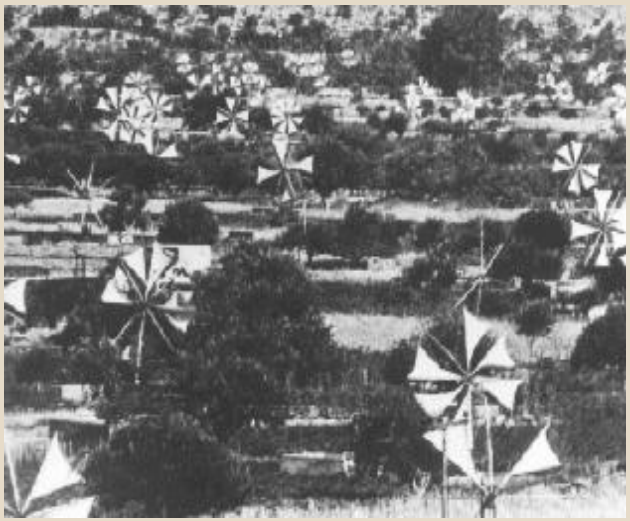

Wind Turbine Energy
Classic Style
April 11, 2011

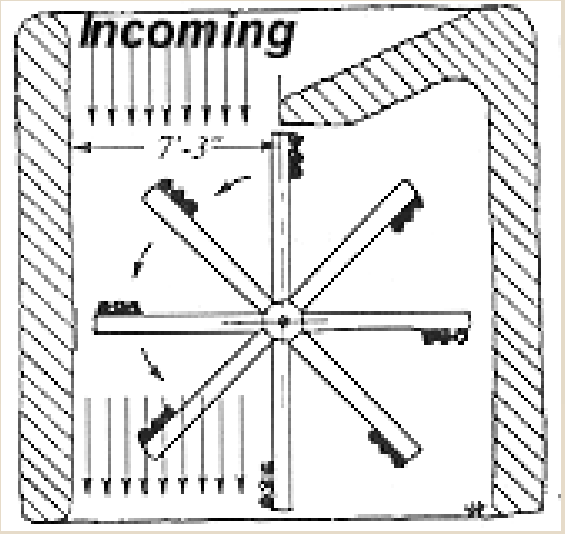
Overview

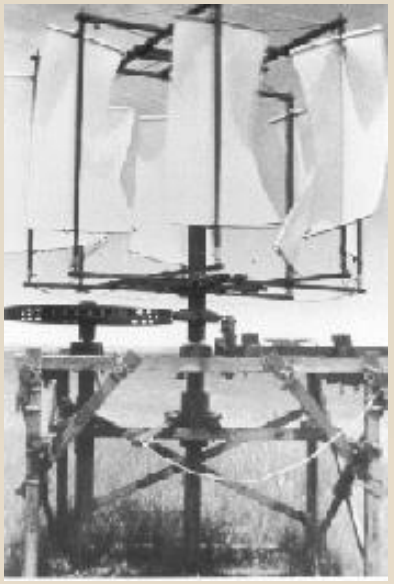
- History
- Anatomy and Materials
- Betz's Law
- Sales and Installation
- Types of Wind Turbines
- Tocco, Italy
- The Future of Wind Turbines

History

- Wind Power's Beginnings (200 B.C. - 1300 A.D.)
  - Started in Persia
  - Egyptians used vertical turbines to grind wheat
  - Windmills

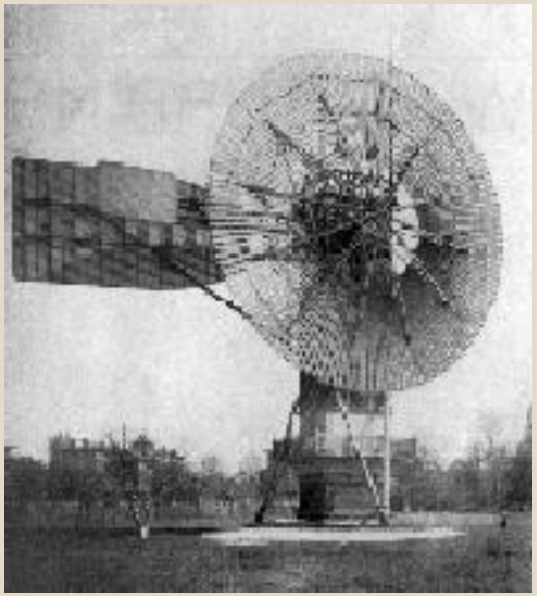


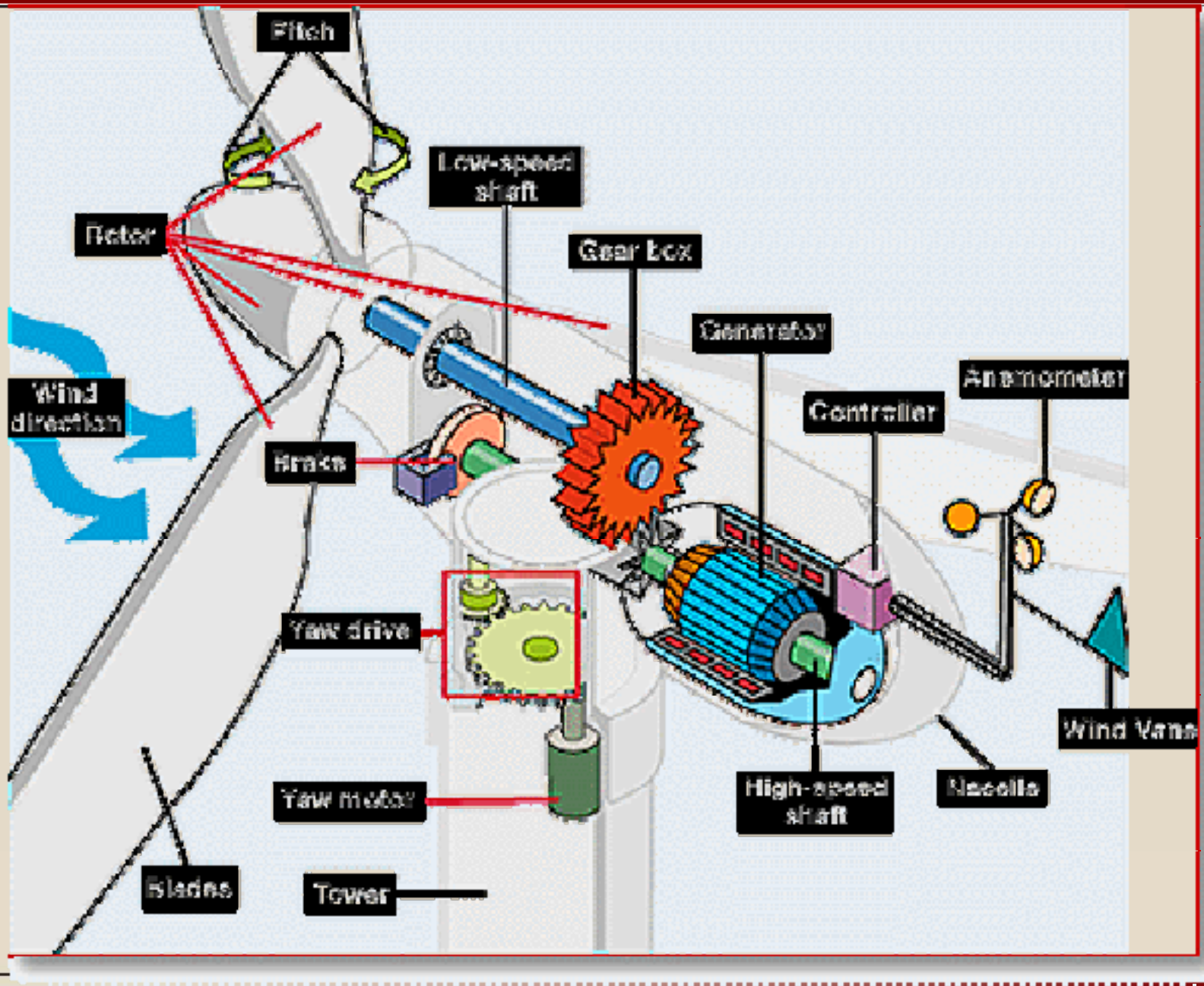




History

- 1880s – First electrical windmill developed
- 1940 – Three blade turbine
- 1990 – Megawatt wind farms




Pitch
Low-speed shaft
Rotor
Gear box
Generator
Anemometer
Wind direction
Controller
Brake
Yaw drive
Wind Vane
Yaw motor
High-speed shaft
Nacelle
Blades
Tower

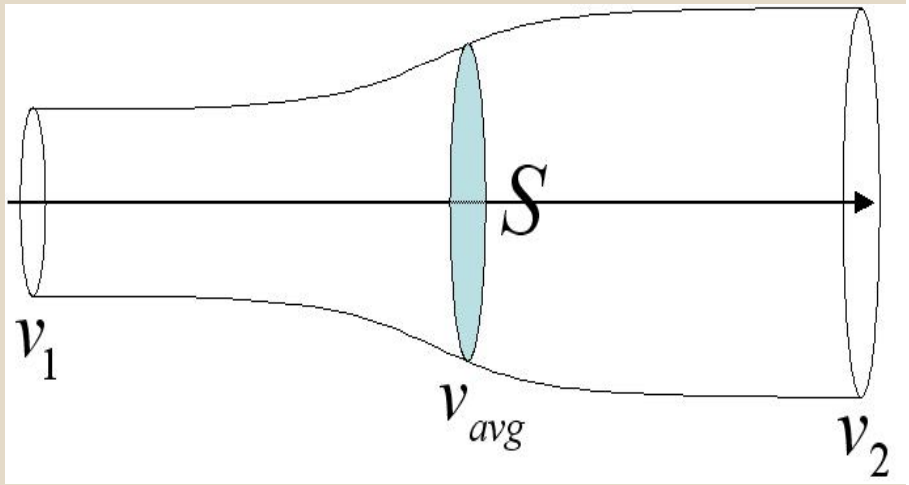
MATERIALS

- Tower – Steel Lattice
- Nacelle – Fiberglass
- Blades – Fiberglass, Lightweight Woods, and Aluminum

Betz law

$$\begin{aligned}\dot{E} &= \tfrac{1}{2}\cdot\dot{m}\cdot(v_1^2 - v_2^2)\\ &= \tfrac{1}{2}\cdot\rho\cdot S\cdot v\cdot(v_1^2 - v_2^2)\\ &= \tfrac{1}{4}\cdot\rho\cdot S\cdot(v_1 + v_2)\cdot(v_1^2 - v_2^2)\\ &= \tfrac{1}{4}\cdot\rho\cdot S\cdot v_1^3\cdot(1 - (\tfrac{v_2}{v_1})^2 + (\tfrac{v_2}{v_1}) - (\tfrac{v_2}{v_1})^3)\end{aligned}$$

$$P_{\max} = \tfrac{16}{27}\cdot\tfrac{1}{2}\cdot\rho\cdot S\cdot v_1^3$$

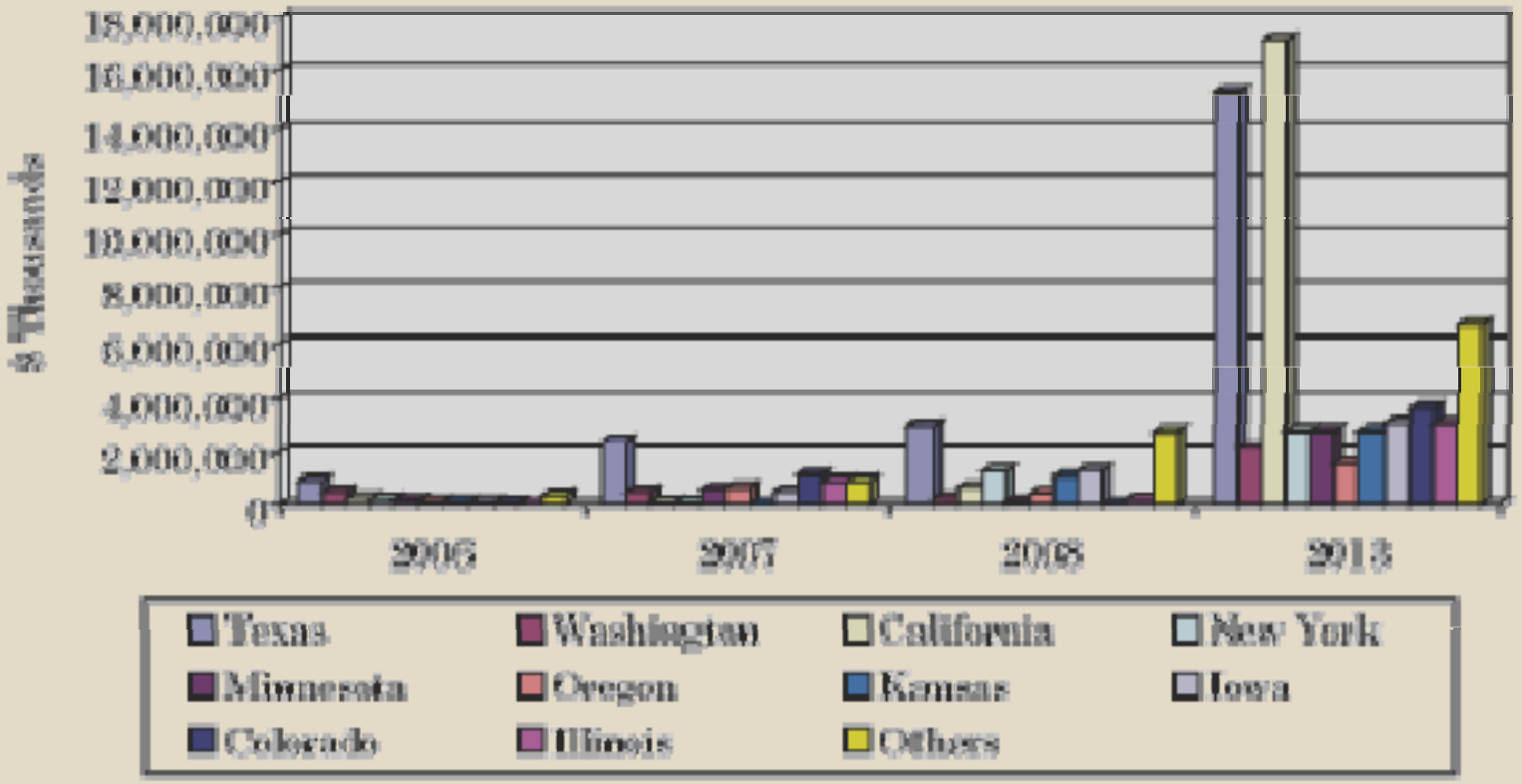


- Developed in 1919 by the German physicist Albert Betz
- No turbine can capture more than 59.3 percent of the kinetic energy in wind

Two Types of Installations Generally Used

- Offshore
- Wind Farms

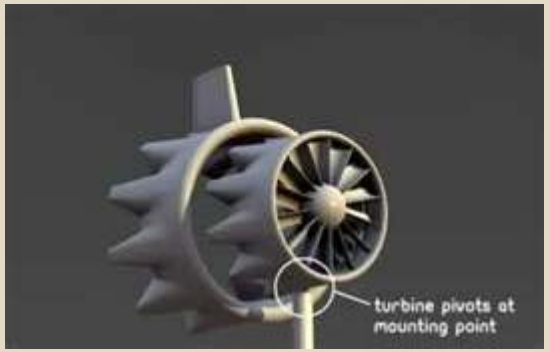
SUMMARY FIGURE
WIND TURBINE SYSTEM EXPENDITURES, BY STATE 2006-2013
($ THOUSANDS)



Source: AWEA data and BCC Research

Types – Horizontal Axis

- Three Blade
- Flodesign



- Highly efficient
- Access to stronger winds
- Industry has found solutions to disadvantages

Types – Vertical Axis

- Darrieus, Giromill, Savonius

- Effective for variable wind
- No directing required

- Low efficiency, but Highly reliable

An Advancement for an Ancient Italian Town

- Tocco, Italy
- Has 4 turbines that produce 30% more energy than the town needs! (about 2700 people)
- With the profit they paid local taxes and garbage pick-up fees

…more on Tocco

- This town creates it's own energy with renewable resources.
- BUT this does not reflect the energy production of the nation.
- Renewable energy is only 7% of Italy's total energy production.
- Energy rates in Italy are 3X the American average

Conclusions

- Wind turbines have the potential to be a great source of renewable energy.
- 3-Blade turbines are most common, but alternatives could be useful.
  - Flodesign
- Creative design and placement of turbines could save millions.
  - Vertical axis turbines

The Future of Wind Turbines

References

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