

U.S. Department of Energy Wind Program Overview

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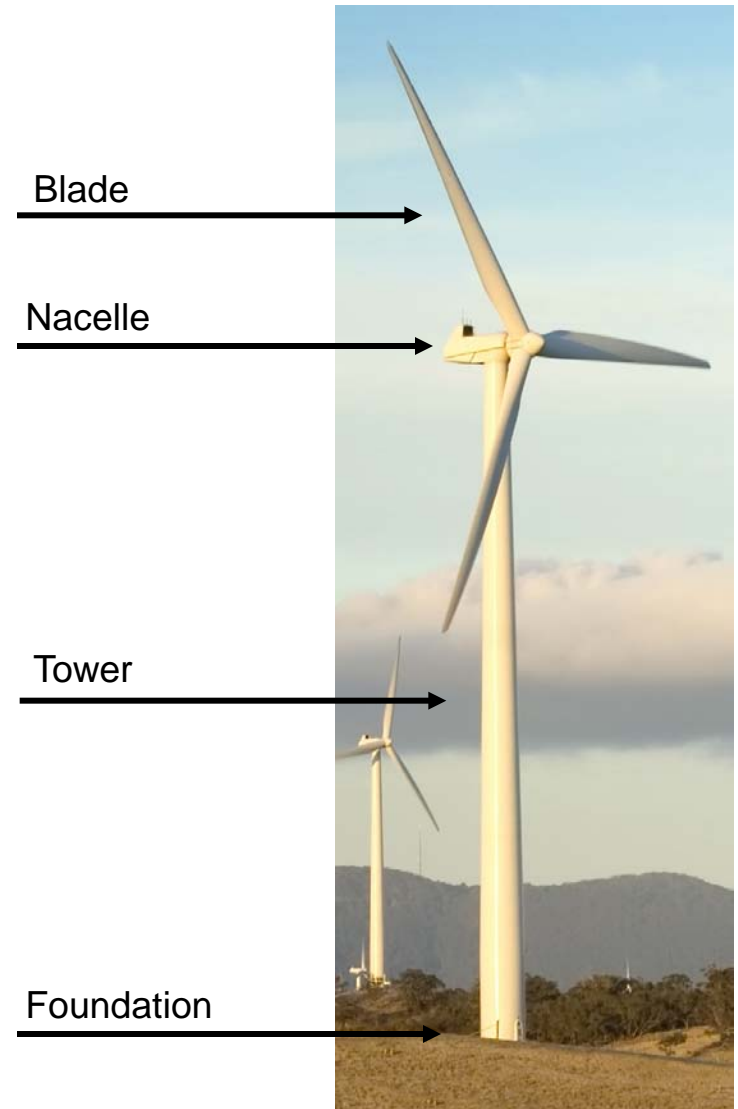
Outline

- How does wind power work
- Benefits of wind
- Size of U.S. Wind industry
- Challenges
- Small wind
- Role of U.S. Dept of Energy
- Microhydro



What is wind power?

- Wind power: using the energy in wind to generate electricity
- Wind turbine = electric fan in reverse
 - Wind moving over blades causes them to ‘lift’ and rotate
 - Spinning blade rotor turns a driveshaft connected to an electric generator
 - Driveshaft, generator, and control systems are housed in the nacelle
 - Typical tower height: 80m or more
 - Max generating capacity: 1.5 megawatts or more





Benefits of wind energy

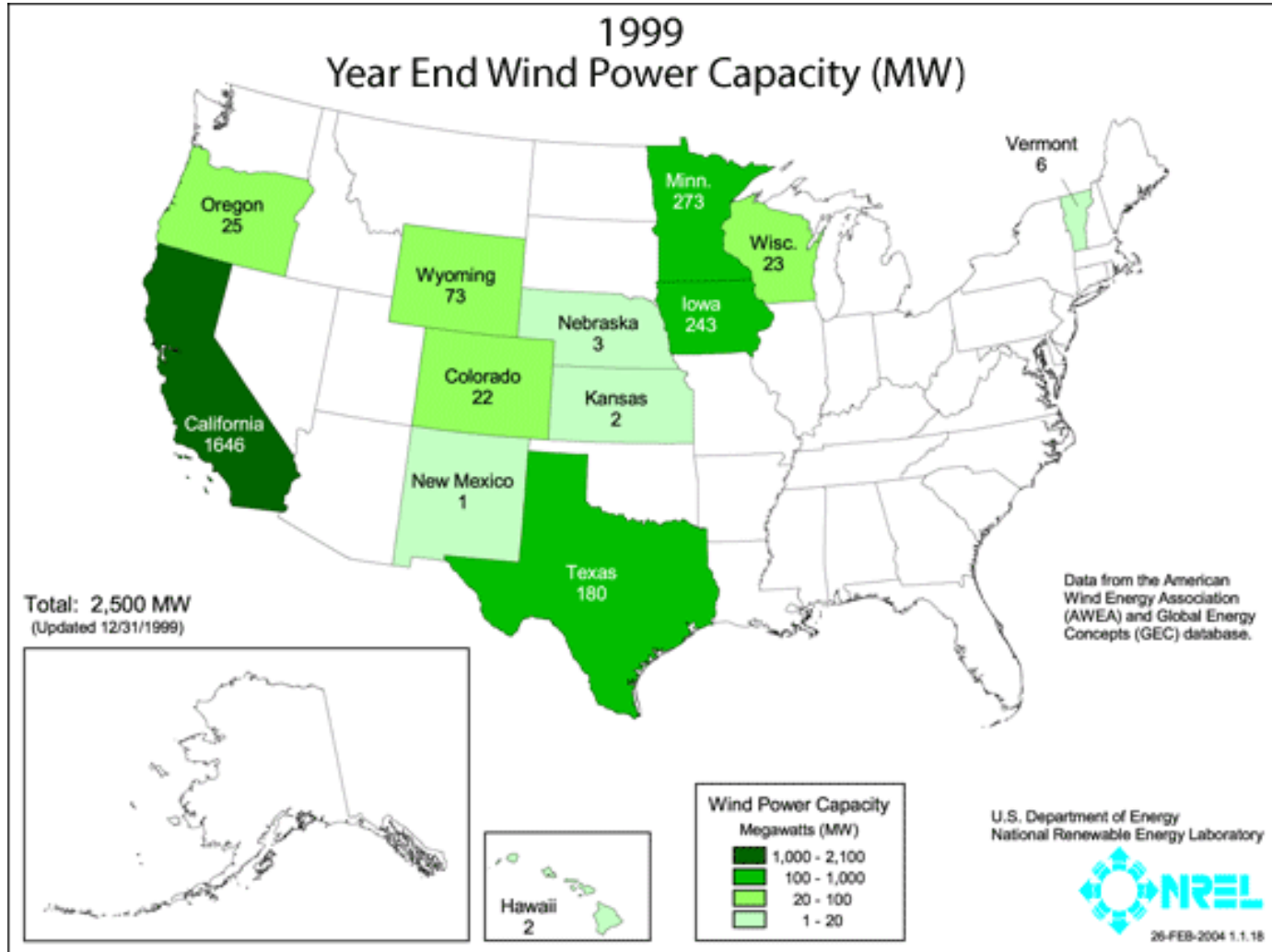
- Renewable: wind can't be used up (no fuel required)
- Clean: no greenhouse gas or other air pollutant emissions
- Domestic: energy is produced in the US - lessens need for imported fuel
- Diversifies the US energy portfolio
- Creates jobs in construction, operation, and manufacturing
- Brings economic development to rural areas
- Doesn't use water for electricity generation
- Predictable long-term electricity costs



Wind Energy in the U.S.

- Over 25,300 megawatts of generating capacity installed
- Produces enough electricity for 7 million households
- Employs 85,000 workers
- \$17 billion dollar investment in 2008
- Rapidly growing industry (27% growth in capacity in 2006, 46% in 2007, 50% in 2008)
- Wind = second-largest source of new electric generating capacity added to the grid
- U.S. has the most wind generating capacity and produces the most wind energy of any country

Wind growth, 1999 - 2008



Types of wind power projects

- **Commercial, utility-scale projects**
 - Large-scale wind power projects (dozens of turbines, millions of dollars worth of investment)
 - Developed by private companies
 - Output sold to electric utilities
- **Distributed wind projects**
 - Installed at private residences / businesses or in remote villages
 - Usually single turbines below 1 MW
 - Output usually used by turbine owner (behind-the-meter)
- **Community wind projects**
 - Projects owned by groups of investors from a community
 - Projects range from single turbines to hundred-MW plants



Distributed wind in Kasigluk, Alaska

- Yup'ik Eskimo village of 500 in southwest Alaska
- Power system incorporates diesel plant and 3 100 KW wind turbines
- Wind turbines installed as part of \$17m project to replace electric generation system
- Wind turbines provide about 23% of all electricity used in village, displacing nearly 65,400 gallons of diesel fuel
- Technical analysis for project provided by DOE



Challenges to large-scale wind deployment

- Technology: improve reliability and reduce costs
- Wind integration: incorporate variable wind energy production into the electrical grid
- Transmission: transmit energy from wind generation in remote areas to demand centers (cities)
- Manufacturing: improve processes and capacity to ensure supply-chain support for turbine manufacturers
- Workforce: train a qualified workforce for the industry
- Siting: address concerns about local impacts on communities and the environment / wildlife

Challenges to small wind projects

- Need to install wind turbines in locations that have sufficient wind to pay back investment – maximize energy production
- Need wind turbines that are simple to install, maintain, and repair
- Need testing to ensure safe, credible, and reliable turbines
- Need to address local concerns: noise, zoning, radar, wildlife, aesthetics, grid connection



Inspiration – William Kamkwamba

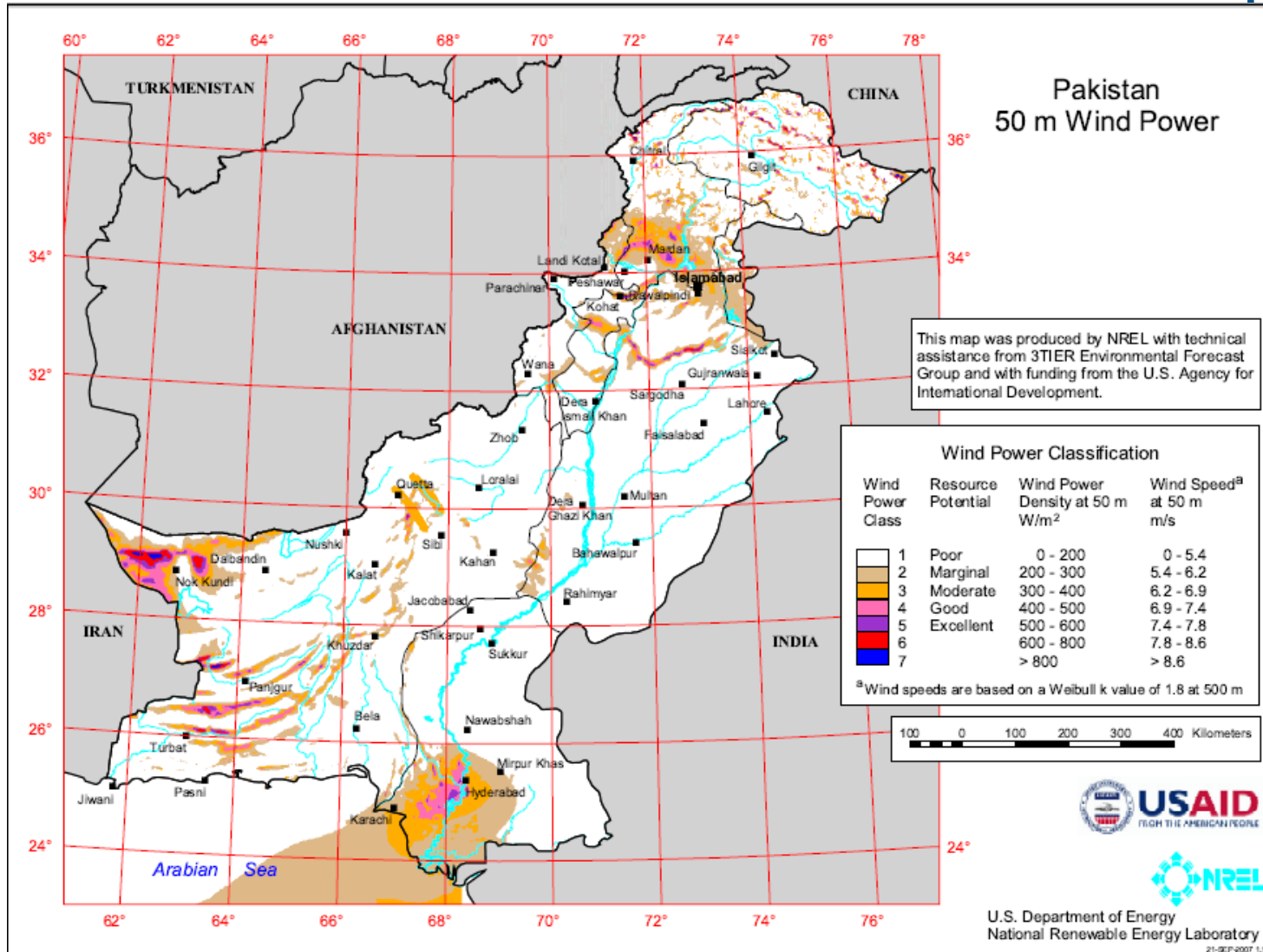
- Teenager in rural Malawi who built two wind turbines from scratch
- Turbines provide electricity for lighting, radios, and mobile phone charging for his family and neighbors
- Efforts profiled in local newspapers, Wall Street Journal, documentary film, and other media
- Now enrolled in the African Leadership Academy in South Africa, and an invited speaker around the world
- Video: <http://www.youtube.com/watch?v=arD374MFk4w>



Women in wind energy

- Denise Bode; CEO, American Wind Energy Association
 - Leads the trade association for the American wind industry
 - Extensive energy experience: oil, gas, utility regulation, Capitol Hill legal staffer
- Lisa Daniels; founder, Windustry
 - Organization empowers communities to develop wind energy as an environmentally sustainable, community-owned asset
 - <http://www.windustry.org/womenofwindenergy>
- Women of Wind Energy
 - Encourages the participation and advancement of professional women in the wind industry
 - Efforts include mentoring, fellowships, networking events, etc

Pakistan 50 meter wind resource map



Role of DOE Wind Program

- **Program mission:** Responsible stewardship of national resources to increase the development and deployment of reliable, affordable, and environmentally sustainable wind and water power and realize the benefits of domestic renewable energy production.
- **Program focus:** Enabling 20% wind generation in the United States by 2030 (300 gigawatts – a \$500 billion investment)

Motivation and Policy Drivers

- **Motivating Factors**

- U.S. energy demand will increase 40%+ over next 25 years, requiring billions of dollars in commercial investment.
- Business as usual will result in security, economic, and environmental vulnerabilities.
- Need to stimulate domestic job creation and economic activity

- **Choices**

- Develop U.S. wind resources or rely on vulnerable generation
- Clean energy or carbon-based sources
- Expand transmission or strand wind and other resources

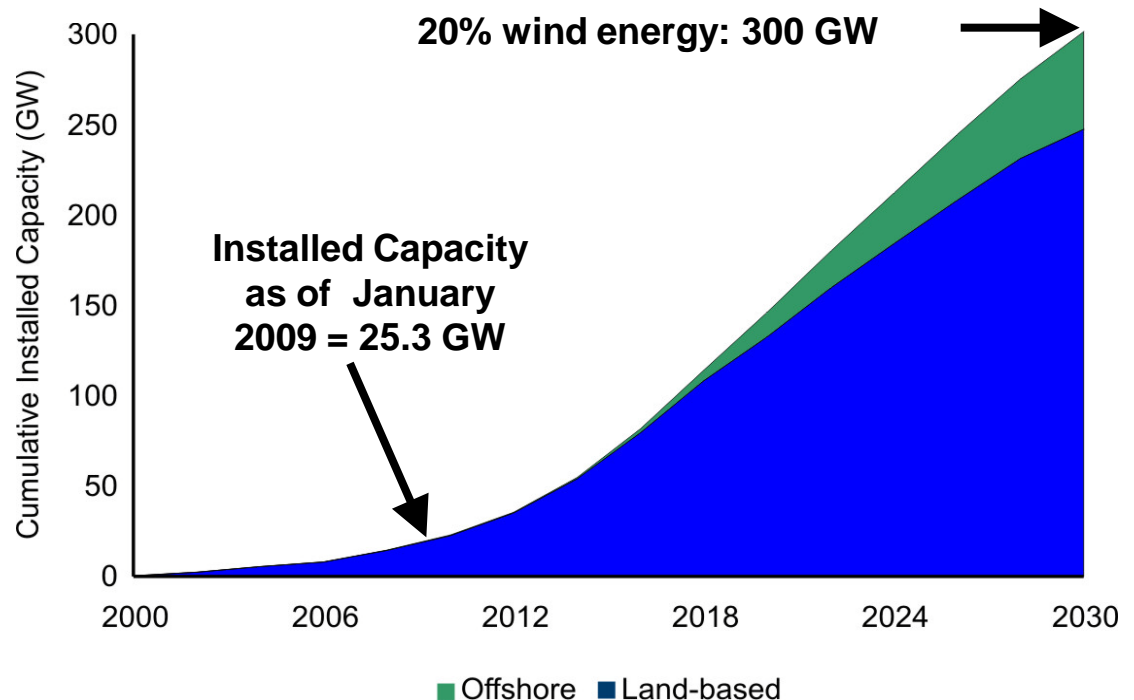
- **Policy Drivers**

- Energy Policy Act of 2005 (EPAAct 2005)
- Energy and Security Independence Act of 2007 (EISA 2007)
- American Recovery and Reinvestment Act of 2009 (ARRA 2009)
- Advanced Energy Initiative (legacy)



20% Wind Energy by 2030

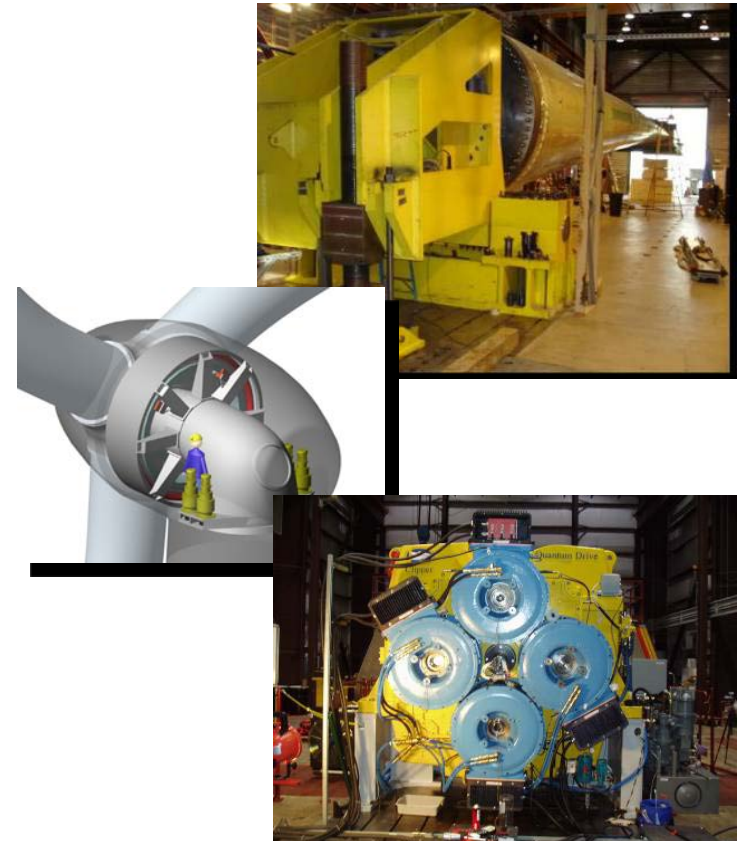
- Explores the feasibility of one scenario for supplying 20% of the nation's electricity from wind by 2030
- Not a prediction or policy recommendation





Turbine technology

- **20% assumptions:** 10% decrease in capital costs, 15% increase in capacity factor by 2030
- **Challenges**
 - Increase the mechanical reliability of current wind technologies
 - Improve the energy production of wind systems
 - Expand the market for wind by bringing it closer to load centers
- **Solutions**
 - Turbine gearbox and drive train reliability
 - Performance enhancement through technology development and testing
 - Advanced component development (blades, advanced controls & generators)
 - Applied research; aerodynamics, materials, and design codes
 - International collaboration and standards development



The testing of large turbine technology is critical to lower financial risk of projects



Manufacturing, materials, jobs

- Challenges
 - Rising raw materials prices
 - Need for domestic manufacturing base
 - Need for qualified workforce
- Solutions
 - R&D for less materials-intensive designs
 - Manufacturing and supply chain initiatives
 - Workforce development

Transmission and integration

- Challenges
 - Variability, uncertainty, and limited output control
 - Lack of transmission for large, remote resource opportunities
 - Fair and appropriate interconnection policy for wind technologies

- Program Activities
 - Wind Plant Performance Characterization
 - Resource assessment and forecasting
 - Generator and wind farm modeling
 - Grid Systems Operations
 - Analysis methods and tools
 - Mitigation strategies
 - Grid System Planning
 - Interconnection and system expansion studies
 - Planning assistance
 - Increasing existing line usage
 - Communication, Policy, Education, and Outreach
 - Collaboration with the DOE Office of Electricity Delivery and Energy Reliability on transmission and integration needs

Accelerate wind deployment

- Accelerate wind energy deployment:
 - Engage key stakeholders
 - Address wind system siting issues
 - Facilitate environmental assessment
 - Interagency collaboratives
 - Facilitation of stakeholder dialog (environmental and siting issues)
 - Federal collaboration – Radar, Fish and Wildlife
 - Enhance public acceptance
 - Promote supportive public policies

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Additional Information:

World Wind Energy Association

<http://www.wwindea.org>

U.S. Dept of Energy, Wind and Hydropower website

<http://www.eere.energy.gov/windandhydro/>