



Vertikalaxlad Entreprenör

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The Vertical Revolution

Already underway for small turbines.
Why Horizontal Axis? Why vertical Axis?

- Large scale vs. Small scale
- Directly driven generators
- Complexity vs. Simplicity
- New generator technology

- ❖ Reduced investment costs
- ❖ Reduced maintenance
- ❖ More robust technology

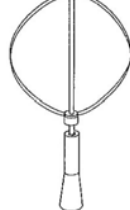
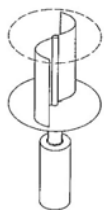


Wind power & Vertical axis

Savonius-Rotor

Darrius-Rotor

H-Darrius-Rotor



Original wind mill:
Persia; ~900 A.D.

Savonius rotor:
most common:
only suited for
very small
turbines (to large
area in storm)

Troposkein
blade Darrius-
Rotor, suited
for small
turbines where
centrifugal
force is main
loading

Straight bladed
Darrius-Rotor,
suited for large
turbines

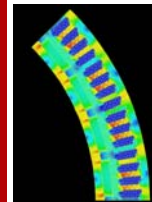


VAWT Research at UU

New technology:

- Vertical axis wind turbine
- Directly driven PM synchronous generator
- Full electric control
- Only 1 movable part

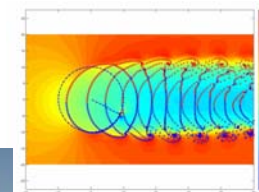
Theory and Experiments:



Full physics
Generator model



Experimental 12 kW turbine



Aerodynamic model



Generator development



Comparison different turbines:

Issue:	H-rotor	HAWT	Darrieus
Height:	High	High	Lower, no tower
Generator position:	Optional	On top of tower	On ground
Hub:	Omni directional	Yaw mechanism	Omni directional
Blade yaw:	Optional	Common	Not possible
Noise:	Low	Inherently high	Moderate
Blade area:	Moderate	Moderate	Large
Tower interference:	Small	Large	Small
Commercial:	Small scale	Yes	No
Turbine Cp:	0.4+	0.5	0.3-0.4
Foundation:	Moderate	Moderate	Simpler
Self starting:	Optional	Normally	No
Structure:	Simple	Complicated	Simple



Sandra Eriksson, Hans Bernhoff and Mats Leijon, "Evaluation of different turbine concepts for wind power", Renewable and Sustainable Energy Reviews, Volume 12, Issue 5, June 2008, Pages 1419-1434.



12 kW H-rotor at Marsta

Uppsala University test site north of Uppsala

- Three 5 m wings
- 6 m rotor diameter
- 12 kW 127 rpm @ 12 m/s
- Direct drive PM-generator



www.el.angstrom.uu.se

Vertical Wind AB

VW Started in Nov 2002.
Aug. 2008: 9 Employees
CEO: Hans Bernhoff, Chairman Mats Leijon

IPR: 1 patent for H-rotor: Granted world wide,
Several patent appl. pending

Focus 2008:

- Development of wind-to-wire simulation for design
- Design 200 kW plant
- Setting up components fabrication and testing

More information at: www.verticalwind.se



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Vertical
WIND



Observationer

- Industri ⇒ Akademi
- Tvärvetenskaplig forskning
- Ny forskning
- Skilja uppfinnare från uppfinning
- Aktieägaravtal och investerare
- Systemperspektiv Kundnytta Kunskap
- Inget nytt under solen
- Experter & utvärderare
- 80/20-regeln för tekniska