**Disclaimer:** The views expressed are those of Paul Gipe and are not necessarily those of the sponsor.

**Disclosure:** Paul Gipe has worked with Aerovironment, ANZSES, APROMA, ASES, AusWEA, AWEA, BWEA, BWE, CanWEA, CAW, CEERT, DGW, DSF, EECA, ES&T, GEO, GPI Atlantic, IREQ, KWEA, MADE, Microsoft, ManSEA, MSU, NRCan, NRG Systems, NASA, NREL, NZWEA, ORWWG, OSEA, PG&E, SeaWest, SEI, TREC, USDOE, WAWWG, WE Energies, the Folkecenter, the Izaak Walton League, the Minnesota Project, the Sierra Club, and Zond Systems, and written for magazines in the USA, Canada, France, Denmark, and Germany.
Overview of Worldwide Wind Development

By Paul Gipe
Wind Energy Has Come of Age

Paul Gipe, wind-works.org
Montefalcone, Italy
Galicia, Spain

Paul Gipe, wind-works.org
Why Now?

- **Wind Works**
  Greater Reliability

- **Productivity Improved**
  More Efficient
  Taller Towers

- **Costs Declined**
  Economies-of-Scale

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Paul Gipe, wind-works.org
Northern Ireland

40 m, 500 kW

80 m, 1.8 MW

Kincardine, Ontario

Paul Gipe, wind-works.org
We Know What Works . . .and What Doesn’t

Eole, Cap Chat

© Vortec

Paul Gipe, wind-works.org
World Wind Capacity 2007
~90,000 MW

Europe 61%
Asia 18%
North America 19%
Africa 1%
South America 1%

Paul Gipe, wind-works.org
2007 World Wind Capacity

18,000 MW 57,000 MW

17,000 MW

Paul Gipe, wind-works.org
Wind Energy is a Real Business
US$50 Billion in 2007

- Project Development: 64%
- Electricity Sales: 32%
- O&M: 4%

Paul Gipe, wind-works.org
Wind Growing Rapidly 2003-2007

- Germany: ~2,200 MW/yr
  30,000 MW by 2012
- Spain: ~1,700 MW/yr
- USA: ~1,800 MW/yr
- India: ~1,100 MW/yr
- Growth: 20%-40%/yr
- ~1% of World Supply

Paul Gipe, wind-works.org
Wind Market Comparison

Thousand MW Total

- Spain
- Germany
- USA

Renewable Tariffs Launched

Year

Paul Gipe, wind-works.org
Why Wind?

• Reduces Use of Fossil & Nuclear Fuels
• Most Cost-Effective of New Renewables
• Relatively Benign

Paul Gipe, wind-works.org
Wind is Modular

- Quickly Installed
- When Needed
- As Needed
- Where Needed
- By Anyone
Wind is Flexible

- **Scale**
  - Big or Small Projects
- **Location**
  - Near or Far
- **Time**
  - Short Lead Times
- **Ownership**
  - Local or Absentee

Paul Gipe, wind-works.org
Wind Energy’s Benefits

• Clean & Green (Mostly)
  No SO$_x$, NO$_x$, or CO$_2$
• Renewable
  Net Positive Energy Balance (4-6 months)
• Domestic: Not Subject to Embargo
• Does Not Consume Water
• Modular = Flexible
• . . . and Can be Removed

Paul Gipe, wind-works.org
Wind Energy’s Impacts

- Aesthetics or Intrusiveness
- Erosion & Scarring from Roads
  Length, Width, Number and Slope
- Shadow Flicker & Disco Effect
- Climate?
- Noise--They are Audible
- Wildlife
  Habitat Disruption
  Bird & Bat Kills: Collisions, Electrocutions

Paul Gipe, wind-works.org
Birds & Bats

• Before & After Studies of Big Projects
• Studies Necessary for Small Projects?

Cros de Gerand, France
Birds & Bats

• Serious Problem
  Tarifa?
  Altamont Pass (900-1,300 Raptors/yr)
• A Concern Elsewhere
• No Quick Fixes--No Panaceas
  Stripes & Whistles Don’t Work
Both Small & Large Turbines

- Eliminate Horizontal Perches & Roosts
  - No Lattice Towers with Horizontal Members
- Avoid Heavy Concentrations of Birds
- Mortality Rate
  - Function of Swept Area, Not Rotor RPM!

Paul Gipe & Assoc.
Mortality Rate

- 34 Deaths in 32 years
- Most in Construction
- Highest Mortality Rate
  USA & NL
- 3 with Small Turbines
- 1 Member of the Public
  German Parachutist

Paul Gipe & Assoc.
Public Safety

• No Passerby Killed or Injured

• Ice Throw
  Max. 100 m
  1.5 X Height
  Post Warnings

• Blade Throw

• Suicides

  Attractive Nuisance

Paul Gipe, wind-works.org
Texas
Ontario
California
Germany

Wind Turbine Area (m²)/Household (~6.4 m/s)

Paul Gipe, wind-works.org
Prices Paid for Wind Energy in Europe

Paul Gipe, wind-works.org
Wind Works!

Paul Gipe & Assoc.