United States Energy Association

GLOBAL WORKSHOP ON GRID CONNECTED RENEWABLE ENERGY

GE Wind Plant and Industry Overview

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GE Energy

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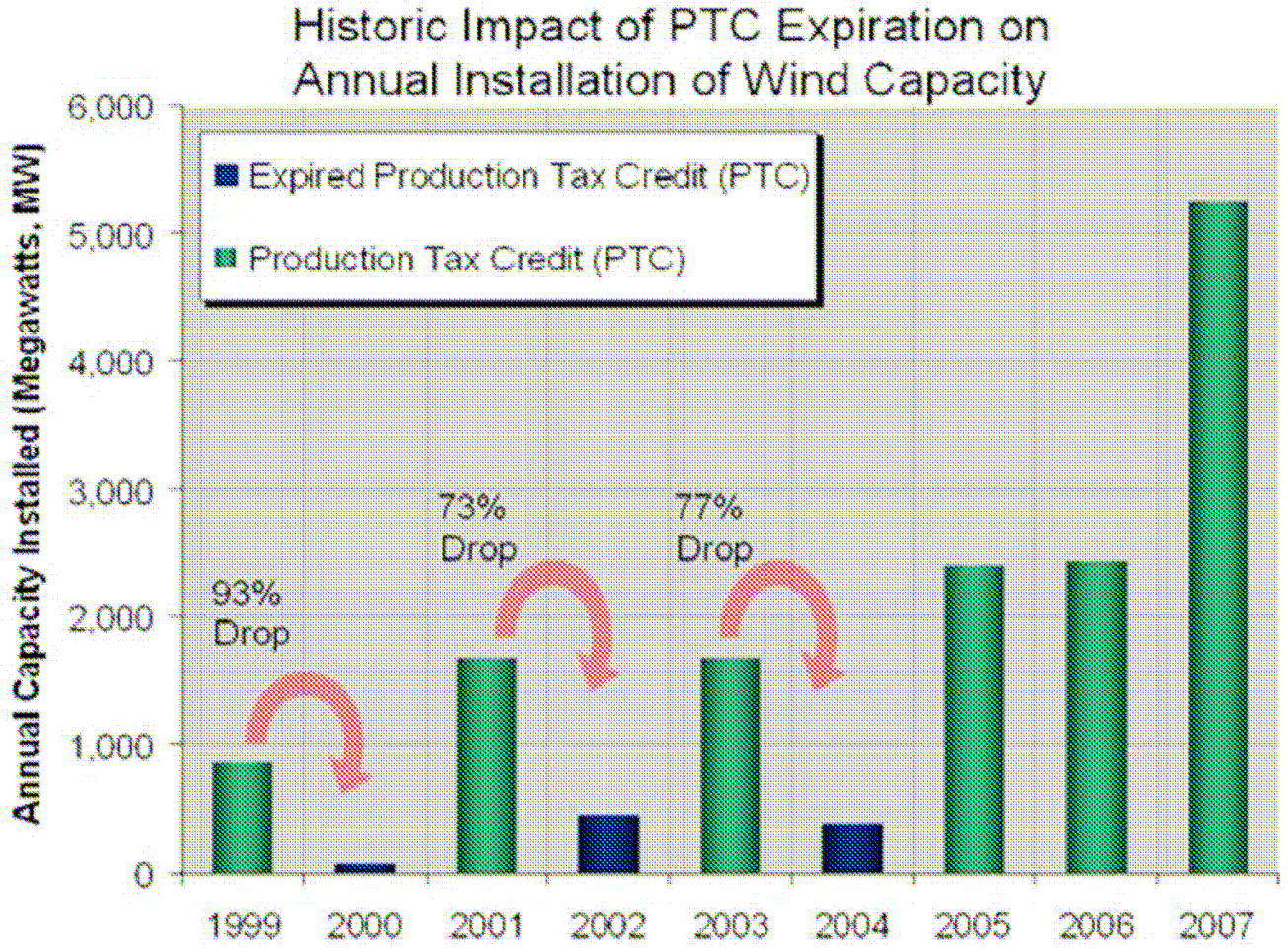
2008 US Wind Industry Highlights

- 1.25 percent of US electricity in 2008
- Could be 20 percent by 2030
- Over 40% of new capacity installed (8,500MW)
- $17 Billion invested in economy
- USA surpassed Germany - most Wind Capacity
- 25,000MW total US installed in 35 States
- 85,000 people employed in US Wind Industry
  - Up from 50,000 people in 2007

Source:
American Wind Energy Association (AWEA)

Key to Industry Growth:
Policy, Policy, Policy (or lack of Policy)



Source:
American Wind Energy Association (AWEA)

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The Past…

Small industry trying to grow into mainstream

Wind turbine generators required to go off-line if grid anomaly

The Present..

Moving to the mainstream

Large global companies have entered wind industry

Transitioning from wind turbines to wind plants

Utilities understanding and Investing in wind

FERC, NERC, ISOs creating requirements for Wind

Units required to remain on-line if grid anomaly

✓**Making wind plants behave like conventional plants**

✓**Stabilizing, Standardizing Technology**

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The Future…

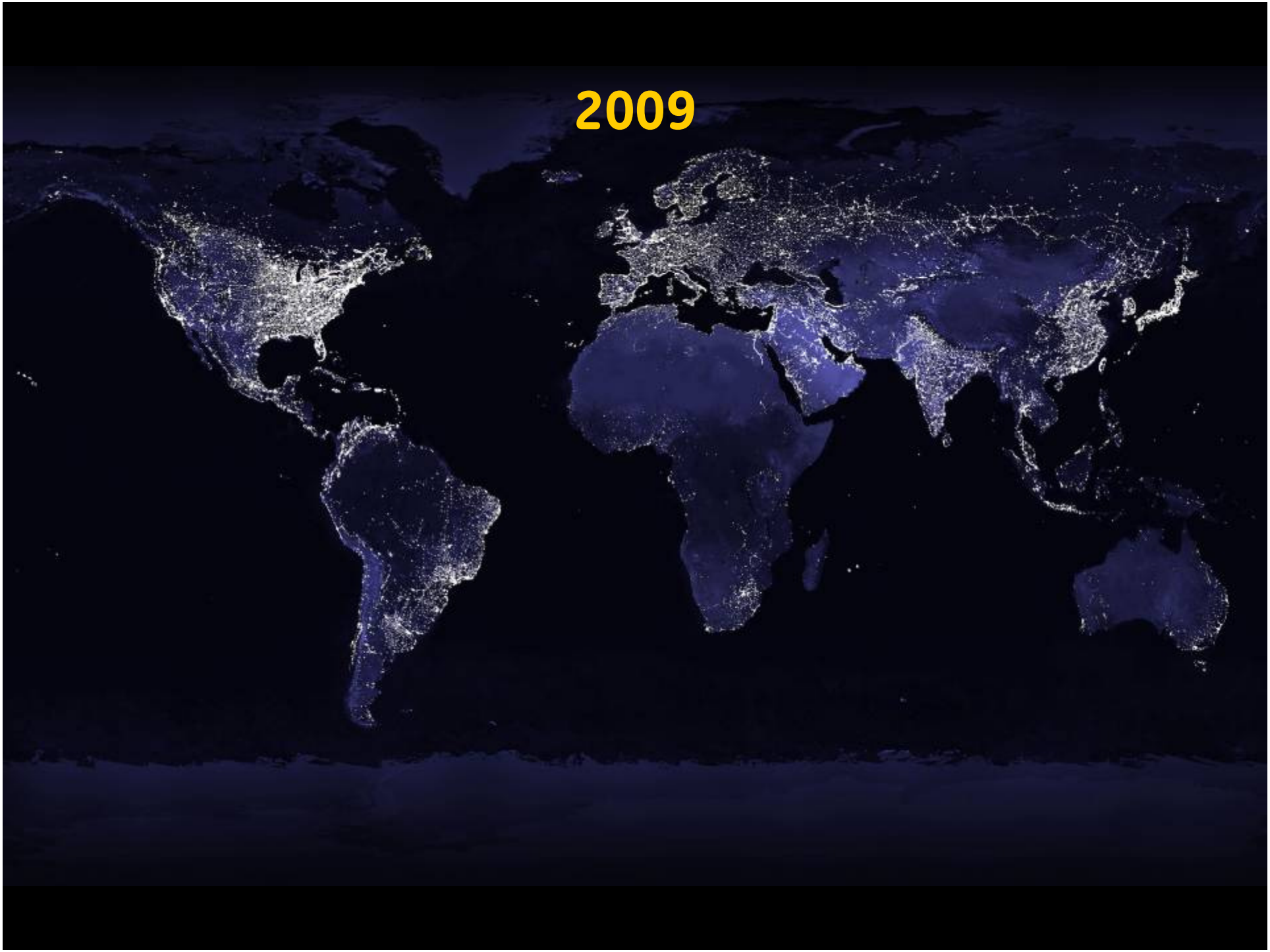
Integrate generation portfolio mix

Refine wind generation scheduling & forecasting (dispatch)

Adapt regulatory mechanisms to accommodate Wind (for example, Renewable Energy Credits)

Institutionalize education/training (Community Colleges, Universities)

Industry Dynamics


2009


2030
Powering the world … responsibly

Technology diversity is critical

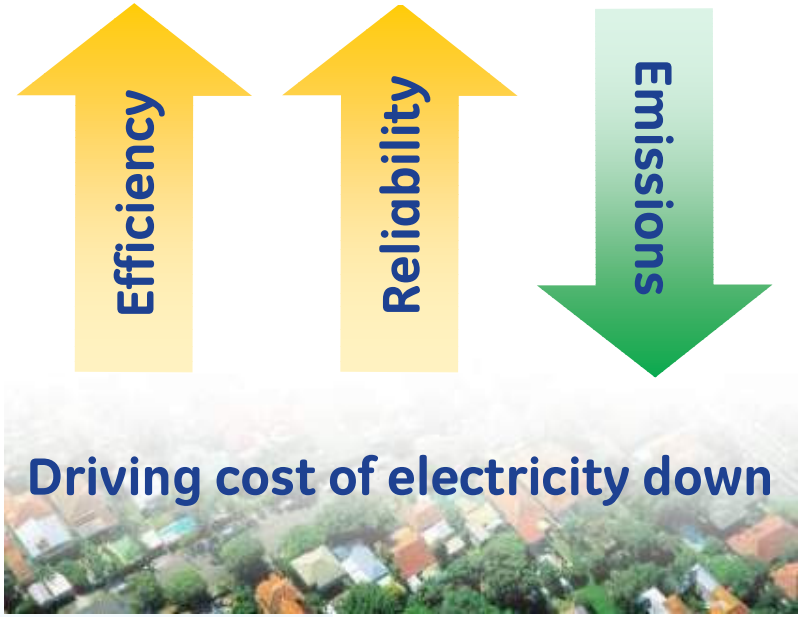
Diverse




Nuclear
Clean Coal
Gas
Wind
Oil
Geothermal
Biomass
Solar

+

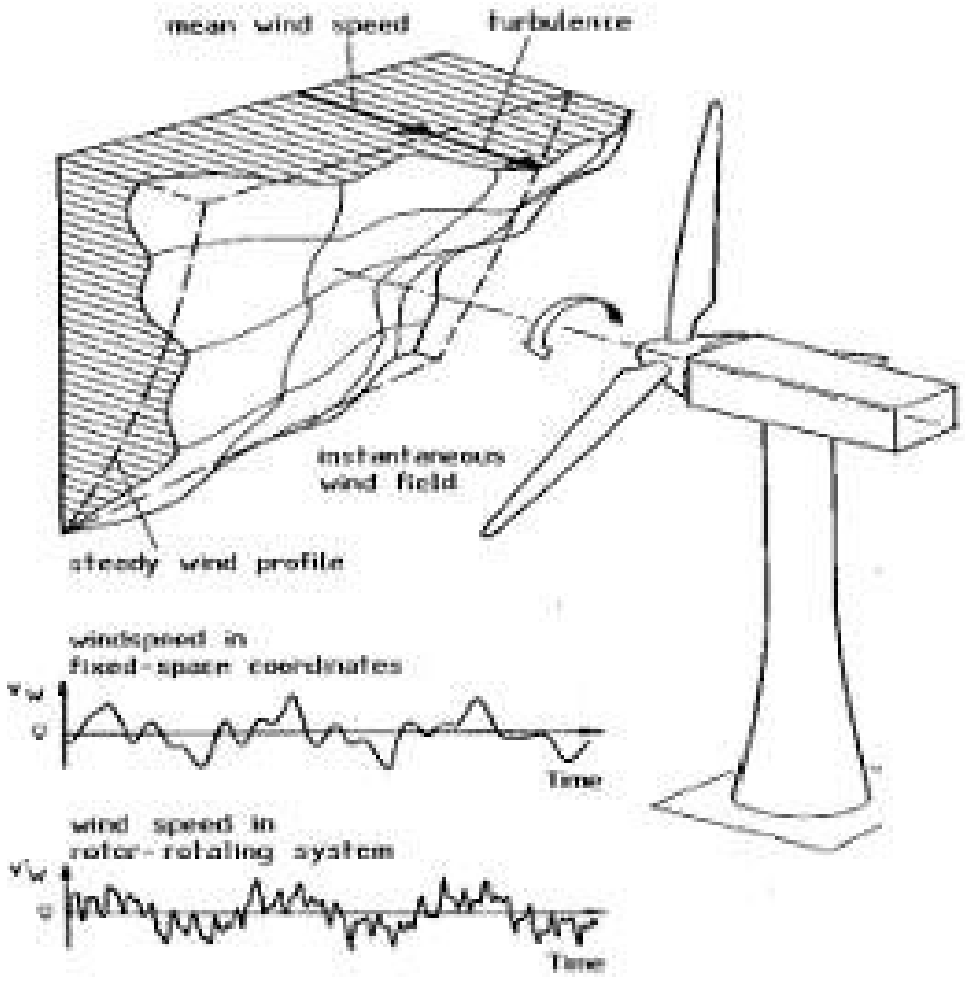
Efficient



Affordable, reliable & environmentally responsible

Wind Turbine Generator (WTG): Overview

Wind – our Fuel



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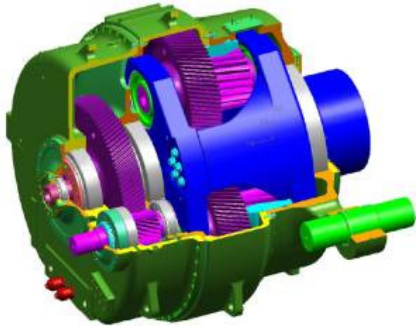
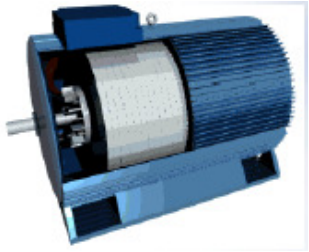
Principles of Wind Turbines

The basic idea is to convert one energy form to another

Kinetic Energy

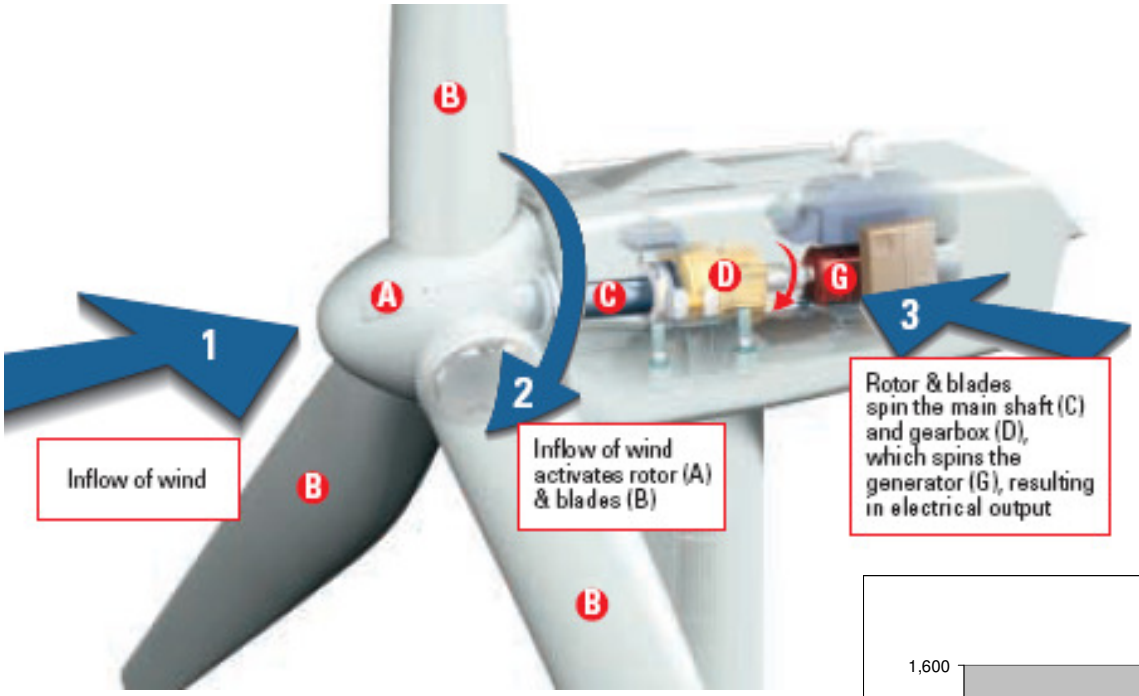


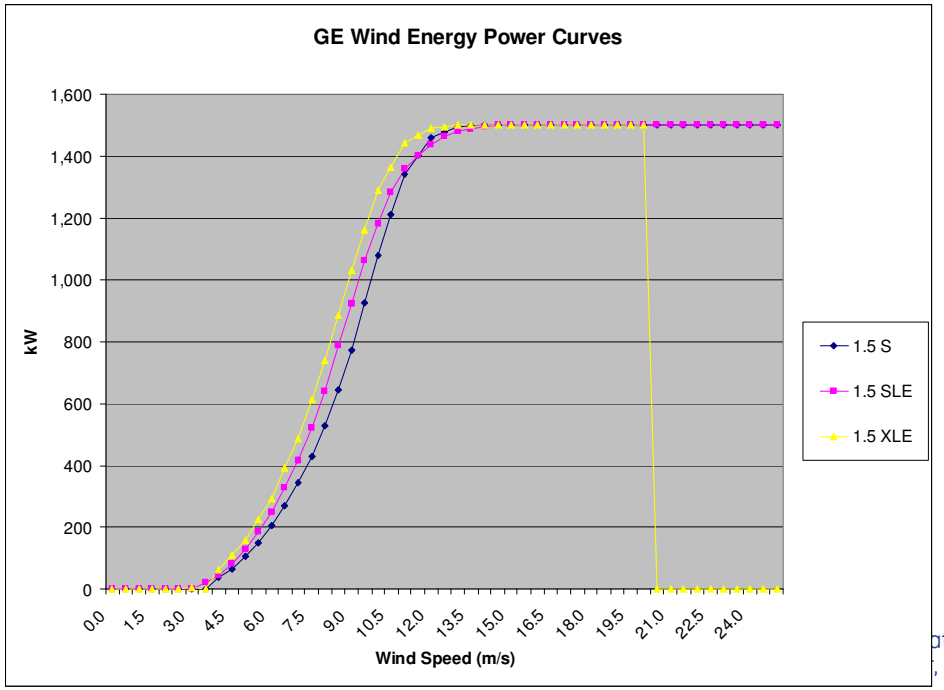
Mechanical Energy



Electrical Energy

Wind Turbine Fundamentals





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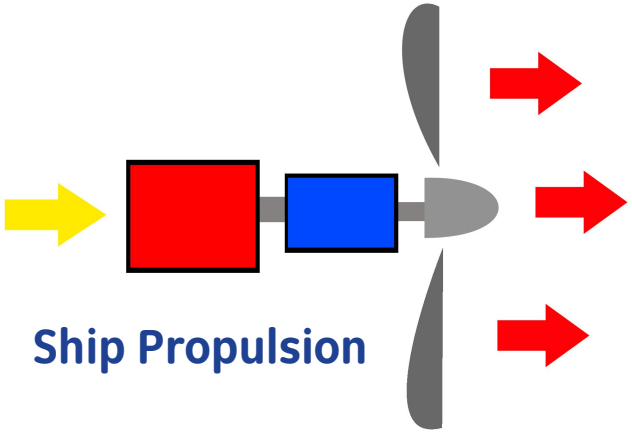
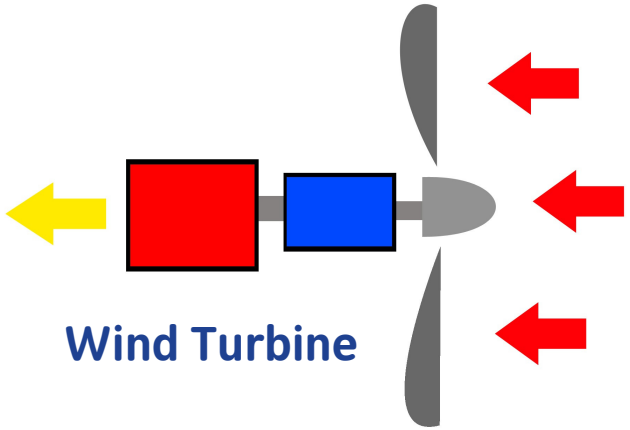
Velocity Cubed.....Power and Speed



Ship Propulsion



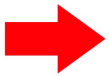
Wind Turbine

Power In/Out

Heat Engine or
Electrical Machine

Hi Speed Shaft
And Gearbox

Low Speed Shaft
And Prop



Relative Fluid
Velocity

Velocity Cubed……Power and Speed

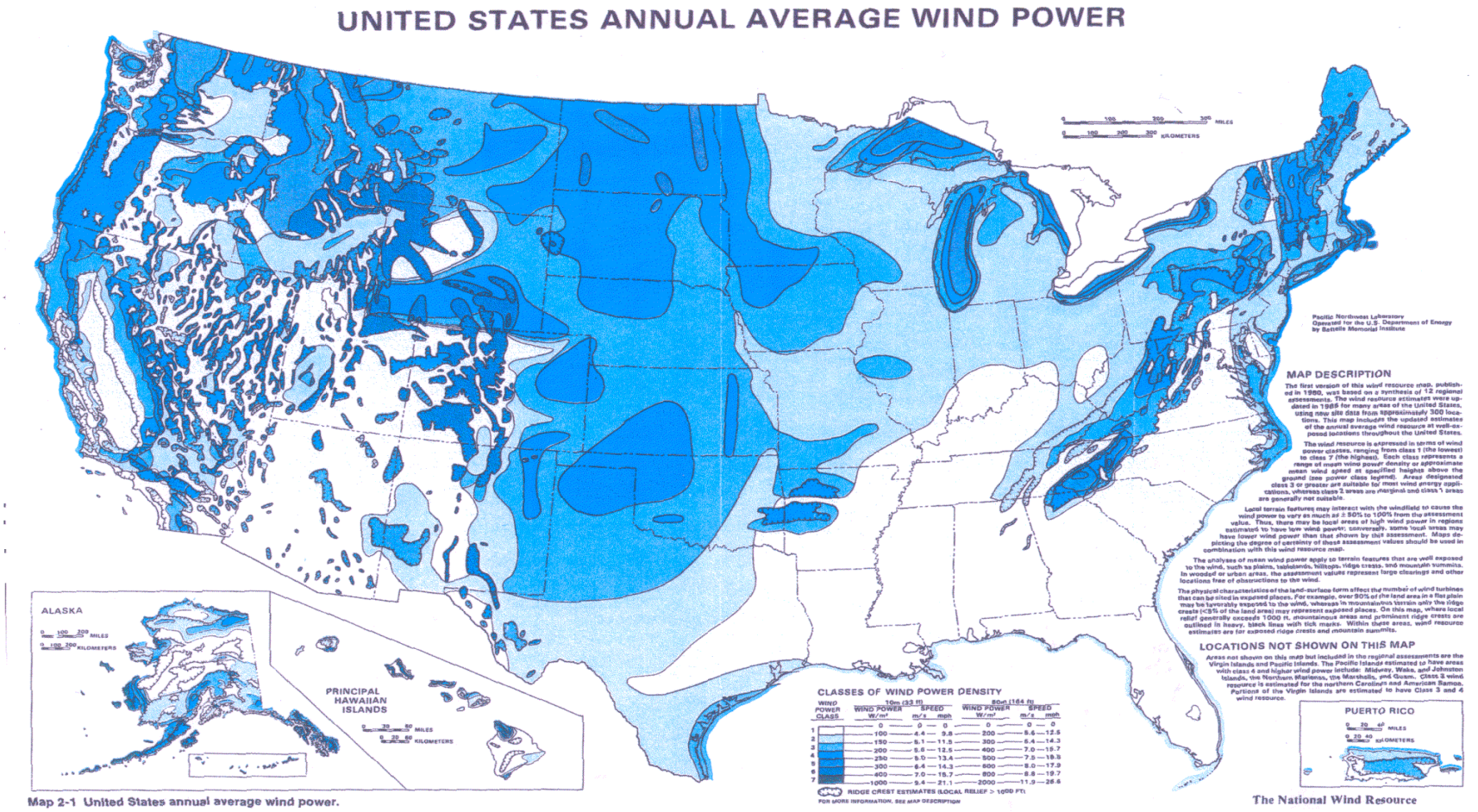
To take a ship from 14 knots to 16 knots requires almost 50% more Power. (16/14)^3 = 1.49

The same relationship applies to a wind turbine.

An average 16 knot wind farm delivers almost 50% more energy than a 14 knot.

Therefore……. Location, Location, Location.

USA Wind Resource



Map 2-1 United States annual average wind power.

Source: NREL

Wind Plant:
a distributed generation system

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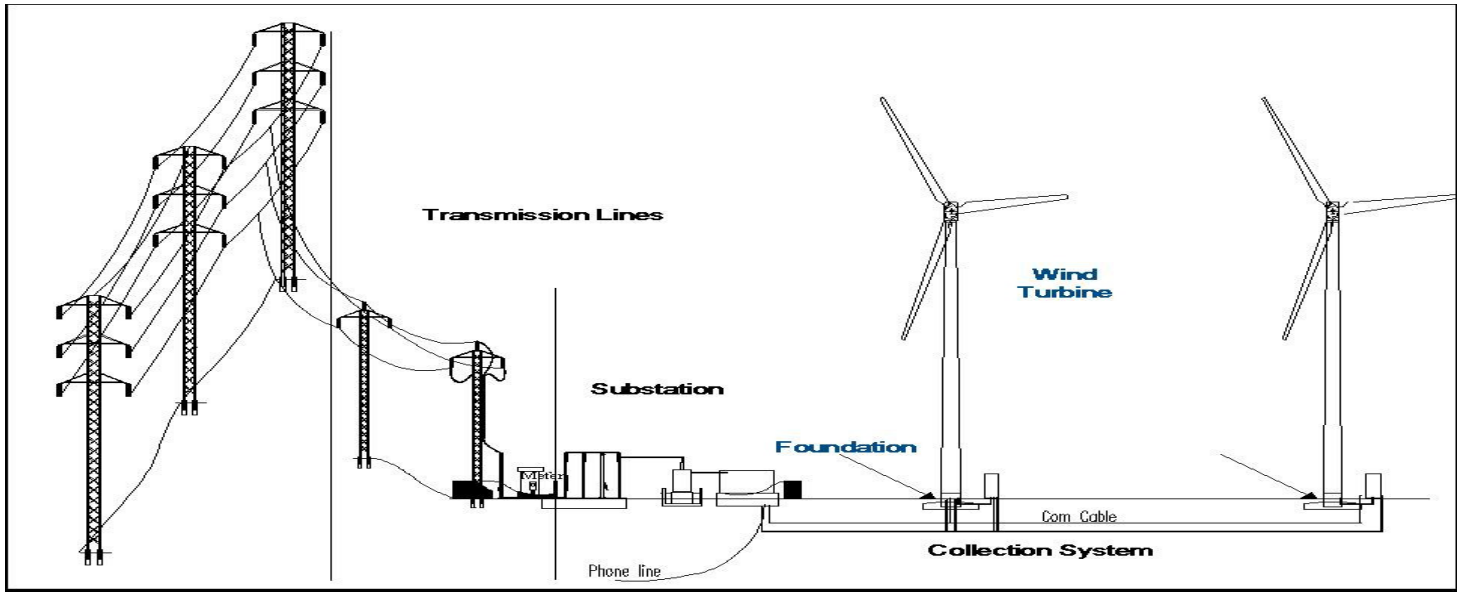
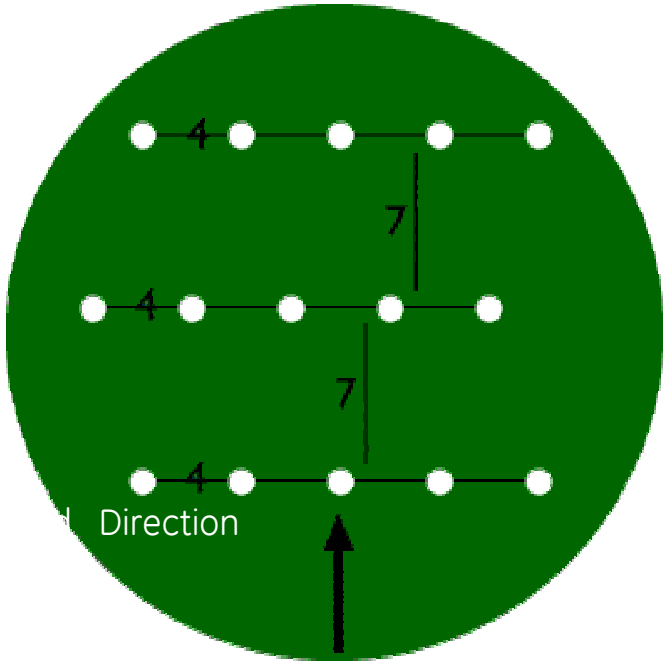
Wind Farm Basic Layout

- Wind turbine generators
- Pad mounted transformers
- Power cables, control circuits, protection, and SCADA
- Substation transformer
- Point of interconnection



Reasonable Turbine Layout

- Minimize wake effects
  - Favorable for energy capture and loads
- Minimum turbine spacing
  - 7-10 D (D=Rotor Diameter) parallel to prevailing wind
  - 3-5 D perpendicular to prevailing wind



Wind Turbine Generator: Installation

Installation Overview

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Technology for the next decade

Wind

Blades

- Sweep area
- Logistics
- Carbon fiber

Controls

- Mark VI
- Load management
- Model driven

Drives

- Compact
- High reliability
- Light-weight

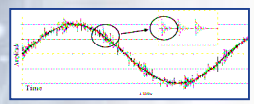
Reliability

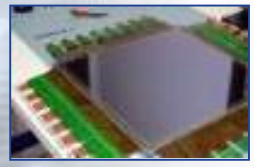
- Remote monitoring
- Return to service
- Upgrades

Solar

Breakthrough technology

- Thin film
- Nano scale materials
- Concentrators





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Technology that drives lower COE & higher reliability

Looking Ahead …

- Global energy demand expected to nearly double by 2030
- Increasing environmental requirements a global challenge
- Renewables is part of the solution … balanced portfolio key

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Thank you for your attention

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