Wind Turbines
Large  Small and Unusual

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Types of turbines
Horizontal axis
Vertical Axis

Sizes
From 1m to 100m diameter
From 5m high to 100m at hub

Locations
Land, Buildings, Water
Some unusual wind turbines

Vertical axis – drag type
Magen Power. Helium filled, 150 – 300m high
100kW ~14m by 30m. $500,000. 2010 - 2011

Wind Wing
Wind Wing Action

- Wing reversing energy recovery reservoir
- Balanced weight
- Energy transfer rod
- Generator, pump or compressor
- Airfoil pushed up
- Downward useful force

Wind direction: arrow pointing left

- Airflow direction: arrows pointing upward and downward
Domestic
Noise
Vibration

The RidgeBlade
www.thepowercollective.com
Amsterdam, September 25 2009

WIND TURBINE WINS GREEN CHALLENGE 2009  A nearly invisible rooftop wind turbine has won the €500,000 Postcode Lottery Green Challenge 2009. “It's beyond a dream,” said English entrepreneur Dean Gregory when Skype founder Niklas Zennström, a contest juror, announced his name. "This means we can focus solely on bringing this to market." Gregory entered the Challenge on behalf of the English company The Power Collective Limited – after finding out about it two days before the deadline.

Each year, the Dutch Postcode Lottery gives away €500,000 to the inventor of the best climate-friendly invention.
Fortis Montana WT - 5m diam.  15 – 18m high
2.5kW at 10m/s >> 5kW at 17m/s

Figure 2-7: Montana power curve; Power (kW) vs wind speed (m/s)
Parapet

Vertical axis  Croydon
Quiet Revolution.Qr5 –
5m high, 3.1m wide,
>15m mast
4 – 7 kW depending on
conditions.
£35K – 40K

Applications for Small Wind Turbines

- Domestic electricity
- Electricity in remote areas:
  refrigeration, communication
- Recovery of water from air - Aeolus etc
  10m high 53 litres/24hr - €9,900
  12m high 149 litres/24hr – €18,000
  14m high 514 litres/24hr - €25,000
For wind speed 10m/s at 25C 60%RH
Bahrain world trade centre

Bahrain World Trade Centre 240 m high
3 x 29m diam.  225kW each
Magnus effect

Spiral Magnus - 11.5m diam. Several KW  www.mecaro.jp
Statoil Floating Turbine

100m immersed below surface

Anchored three points

Install in 100m to 700m depth

Blue H Group. Floating turbine - Italy
Selsam Deep Water - Floating multiple turbine

Vertax Wind Turbine
up to 10MW  15,000 m² swept area
www.vertexwind.com
Wind scoop. KE converted to PE at base

Typical modern wind turbines
Energy in the Wind

Rotor power \( P = \frac{1}{2} \rho A U^3 \ 4a(1-a)^2 \)

Power coefficient
= rotor power/wind power = \( P/ \frac{1}{2} \rho A U^3 \)
= \( 4a(1-a)^2 \) Max value 0.59

\( \rho \) = density of air
\( A \) = area of sweep
\( U \) = wind velocity
\( a \) = fractional change in velocity

Vestas V90

Hub height 107m
Rotor diameter 90m
Rotor centre to tower axis 5m
Rated electrical power 3MW
Sound power level 105 dBA
Weight 379 tonnes

Sound power 120dB = 1W, 110dB = 0.1W, 100dBA = 0.01W
Sound pressure = Sound power – 20logr – 11 + XYZ
The things they say about….INFRASOUND

- Vibroacoustic Disease
- Wind Turbine Syndrome
- No appreciation of magnitudes
- Safe and unsafe doses
- Attitude to a noise is an important factor in response
The infrasound fallacy

Infrasound is inaudible  X
Infrasound can be felt by the body  √
Therefore inaudible infrasound is affecting the body  X

Infrasound is clearly audible before it affects the body

Vibroacoustics Disease

Initially described for aircraft technicians
Noise Levels 12.8m from the aircraft centre line and 6m behind the engine outlet.

Wind turbine noise levels and threshold.
Infrasound and low frequency noise in a quiet suburban indoor location on a still day.

Pressure Magnitudes

1 atmosphere = 100,000 Pa
94dB SPL = 1Pa
54dB = 0.01 Pa
54dB = $10^{-7}$ atmosphere
1 Atmos = 10m water = 10,000mm water
54dB = $10,000 \div (10,000,000)$ mm of water
= 0.001mm water (Skin ~ 1mm)
Wind Turbine Syndrome

Effects of Infrasound on the vestibular and other balance organs ×

Symptoms same as those of noise annoyance. Psychological, not physiological ✓

WT Syndrome

sleep disturbance, headache, tinnitus, ear pressure, dizziness, vertigo, nausea, visual blurring, tachycardia, irritability, problems with concentration and memory, and panic episodes associated with sensations of internal pulsation or quivering which arise while awake or asleep”

Noise annoyance

insomnia; headache; pressure in the ears or head;
Dizziness; nausea;
eye strain; fatigue;
distraction;
nose bleeds;
feeling vibration; muscle spasms;
apalpitations; skin burning; stress; tension etc
THE FUTURE - 2030

November 2009 issue Scientific American. Article on energy needs*

Water 1.1TW 9% < 1% in place

Wind 5.8TW 51% 3.8million 5MW turbines

Solar 4.6TW 40% 1,700,000,000 ~3kW rooftop systems plus large systems

* A path to sustainable energy. Jacobsen and Delucchi

The things they say about....INFRASOUND

Why the crew abandoned the Marie Celeste

The mystery was unsolved for decades, until it became clear that infrasound was the explanation of the phenomenon. As it turned out, infrasound of seven hertz emitted by ocean waves under some definite conditions was the reason of it. But infrasound of seven hertz is terrible for people: they may go mad and throw themselves overboard to save their lives.

http://ghosts.monstrous.com/infrasound.htm