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

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Paul Gipe, wind-works.org
Plus Energy Building: Wind Energy, Small Wind, & Community Wind
by
Paul Gipe
Wind Energy Has Come of Age

Noordoostpolder, The Netherlands

Paul Gipe, wind-works.org
The Troika of Meeting Demand

- Conservation
  #1 Use Less
- Improve Efficiency
  #2 Do More with Less
- Renewable Energy
  #3 Invest in the Future

Fuchskauta
Höhe Westerwald, Germany
Typical Household Consumption

<table>
<thead>
<tr>
<th></th>
<th>kWh/yr/home</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas</td>
<td>14,000</td>
</tr>
<tr>
<td>Ontario</td>
<td>10,000</td>
</tr>
<tr>
<td>California</td>
<td>6,500</td>
</tr>
<tr>
<td>Netherlands</td>
<td>3,000</td>
</tr>
</tbody>
</table>

Paul Gipe, wind-works.org
Living Better on Less

• 10 Million California Households
• 2 x 100 W Bulbs
• 2 x 25 W CF
• 150 W Savings x 10 Million
• = 1,500 MW Savings!
Many More Opportunities

• Task Lighting
• Notebooks = 90% Savings!
• Juwi--Only Notebooks
The Result in the Nies-Gipe Household

Electricity Consumption Gipe-Nies Household

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
We Know What Works
...and What Doesn’t

Eole, Cap Chat

© Vortec

Paul Gipe, wind-works.org
40 m, 500 kW

80 m, 1.8 MW

Northern Ireland

Kincardine, Ontario

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Why Wind?

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

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Wind is Modular

• Quickly Installed
• When Needed
• As Needed
• Where Needed
• By Anyone

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Tehachapi, California
Wind is Flexible

- **Scale**
  Big or Small Projects

- **Location**
  Near or Far

- **Time**
  Short Lead Times

- **Ownership**
  Local or Absentee

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Wind Energy’s Benefits

- Clean & Green ( Mostly)
  - No SO\textsubscript{x}, NO\textsubscript{x}, or CO\textsubscript{2}
- Renewable
  - Net Positive Energy Balance (4-6 months)
- Domestic: Not Subject to Embargo
- Does Not Consume Water
- Modular = Flexible
- ... and Can be Removed

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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
Applications
Interconnected Operation
Battery Charging
Lessons Learned

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Nomenclature
What is a Wind Turbine

- **Turbine**: Rotor
  Assemblage of Blades

- **Generator**: Nacelle

- **Tower**: Guyed, Freestanding

- **Foundation**
Nomenclature

- Mid-80s HAWT
- Internal Ladder
- w/ Fall Restraint
- Work Platform
- Tip Brakes
- “Rocket” Tower
Applications--Off-the-Grid

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Applications--Homes

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Applications--Farms

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Electric Vehicle Charging

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Single Turbine Interconnection

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Cluster

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Applications--Wind Power Plants

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Lessons
From 30+ Years of Experience

• No Panaceas
• No Cheap Solutions
• No Breakthroughs--No Miracles
• Numbers Matter
• Experience Matters
• Size Matters

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Lessons

• Always Check the Numbers
  Vortec: The Numbers Didn’t Add Up

• Always Check the References
  Vortec: References Discredited in the USA

• Always Google
  Vortec: Ducted Turbine Critics on the Web

• Always Go to the Library
  . . . Or to Your Neighborhood Bookstore!
  Lots of Wind Books Now Available

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Lessons

• Always Be Wary of “New” Designs
Scams, Frauds, & Flakes
Tell-Tale Signs

Heavy on Hype--Weak on Experience

Fancy Web Site
Web Sites are Much Cheaper than Real Turbines

Aggressive Marketing
Watch for Multi-Level Pyramid Schemes
“Get in on the Ground Floor”

“New” Design, “Not Like The Others”
Often VAWTs, Squirrel Cage, Ducted (DAWT)
Scams, Frauds, & Flakes
Tell-Tale Signs

• **Patents**
  Rarely Mean Anything

• **Works at Low Speeds (<3 m/s)**
  There’s Little Power in Low Winds

• **Silent!**
  Yes, Because They Seldom Do Anything

• **Doesn’t Kill Birds**
  Yeah, right!

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Wind Energy Conversion Devices

• Drag Devices
  HAWT (Seldom)
  VAWT (Often)
  First Choice of “Inventors”

• Lift Devices
  HAWT (Dominant)
  VAWT (Rare)
Configuration: Axis of Rotation

HAWT  VAWT

Paul Gipe & Assoc.
VAWT Configurations

“H”
DELTA
DIAMOND
“Y”
PHI
VAWTs

φ Darrieus

2 Blades

DAF-Indal
Atlantic Wind Test Site, PEI

Paul Gipe, wind-works.org
Giromill

Articulating Straight Blade VAWT

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HAWT Configurations

ONE BLADE
TWO BLADES
THREE BLADES
MULTIBLADE
UPWIND PASSIVE YAW WITH TAIL VANE
UPWIND PASSIVE YAW WITH FAN TAIL
UPWIND ACTIVE YAW
DOWNWIND PASSIVE YAW WITH CONING

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Rotor Overspeed Controls

- All Wind Turbines Must Have Some Form of Rotor Overspeed Control—All
  Micro: Dynamic Brake OK
  Mini: Dynamic Brake Maybe OK
  Household-size: Dynamic Brake Typically Not Sufficient
Overspeed Controls
Furling-Vertical

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Towers-Guyed Small Turbines

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Towers-Freestanding
Small Turbines

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Towers-Tubular Small Turbines

Paul Gipe, wind-works.org
Towers-Hinged Small Turbines

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Small Wind--A Checkered Past

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

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Poor Performance

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

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

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

Air Breeze

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Incredible Shrinking Wind Turbine

- Air 403: 400 W
- AirX: 300 W
- Air Breeze: 200 W
- Air Breeze: 150 W
- Measured: 125 W

Air Breeze Power Curve 2010
Too Short a Tower
Worst Turbine Install?

- Helix VAWT
- Seattle, WA
- If You Don’t Know What’s Wrong with This Picture, You Are in the Wrong Business!

Photo by Mike Nelson, WSU

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Too Short a Tower
Worst Turbine Install?

• Mariah VAWT
• Indianapolis, IN
• Kinetic Sculpture--Not a Wind Turbine

Photo by Laura Arnold, INREA

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Poor Reliability

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

For Years

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H40 Wulf Test Field
## Small Wind Too Costly
### 3X Large Wind

<table>
<thead>
<tr>
<th>Size</th>
<th>Low ($/m²)</th>
<th>High ($/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro</td>
<td>1,500</td>
<td>2,500</td>
</tr>
<tr>
<td>Mini</td>
<td>1,250</td>
<td>2,500</td>
</tr>
<tr>
<td>Household</td>
<td>1,250</td>
<td>2,250</td>
</tr>
<tr>
<td>Small Commercial</td>
<td>800</td>
<td>1,250</td>
</tr>
<tr>
<td>Large</td>
<td>700</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Adapted from Wind Energy Basics: A Guide to Home- and Community-Scale wind Energy Systems

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Magnet for Hustlers & Charlatans

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

Magwind, Whitby Ontario

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Roof Top Mounting?

- Turbulence
- Poor Performance
  ~0 Net Energy!
- Noise & Vibration
- Safety
- Simply a Bad Idea

Possibly Dublin, circa 1990s

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Roof Top Mounting?

• No, Don’t Do This!

DAF-Indal, Canada

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Roof Top Mounting?

• Tied Off

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Small Wind Turbine Tower Safety

- No Fall-Arrest System
- No Work Platform
- No Anchors
- No Training

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

• Tilt-up Towers for Micros & Minis Always Preferable

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Small Wind Turbine Tower Safety

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

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Small Wind Turbine Fall Safety

- Work Platform
- Anchors
- Full Harness
- Lanyard

Folkecenter, Denmark, 1997

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Small Wind--What’s Needed

• Compulsory Standards
  For Products & Installers

• Testing
  with Published Results!

• Facing Reality
  Small Wind’s Limits
  What Small Wind Can & Cannot Do

Paul Gipe, wind-works.org

Chateau Lastours, France
Small Wind Turbine Certification
• Minimum Requirement!

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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

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Small Wind--Facing Reality

• Many SWT Not Ready for Prime Time
• Much Must be Done
• Performance Will Lag
  Large Turbines
• Micros & Minis for Battery Charging

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Chateau Lastours, France
Wind Works!

• But It Must be Done Right