Wind Turbine Technology for Telecom

Zephyr Corporation

" Empowering the Wind to Energize the World"

Mats Vilander, General Manager EMEA, Zephyr Corporation

7th GPM Working Group, CEBU, September 21 – 23, 2010

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Agenda

- Introduction of Zephyr Corporation
- Products and Solutions
- Case study for a Telecom Site
- Summary
- Reference Cases

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About Zephyr Corporation

- Zephyr Corporation, was established in 1997 – 14 years of experience in design, manufacture, and sales of small wind turbines.
- Our business activities is development, manufacturing, sales of small wind turbines
- All manufacturing and assembling is in Japan.
- Over 4000 deployed turbines on the international market through 40 distributors in 40 countries.
- Member of AWEA (American Wind Energy Association) and EWEA (European Wind Energy Association).
- Active in SWT forums and MCS (UK) for FIT

Some Telecom Operator Customers

TURKCELL

- Since 2007,4 sites, 7 x 24 VDC Airdolphin, on and off grid
- Hybrid, PV + Wind

VIETTEL TELECOM

- Since 2009, 2 sites, 5 x 48 VDC Airdolphin, off grid
- Wind

Spain

- 2 sites, 3 x 48 VDC Airdolphins, Off-grid
- Wind + Hybrid

NTT docomo

- 1site, 2 x 48 Airdolphin
- Wind

Zephyr

GSMA Green Power For Mobile

Products and Solutions

Jonas Mattesson, Technical Manager EMEA, Zephyr Corporation

The Airdolphin Portfolio

The Airdolphin turbine comes in 3 voltages, each rated at 1 kW output at 12 m/s (26.8 mph):

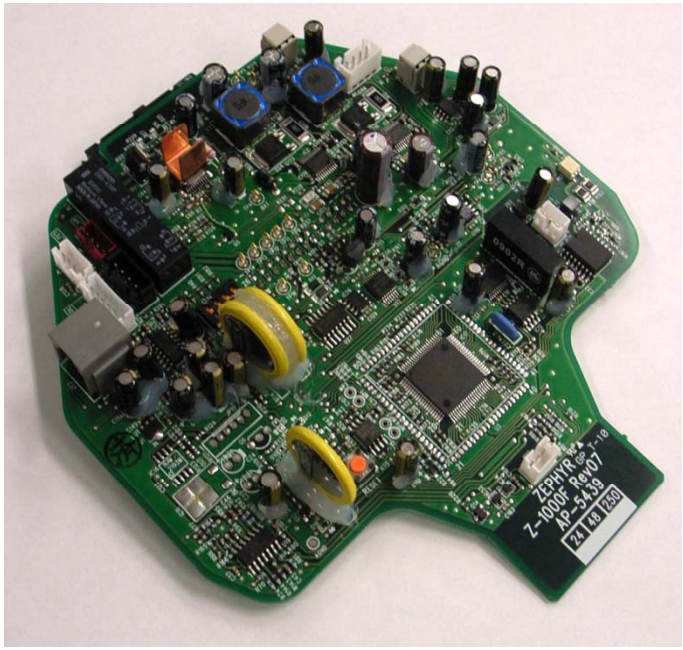
Airdolphin Mark Zero 24 VDC

Airdolphin Pro 48 VDC

Airdolphin GTO 250VDC

Differentiation Factors

- Low Mass/energy---17.5g per 1 Watt
- Compact---Diameter of 1,8 m and 17,5 kg
- Markets lowest cut-in wind speed (2,5 m/s)
- Normal operations up to 50 m/s, withstands up to 65 m/s
- Easy to install
- No Maintenance
- AC/DC Inverter built in
- Remotely control
- A microprocessor that monitors and controls rpm, charging and torque.
- 3.5 months CO2 payback



Key Uniqueness

1) Super light-weight design

Overall mass is only 17.5 kg. Mass per 1 watt output is amazing 17,5 grams. Typical LWTs have150+ grams/W.

2) Rigid carbon-fiber blades

Adopted carbon-fiber blades for the first time in the industry. They are extremely light-weight but rigid. Using aerodynamic design that delivers non-stop operation from very low, mid and up to storming high wind speeds for optimum torque throughout and responding instantaneously

3) Silent disruptor blades

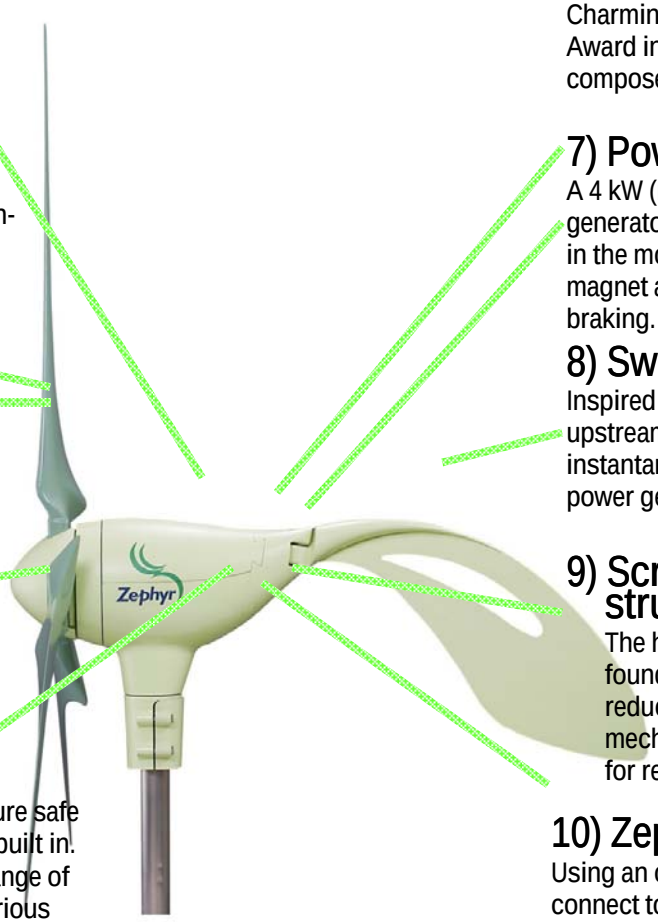
Inspired by owl's wings, fine ribs are formed on the back of the blades to streamline the air flow thereby reducing acoustic noise to extremely low levels of 32dB. (patented)

4) Power-assisted startup

In the absence of wind, blades are forced to turn for 10 sec. that increase chances of capturing even breeze levels of wind.(patented)

5) Power management system

For capturing maximum energy available and to ensure safe operation, Zephyr proprietary algorithms have been built in. They enable non-stop operation under a very wide range of wind speeds. Fail-safe systems functions against various troubles such as blackouts. Power management adopts to connection to PV inverters.



6) Sophisticated styling

Charming bionic styling won Japan Good Design Award in 2005. The streamlined, functional *forme* is composed of arbitrary free curves of futuristic image.

7) Powerful turbine generators

A 4 kW (max) 3-phase brushless synchro-nous generator using dense wire-winding structure as used in the motors for HV cars. "NEOMAX" neodymium magnet adopted realizes high efficiency and firm braking.

8) Swing-ladder system tail fins

Inspired by the movement of a tail fin of fish swimming upstream, this unique hinged tail catches instantaneous changes in wind direction for maximum power generation. (patented)

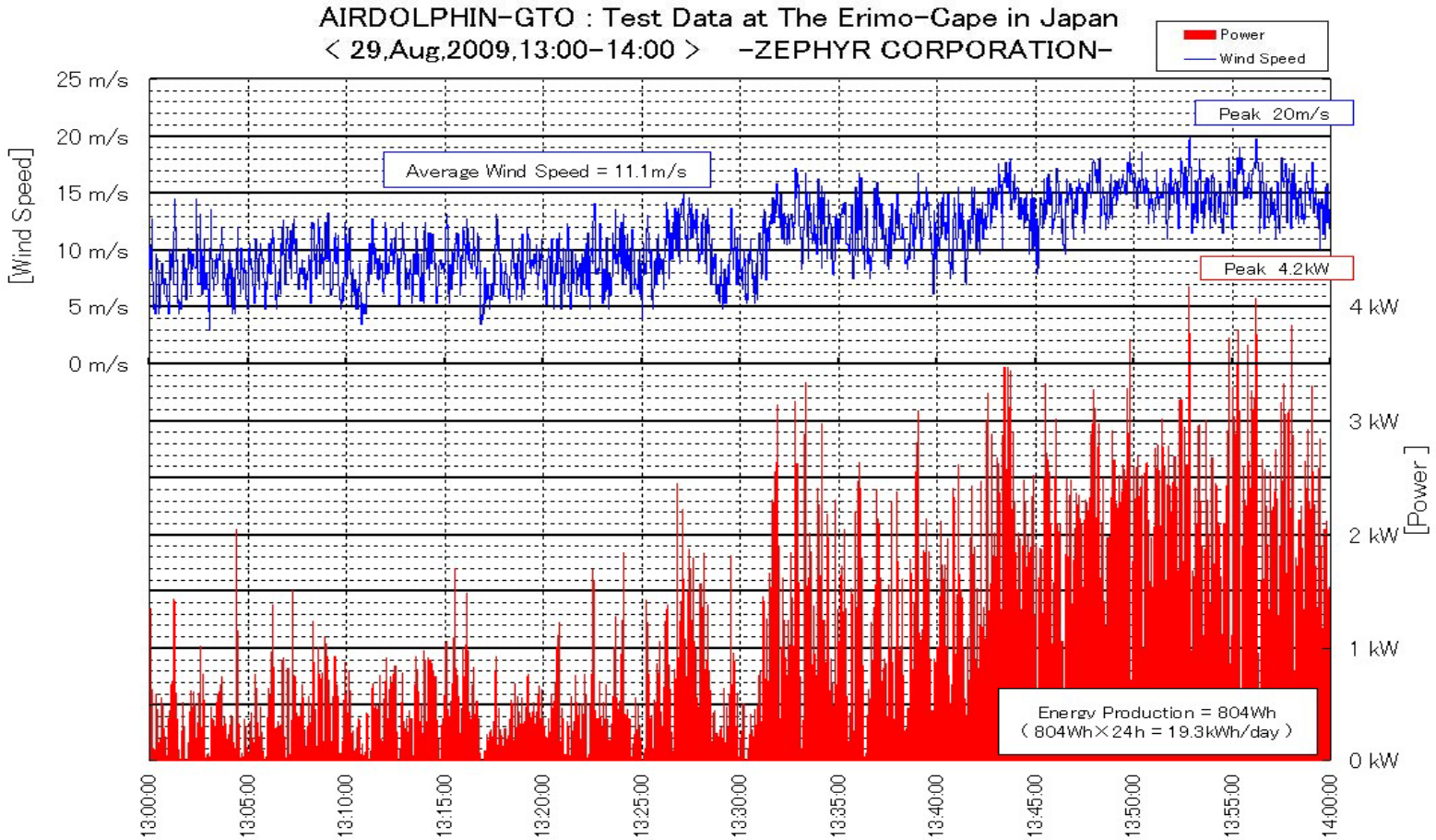
9) Screw-less interlocking body structure of the nacelles

The housing components interlock each other as found in Japan's traditional wood craft. By reducing bolts, nuts & screws, this offers mechanical reliability as well as eliminating need for repair due to structures.

10) Zephyr communication system

Using an optional remote monitoring device, SWT can connect to the Internet. Data (energy production, etc.) retrieval and SWT controls (on/off, mode selection) can be achieved from remote locations.

Airdolphin Power Output (GTO)



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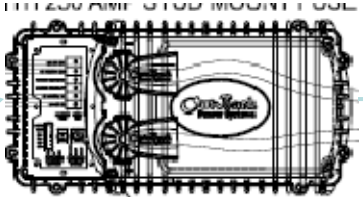
Telecom Solution 1: New micro base station

Airdolphin PRO (130 W @ 6 m/s)

Micro base station (50 W)

Satellite communication (50 W)

PV panel 6 m²



PV inverter/charger 800W

Battery bank 48 V (210 Ah)

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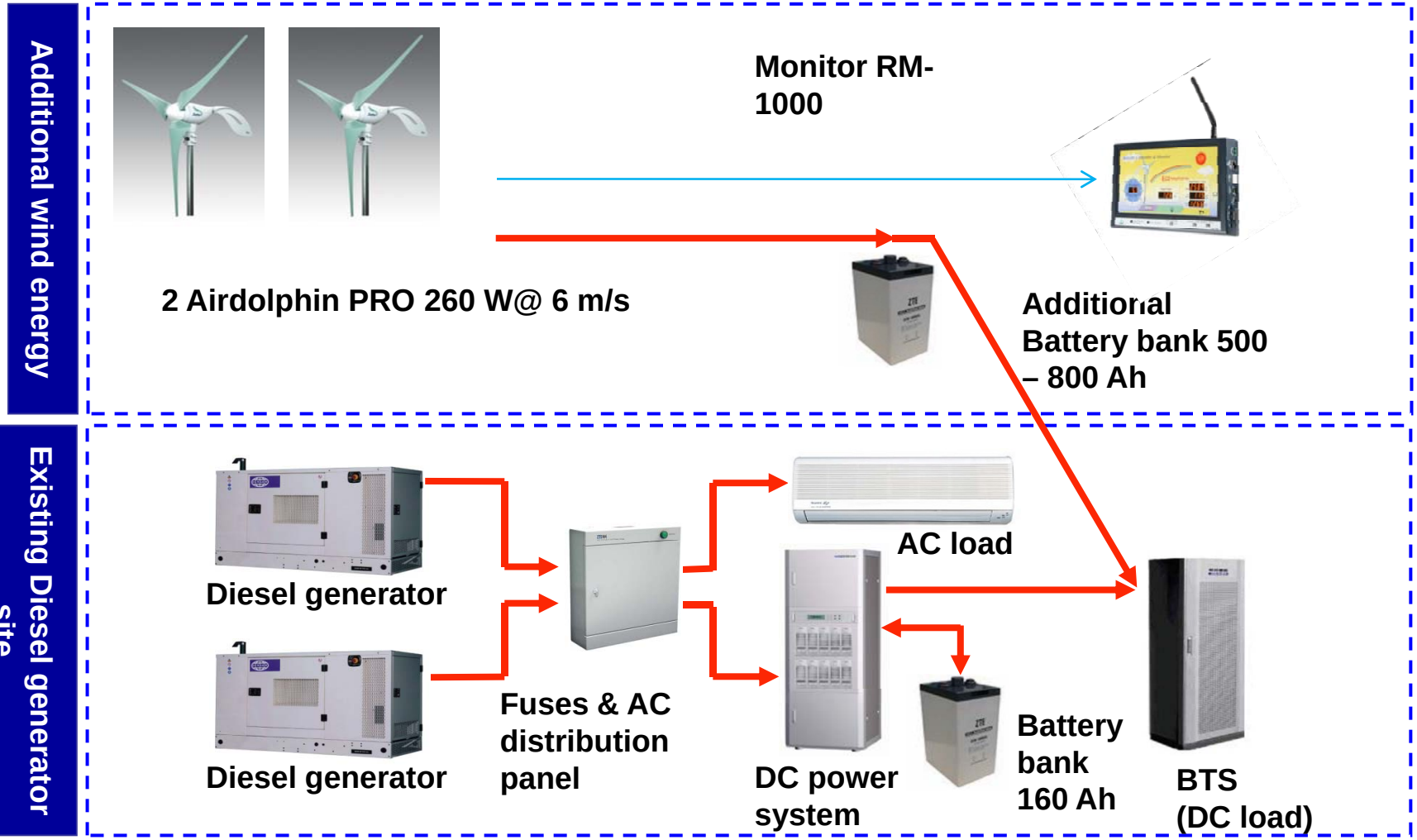
Telecom Solution 2: Add on wind to existing base station



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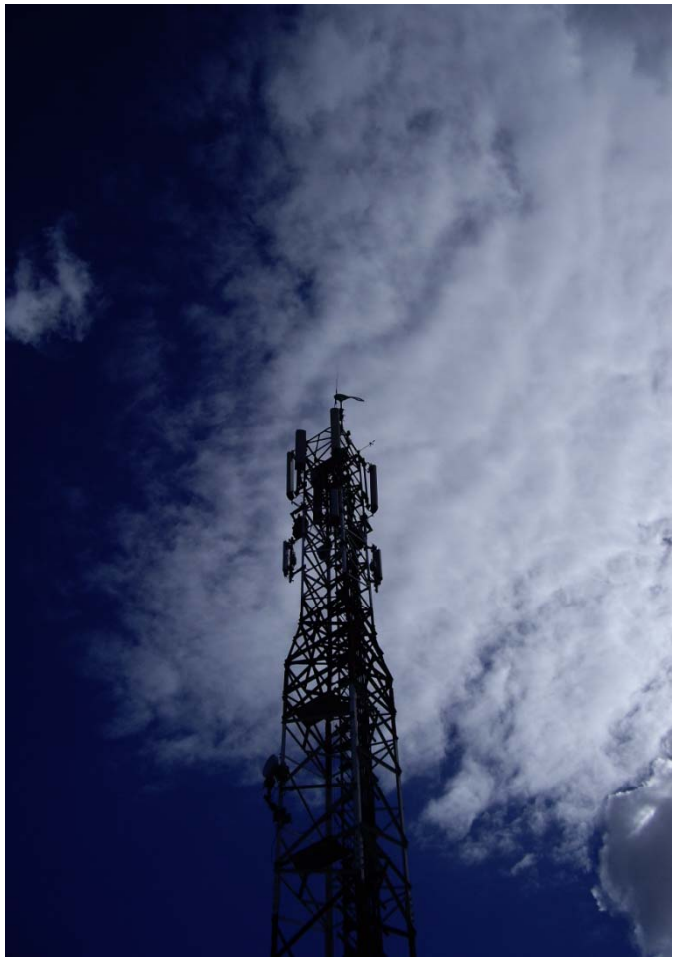
Case Study for a Telecom Site

Mats Vilander, General Manager EMEA, Zephyr Corporation

Building a Renewable Energy Site With Wind

- The Business Case for an existing site depends on a number of factors;
  - Average wind speed in the area/site
  - Height of the tower
  - Site load, max load during the day
    - Site design, No of TRX, Base station type, Transmission, A/C
  - Cost per Kwh from the Grid or total diesel costs
  - Battery capacity
  - Wind as a backup, or primary source, Solar elements
  - Accesibility of site
  - Total Cost of Ownership



Case Study from Spain

Background information

- Off grid site outside downtown area in east Spain
- hosting 2G and 3G multi operator base station
- 100 % diesel with 500 liters consumption per week
- battery capacity is
  720 Ah@ 48 V
- Typical operation of genset is 17 hours/day, rest (7 hour) is run on battery
- 35 meter tower in a “good” wind condition area
- Average load on DC bus is 650 W
- No Space for PV on site

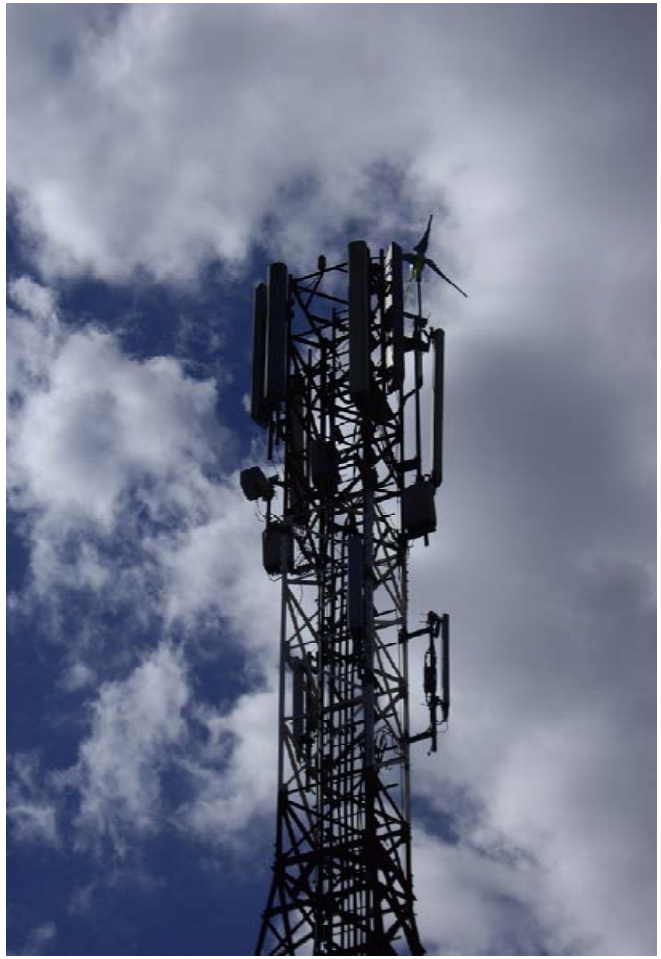
Case Study from Spain

After installation of Airdolphin PRO (4 months of operation)

•Typical operation of genset was reduced to 12 hours/day, rest of day (12 hour) is run on battery

• Diesel consumption saving of 30 % or 150 L/week
• Interval for tanking extending from every second week to every 20th day
• service interval extending from 6 to 8 ½ month on genset

• Payback on investment in less than 24 months



Case Study from Spain

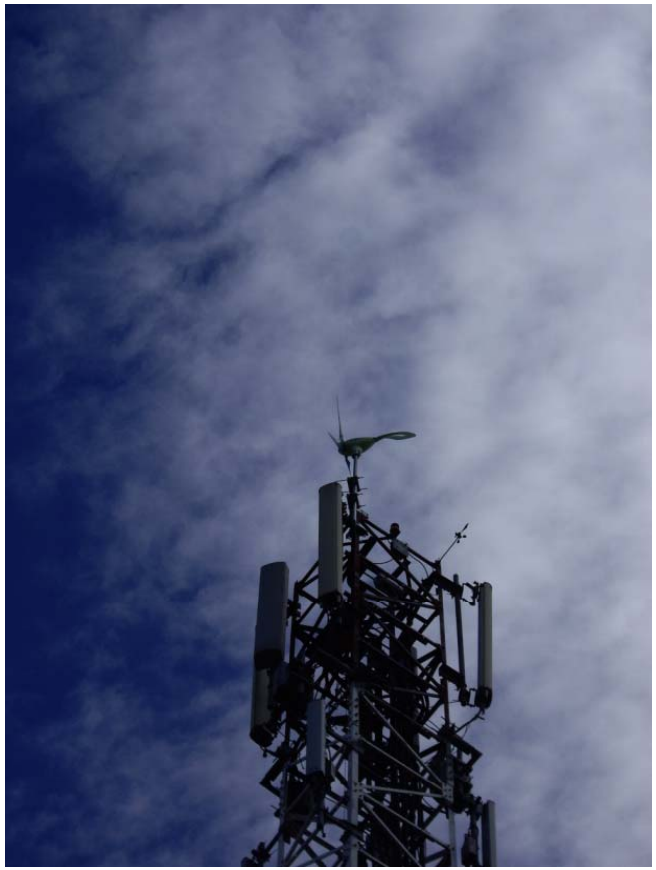
Key success factors

• Secure sufficient battery capacity with deep charge capability

• Optimize genset charging conditions for wind power

• Spare load capacity in existing telecom tower

• good average wind
(minimum 5 m/s)



Airdolphin Installations (4 sites, 7 turbines, 2007-2009)

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Summary

- Official wind maps does not give appropriate information
  - Average wind speed is just an indication and does not reflect changes of wind, which a light weight turbine can capture
- Appropriate dimensioning should reflect the use of the existing batteries and thus standby time should be considered
- Site design should be scalable in order to optimise and not to overdimension
- System should be easy to install and relative maintenance free
- Usage of the existing tower means lower CAPEX
- Wind can never replace diesel back up (Off grid) completely, are a complement to PV, Diesel
- New sites can though be designed with 100% renewable energy supply, due to low power mobile base stations

Nominal Business Case in Pakistan(6 M/S average wind speed)

2 X 1.0 kW Wind Turbine System Cash Flow

Prepared for:
Date:

Assumptions (Inputs)

Total Installed Cost ($):	$22 347
Allocation to Business (%):	0%
Annual Energy Output (kWh):	4 088
Electricity Cost ($/kWh):	$1,80
Electricity Inflation Rate (%):	2
Loan Downpayment (%):	100
Down Payment ($):	$22 347
Amount of Loan ($):	$0
Interest Rate (%):	0
Loan Term (Years):	2
Month Installed:	0
Net Federal Tax Rate (%):	0%
Net State Tax Rate (%):	0
O & M Cost ($/kWh):	$0,005
O & M Inflation Rate (%):	3
State Rebate (%):	0
State Tax Credit (%):	0
Federal Tax Credit (%):	0

Results

Loan Payments

Monthly Payment ($):	$0
Value of Interest Deduction ($):	$0
Net Monthly Payment ($):	$0

Ave. Monthly Savings on Bill

Year 1 ($):	$613
Year 10 ($):	$747
Year 20 ($):	$911

Internal Rate of Retrurn

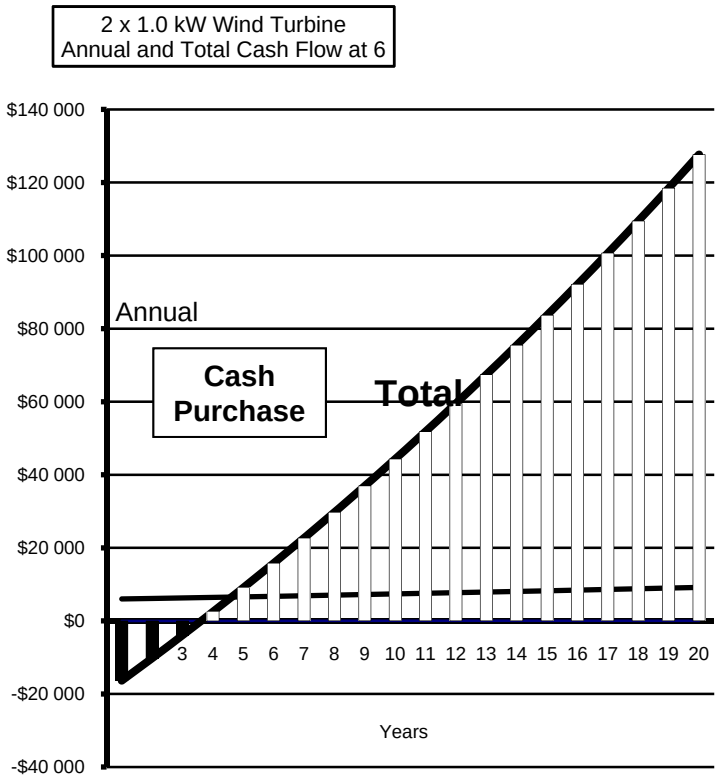
Years 1 - 20:	28,9%

Annual Cash Flow Model

Year	Net Energy	O&M Costs	Net Deprec.	Net Loan Payments	Annual Cash Flow	Total Cash Flow
0					($22 347)	($22 347)
1	$7 358	($240)	($1 117)	$0	$6 001	($16 346)
2	$7 506	($247)	($1 117)	$0	$6 141	($10 205)
3	$7 656	($255)	($1 117)	$0	$6 284	($3 922)
4	$7 809	($262)	($1 117)	$0	$6 429	$2 508
5	$7 965	($270)	($1 117)	$0	$6 577	$9 085
6	$8 124	($278)	($1 117)	$0	$6 729	$15 814
7	$8 287	($287)	($1 117)	$0	$6 883	$22 697
8	$8 452	($295)	($1 117)	$0	$7 040	$29 737
9	$8 622	($304)	($1 117)	$0	$7 200	$36 937
10	$8 794	($313)	($1 117)	$0	$7 363	$44 300
11	$8 970	($323)	($1 117)	$0	$7 530	$51 830
12	$9 149	($332)	($1 117)	$0	$7 700	$59 530
13	$9 332	($342)	($1 117)	$0	$7 873	$67 402
14	$9 519	($352)	($1 117)	$0	$8 049	$75 451
15	$9 709	($363)	($1 117)	$0	$8 229	$83 680
16	$9 903	($374)	($1 117)	$0	$8 412	$92 093
17	$10 102	($385)	($1 117)	$0	$8 599	$100 692
18	$10 304	($397)	($1 117)	$0	$8 789	$109 481
19	$10 510	($409)	($1 117)	$0	$8 984	$118 465
20	$10 720	($421)	($1 117)	$0	$9 182	$127 646

Conservative assumption of no scrap value after 20 years.

Cash flow analysis is pre-tax.



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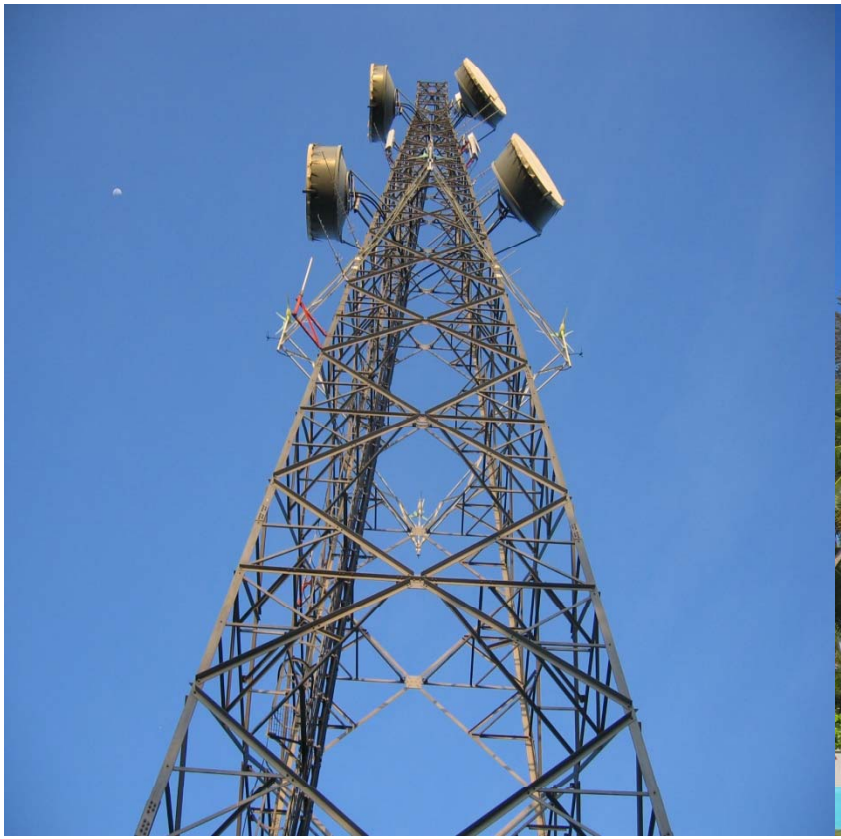
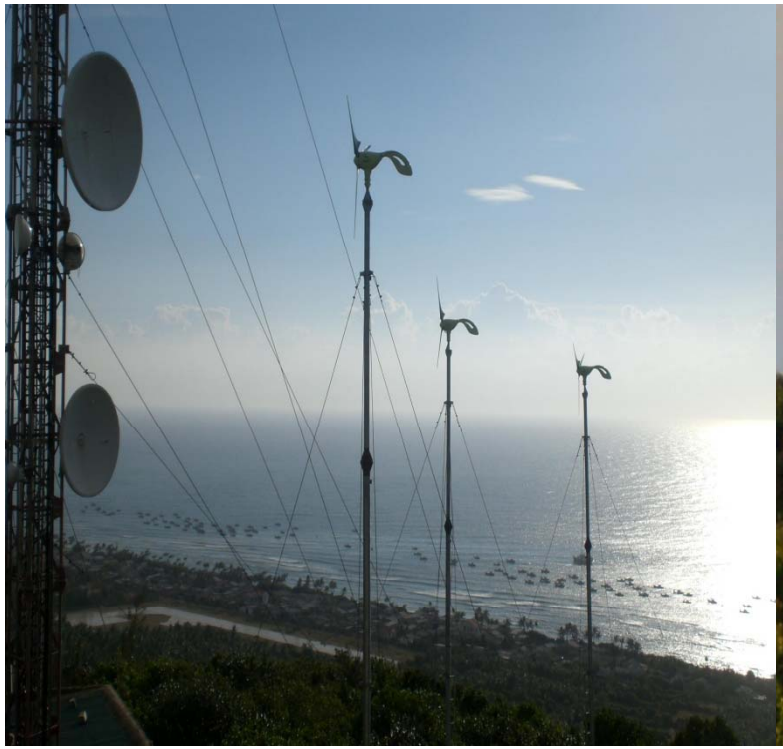
Airdolphin Installations (1 Site, 4 turbines), 2010) Dhiraguu, Maldives



Airdolphin Installations, 1 site, 5 turbines, 2010)

VIETTEL TELECOM



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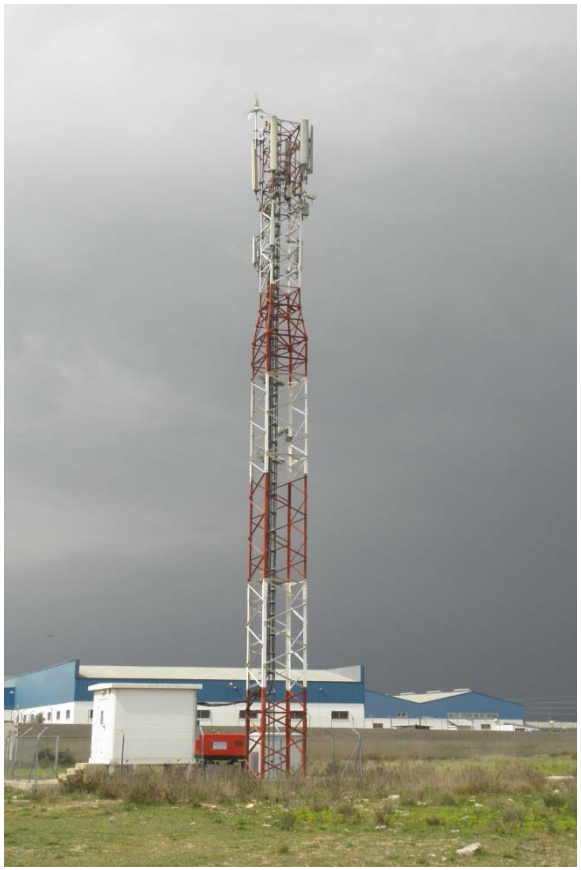
Airdolphin Installations, 1 site, 2 turbines, 2010, Spain



Contact Zephyr Corporation

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