Configuration: Axis of Rotation

HAWT

VAWT

Paul Gipe & Assoc.
Horizontal Axis Wind Turbine (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

Paul Gipe, wind-works.org
Rival Calzoni, Central Italy

One-Blade Downwind

Paul Gipe, wind-works.org
Two Blades Upwind

Palm Springs, California

Paul Gipe, wind-works.org
Three Blades Upwind

Paul Gipe, wind-works.org

Bay Wind Co-op, Ulverston, Cumbria, England
Pointe-au-Pere, Quebec

Small Turbine
Upwind with Tail Vane
Skystream, Alexandria, Indiana

Small Turbine
Downwind Rotor

Paul Gipe, wind-works.org
Applications: How Wind Energy is Used

Ydby, Denmark

Paul Gipe, wind-works.org
Applications--Off-the-Grid

Paul Gipe, wind-works.org
Applications--Farms

Paul Gipe, wind-works.org

Pincher Creek, Alberta
Electric Vehicle Charging

Paul Gipe, wind-works.org
Multiple Turbine Cluster

Paul Gipe, wind-works.org
Multiple Turbine Cluster

Paul Gipe, wind-works.org

Dardesheim, Germany
Wind Power Plants

Paul Gipe, wind-works.org

Buffalo Ridge, Minnesota
Off-Shore

Paul Gipe, wind-works.org

Wikimedia.org
What Were They Thinking: Rooftop (Building Integrated) Wind

12 West, Portland, Oregon

Paul Gipe, wind-works.org
Rooftop Wind: Why Bother?

• It is Where the People Live
• Solar PV **Was** Expensive
  Wind **Was** Cheaper than Solar PV
• Tall Buildings--No Tower Needed
  Wrong!

Dyocore, Morro Bay, CA

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

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

Dublin, circa 1990s

Paul Gipe, wind-works.org
Oh, This Isn’t Going to Work!

1979, St. Eleanors, Prince Edward Island

Paul Gipe, wind-works.org
Roof Top Turbine
Toronto

Only Works in Animation on a Web Site

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

• Tied Off

Paul Gipe, wind-works.org
Renewable Energy Devices Swift

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

• Tied Off

Paul Gipe, wind-works.org
Boston Museum of Science Rooftop Wind Test Site

- Most Thorough Testing in USA
- Downwind, Upwind, & VAWT
- 5 Models
- Full Power Curves & Scatter Plots
- Performance Metric: kWh/m2!!!!!
- Average Wind Speed: 3-3.7 m/s

Paul Gipe, wind-works.org
Boston MoS Rooftop Wind Test Site Lessons Learned after Two Years

- No Issue with Noise, Vibration, Ice Throw, Flicker, Bats, or Neighbors
- 1 Bird Killed (Red-tail Hawk)
- Several Turbines “Underperformed”
- “Not Cost-Effective at This Site”

Paul Gipe, wind-works.org
## Boston MoS Rooftop Wind Test Site Comparison

<table>
<thead>
<tr>
<th></th>
<th>kWh/m²</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hull V47</td>
<td>900</td>
<td>Conventional</td>
</tr>
<tr>
<td>Hull V80</td>
<td>753</td>
<td>Conventional</td>
</tr>
<tr>
<td>IBEW NPS 100</td>
<td>231</td>
<td>Conventional</td>
</tr>
<tr>
<td>Skystream</td>
<td>140</td>
<td>Rooftop</td>
</tr>
<tr>
<td>Proven</td>
<td>100</td>
<td>Rooftop</td>
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<tr>
<td>Aerovironment</td>
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<tr>
<td>Swift</td>
<td>30</td>
<td>Rooftop</td>
</tr>
<tr>
<td>Windspire</td>
<td>23</td>
<td>Rooftop</td>
</tr>
</tbody>
</table>

Paul Gipe, wind-works.org
Urban Wind: What is It?

- Rooftop Wind Turbines
- Building Integrated Wind Turbines
- Architectural Greenwashing
- Indianapolis: Ground Zero
Greenwashing: What Is It?

- Make Believe Wind
- Fake, Deceptive—a Sham, Phony
- PR Value Exceeds Energy Generation
  Mining LEED Points
- “Kinetic Sculptures”
  Sometimes Not Even That!
- Often “Not Like Those Other” Turbines
Urban Wind: Mariah (KIB)

LEED Points for Keep Indianapolis Beautiful

Possibly Not Even Kinetic Sculpture

Paul Gipe, wind-works.org
Indiana Nature Conservancy

- “Crown Jewell” (Architectural Bling)
- $30,000
- “Might Not Generate 8,000 kWh/yr”
- They Got That Right!

Paul Gipe, wind-works.org
In Contrast—RSPB & Real Green

• Real Wind—Not Token Wind
• Society’s Headquarters—The Lodge
• 2012: Announced
• 2016: Enercon E53 (800 kW)
• 1.9 million kWh/yr
• Statements Bold & Clear
UGE Vying for Top Greenwashing Spot

©Mick Sagrillo, Albuquerque, NM
UGE Vying for Top Spot

Gustave Eiffel Rolling Over in His Grave!

• For Greenwashing, 2 VAWTs Inside

Paul Gipe, wind-works.org
Building Integrated & Rooftop Wind? A Failure Says NREL—Sort of

• Experience Mixed Results—Really?
• Success Defined as

  Meeting their PR Objectives . . .
  Most “Successful” Project: 12 West
  $240,000 for 4 Skystreams on 45-foot Towers
  $30,000/kW
  $44/kWh—100 X of Commercial Wind
  Only Project Where the Turbines Operated Reliably!

Paul Gipe, wind-works.org
Real Urban Wind

• Real Turbines on Real Towers
• Producing Real Electricity
• Compatible with Existing Uses

Eiffel’s Tower of Today
... In the Urban Skyline

Paul Gipe, wind-works.org
At Schools

Paul Gipe, wind-works.org

Forest City, Iowa
Medford, Mass (Boston): NPS 100

Paul Gipe, wind-works.org
Medford, Mass (Boston): NPS 100

Map © Google.com

Paul Gipe, wind-works.org
Medford, Mass (Boston): NPS 100

- Installed 2009, No Complaints
- ~80,000 kWh/yr
  What Would They do Differently: Taller Tower
- Public Access, Public Park/Playground
- Site of “Energy Harvest Festival” in Fall

Paul Gipe, wind-works.org
Lessons Learned

• Always Be Wary of “New” Designs

Paul Gipe, wind-works.org
Lessons Learned
From 40 Years of Experience

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

Paul Gipe, wind-works.org
Lessons Learned?

- Performance Matters
- Reliability Matters
- Service Matters
- Client Profitability Matters

Paul Gipe, wind-works.org
Lessons Learned

• 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!

Paul Gipe, wind-works.org
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 & DAWTs
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!

Paul Gipe, wind-works.org
Small Wind Turbines Today

• Testing & Certification
  SWCC Weeding Out the Crap
• More Productive
  High-Performance Generators
• More Durable
• More Swept Area
• . . . More Profitable

Paul Gipe, wind-works.org

2013, Jonica Impianti Cooperativo, Puglia, Italy
Improved Performance

- With New Turbines
- New Generators

Paul Gipe, wind-works.org
~ 50% Performance Improvement

Annual Specific Yield @ 6 m/s Average Annual Wind Speed

Old Designs

New Designs

Specific Yield (kWh/m²/yr)

0 100 200 300 400 500 600

Paul Gipe, wind-works.org
Improved Durability

- Air Breeze 12/2007-4/2017
- ~10 Years Unattended

Nancy Nies

Paul Gipe, wind-works.org

Wulf Test Field, Tehachapi, California
Small wind small player in worldwide wind energy market.
Articles on Small & Household Size Wind Turbines

Small wind turbines encompass a broad range of wind turbines from micro turbines, to mini turbines, to household-size turbines. Wind turbines in these size classes may have power ratings from a few watts to dozens of kW. Internationally, this category includes wind turbines up to 15 meters (49 feet) in diameter. Wind turbines of this size may have power ratings from 50 to 100 kW.

While ducted or shrouded wind turbines and Vertical Axis Wind Turbines can be of any size, they are listed here because they are outside the mainstream of the commercial wind industry.

Small Wind Conference Chooses Gipe for Keynote Speaker

March 10, 2017,

The Small Wind Conference has chosen Paul Gipe as its keynote speaker for its 2017 conference in Minneapolis, Minnesota. Calling Gipe "legendary" for his four decades writing about wind energy, the... [more]

Endurance Wind Power bankruptcy spreads to UK

December 9, 2016, by Nelson Bennett

Endurance Wind Power filed for bankruptcy sometime around early November and placed under trust with Grant Thorntan, after its bank called in its loan.
Small Wind on Wind-Works.org

**SMALL WIND TURBINES**
- Ducted Wind Turbines
- FITs for Small Wind
- LEED Leads to Bad Wind
- Questionable Concepts
- Rooftop and Urban Wind
- Small Turbine Testing
- Vertical Axis Wind Turbines
- Worst Install in History

**Small Turbine Testing**
- Wulf Test Field
- Small Turbine Product Reviews

**Rooftop and Urban Wind**
- Cleanfield
- Honeywell Windtronics
- Mag-Wind
- Renewable Devices Swift

**Vertical Axis Wind Turbines**
- FloWind
- Mag-Wind
- Mariah Windspire
- Cleanfield
- Worst Install in History

Paul Gipe, wind-works.org