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.
Preparing for Prime Time: What Small Wind Needs to Make Its Mark

by Paul Gipe
Small Wind--A Checkered Past

- Poor Performance
- Poor Reliability
- Costly
- Noisy
- Magnet for Hustlers & Charlatans
- Unsafe

Paul Gipe, wind-works.org
Better Performance

• 1/2 That of Large Turbines
  At Best
• Seldom Meet Projections
• Short Towers
  Big Problem

Paul Gipe, wind-works.org
Typical Yields
Large & Small Turbines

Paul Gipe, wind-works.org
Higher Reliability

• Cheap = Short Life
• Seldom Last Long Enough
• Many Remain Derelict For Years

Paul Gipe, wind-works.org

H40 Wulf Test Field
H40 4-Year Life

- Blade Failure
- Yaw Failure
- Insulation Failure
Less Costly

- SkyStream
- $18,000 Installed
- Yield: 375 kWh/m2/yr (6+ m/s)
- SPBT 12 years
- COE: $0.50/kWh

Paul Gipe, wind-works.org
Quieter

Noise Emissions: Source Sound Power Level at 8 m/s

Sound Power Level (dBA)

Diameter (meters)

Paul Gipe, wind-works.org
Magnet for Hustlers & Charlatans

- Ease of Entry
- Preying on Ignorance
- Pyramid Schemes
- Drag Devices
- Ducted Devices
- Fantasy Wind
- Roof Top Wind

Magwind, Whitby Ontario

Paul Gipe, wind-works.org
Roof Top Mounting?

- Turbulence
- Poor Performance
- Noise & Vibration
- Safety
- Simply a Bad Idea

Possibly Dublin, circa 1990s

Paul Gipe, wind-works.org
Roof Top Mounting?

• No, Don’t Do This!
Roof Top Mounting?

• Tied Off

Paul Gipe, wind-works.org
Roof Top Mounting

- Tied Off

Similar installation along main rail line near Bonn. AlGauier?
Roof Top Mounting?

- Tied Off

Paul Gipe, wind-works.org
Roof Top Mounting

- Never Operates
- Across from AGO
- Highly Visible
Roof Top Mounting?

- Well, OK Here
- Battery Charging
- Uninhabited

Newcastle, Indiana

Paul Gipe, wind-works.org

Jutland, Denmark
Safer

• 3 Deaths <30 kW in 30 Years
• 12 Deaths <100 kW in 30 Years

Pat Acker, 28, Bushland, TX, 1982
Small Wind Turbine Tower Safety

- Tilt-up Towers for Micros & Minis Always Preferable

Paul Gipe, wind-works.org
Small Wind Turbine Tower Safety

- All Other Towers
  Person Lifts
  Fall Arrest Systems
  Work Platforms
  Anchors
  Rotor Locking Pins
  Tower Training

Paul Gipe, wind-works.org
Small Wind Turbine Tower Safety

- Minimal or No Work on Tower
- No Fall-Arrest System
- No Work Platform
- No Anchors
- No Training

Paul Gipe, wind-works.org  Canyon, Texas, 1979
Small Wind Turbine Fall Safety

- Work Platform
- Anchors
- Full Harness
- Lanyard

Folkecenter, Denmark, 1997
Small Wind Turbine Tower Safety
1930s Had Work Platforms

Wincharger, Grand Teton NP, Wyoming

Paul Gipe, wind-works.org
Large Turbine Tower Safety

- Helmet
- Gloves
- Harness
- Radio
- Fall Arrest

© Rope Partner

Paul Gipe, wind-works.org
Small Wind--What’s Needed

• Standards
• Testing
  with Published Results!
• Informed Consumers
• Facing Reality
  Small Wind’s Limits

Paul Gipe, wind-works.org

Chateau Lastours, France
Small Turbine Testing Standards

- AWEA Proposed 1979
- Adopted 1988
  ... Sort of
- No Standard In Force
  ... After 30 Years!

Pinson Cycloturbine, 1979

Paul Gipe, wind-works.org
Small Wind Test Fields

- **Commercial**
  - NREL, CO
  - WindTest, Germany
  - AEI, TX
  - Windward, UT
  - PEI, Canada

- **Private Unfunded**
  - Mike Klemen, ND
  - Wulf Test Field, CA
  - Folkecenter, DK

Paul Gipe, wind-works.org
Wulf Field Tehachapi, California
Turbines Tested

Air 303/403/X.1/X.2/X.3
Marlec 910F
BWC 850
Whisper H40
LVM 6F

Paul Gipe, wind-works.org
Wulf Field Tehachapi, California
Tests Performed

Power Curves

Power Loss

Noise Emissions

Paul Gipe, wind-works.org
Wulf Field Tehachapi, California
Test Results Published

Small Turbine Testing
- The Need for an International Small Wind Turbine Test Center
- Testing the Power Curves of Small Wind Turbines
- Comments on a Proposed Performance Standard for Small Wind Turbines
- Detronics Field Tests the Air X
- Side by Side Comparison of Proven 5 kW and Iskra 5 kW at Hockerton Housing Project
- USDA Noise and Power Curve Tests of Small and Household-Size Wind Turbines
- NREL Noise and Power Curve Tests on Small & Household-size Turbines
- Whisper H40 Final Report
- Inventus 5 kW Power Curve
- AirX Noise Emission Measurements
- AirX Fails Power Curve Tests
- Brazilian Tests Confirm Air 403 Underperforms Power Curve
- Summary of Power Curves Measured at the Wulf Test Field
- Noise from Small Wind Turbines: An Unaddressed Issue

Paul Gipe, wind-works.org
Micro Turbine Measured Power Curves
1-min. Averages, 15 C, Sea Level

Watts

mph

Marlec 910  LVM6  Air 3D3H  Air 4D3  Ampair  ARX.1  ARX.2
Air X Power Curve Measurements
400 W = 175 W (40%)
H40 Power Curve Measurements
900 W = 700 W (80%)

H40 Power Curve Test Update
Corrected for Temperature & Elevation

![Graph showing power vs wind speed]

- 2003 Data
- 2002 Data
H40 Power Loss

H40 Total Power and Power to Batteries
Corrected for Temperature & Elevation

Power (W)

0 100 200 300 400 500 600 700 800 900 1000

Wind Speed (mph)

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

- Power Delivered
- Gross Power

Calculated Gross Power
Small Turbine Noise Measurements

- Meters Costly
- Somewhat Complex
- Difficult for Amateurs
Air 403 Noise Measurements

Air 403 Noise at Wulf Test Field

dB(A) (Leq) vs. Wind Speed (mph)
Calculated Emission Source Strength
Selected Small Wind Turbines

Paul Gipe, wind-works.org
Informed Consumers

• Demand Better Products
  Less Susceptible to Hustlers & Charlatans
  Less Susceptible to Aggressive Marketing
• Know What They’re Buying
• Know What to Expect
  Published Test Results
• Know What is Being Delivered
  Metering a Must

Paul Gipe, wind-works.org
Facing Reality

- Many SWTs
  Not Ready for Prime Time
- Much Work Must be Done
- Performance Will Lag
  Large Turbines
- Micros & Minis
  Only for Battery Charging

Paul Gipe, wind-works.org
Small Turbines Must Become as Reliable and as Productive as Today’s Big Turbines

Hinesburg, Vermont

Paul Gipe, wind-works.org