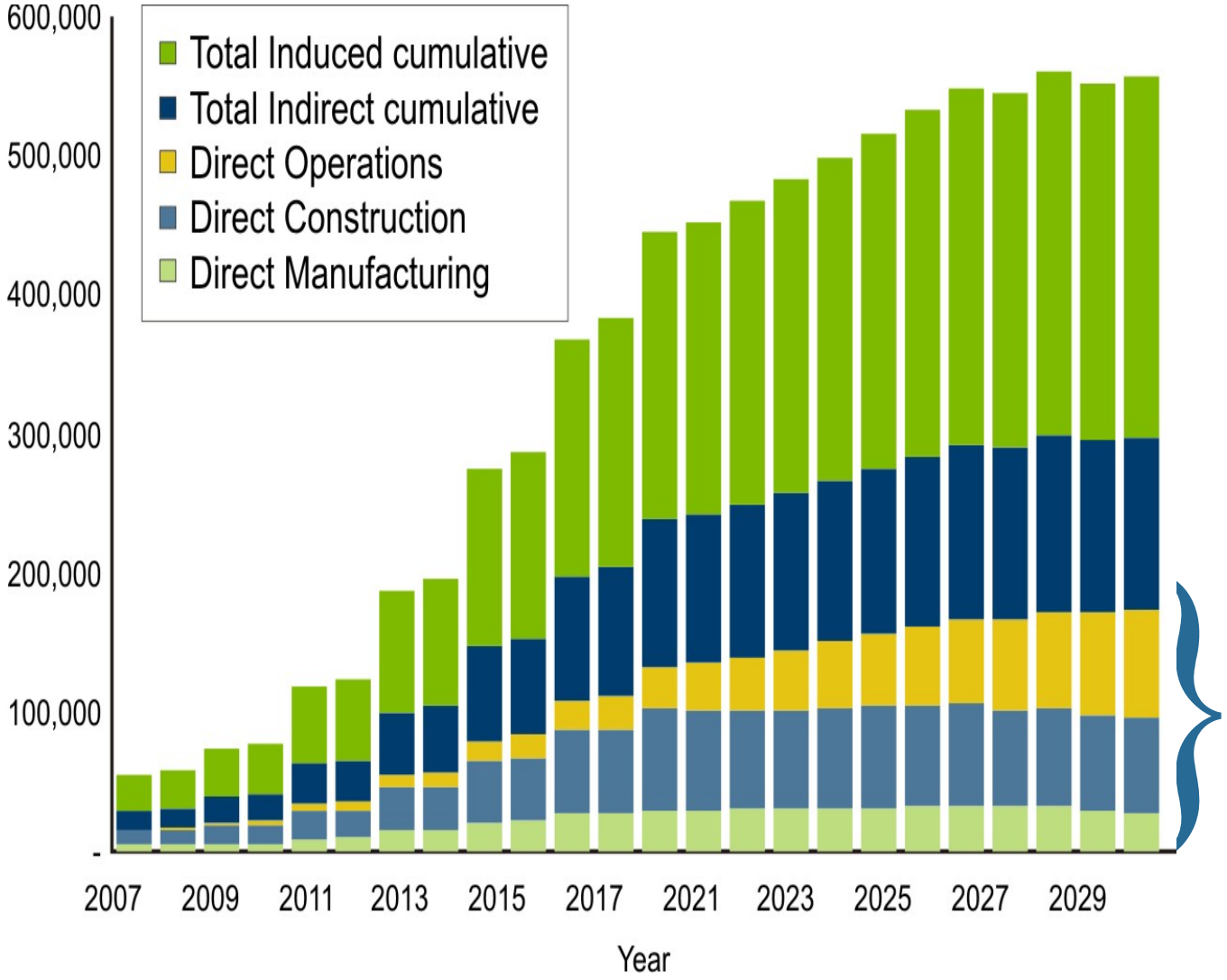


Manufacturing capacity would need to ramp up to support an installation increase from 3 GW per year in 2006 to over 16 GW per year by 2018



Source: AWEA, 2008

Under 20% Wind Scenario wind industry would employ over 500,000 workers



Over 500,000 total jobs would be supported by the wind industry

Approx. 180,000 jobs supported directly by the wind industry in operations, construction, and manufacturing

The decreasing availability of a qualified work force continues to be a challenge

- As of January 2009, 85,000 workers are employed in the wind industry*
- Increased educational opportunities for engineers and technicians are being offered, but more are needed

Sample Career Opportunities:
Electrical Engineers Electricians
Industrial Machinery Mechanics
Welders and Metal Fabricators
Electrical Equipment Assemblers
Construction Equipment Operators
Installation Helpers
Laborers
Construction Managers

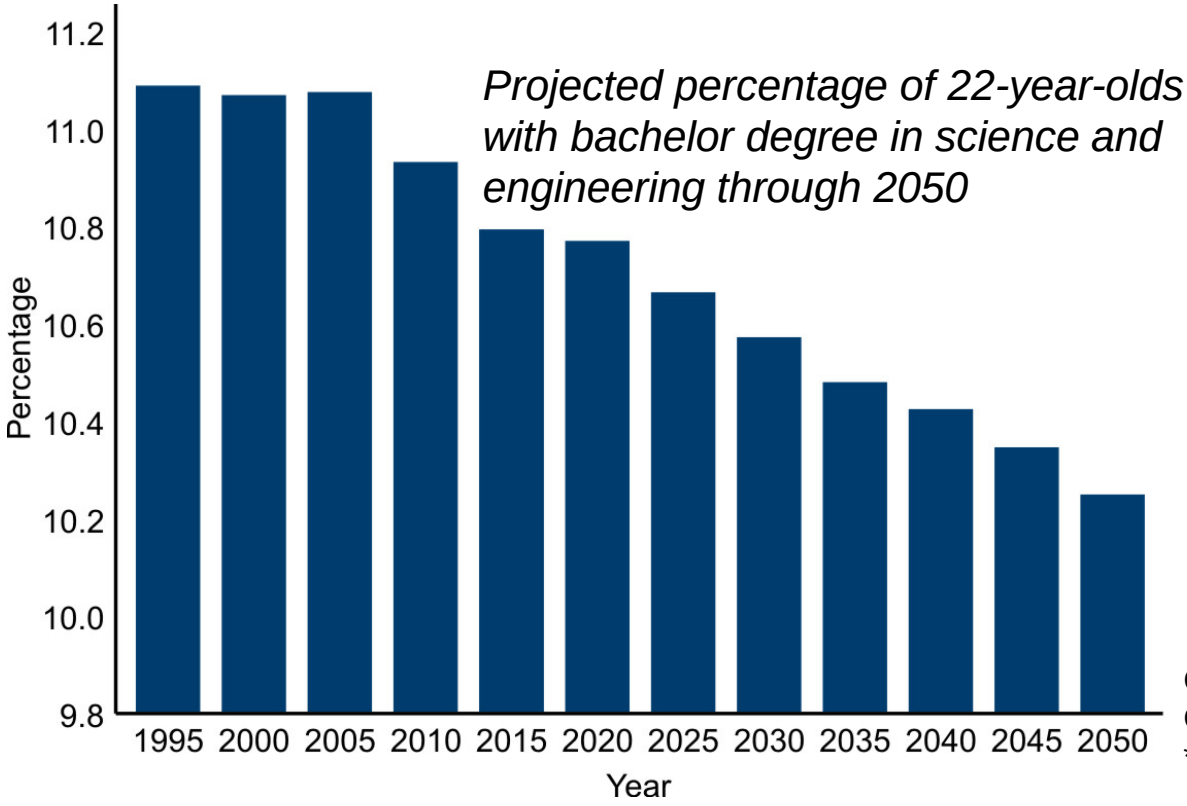


Chart Source: National Science an Technology Council, 2000
* Source: AWEA, 2009

Paths forward

- Materials
  - Opportunities exist for introducing aluminum or lightweight composites
  - The use of carbon fiber might help reduce weight and cost
- Manufacturing
  - Stable and consistent policies will encourage investment in manufacturing capacity
  - Timely manufacturing expansion needed is feasible: historical precedents with other major products (e.g. defense equipment, automobiles)
- Education and workforce
  - More support from industry, trade organizations, and various level of government could foster university programs that prepare the work force for careers in wind and renewable energy technology

Photo courtesy of NREL