

Zephyr Corporation specializes in developing and manufacturing small wind turbines. Our dream is for all the people of the world to be able to use wind power — a clean and inexhaustible alternative energy — to generate electricity easily at home. In order to make this dream come true, we decided to throw away all preconceived notions and started developing the ideal wind turbine from ground zero. This led to the beginning of Project Z\*1 in 2002 — a joint industry-government-academia initiative, which later received a government subsidy.

Combining state-of-the-art technologies and expert construction — reminiscent of the craftsmanship of traditional Japanese artisans — we successfully developed the Airdolphin Mark-Zero, a next-generation small wind turbine, which can work seamlessly under changing weather conditions, from slight to stormy winds. This wind turbine can deliver 100kWh per month at an average wind speed of 6m/s.

After being tested in extremely windy sites\*2 inside and outside Japan, the Airdolphin Mark-Zero is now ready to be introduced all over the world.



Los Lances in Tarifa, Spain (in collaboration with )



A mountain lodge at Mt. Yatsugatake, Nagano, Japan (elevation: 2,400 meters)



CIEMAT-CEDER test facility (Sora), Spain (in collaboration with )



Takashimaya department store in Yokohama, Kanagawa, Japan



Reclaimed land from Tokyo Bay in Odaiba, Japan (operated by the University of Tokyo)

\*1 Project Z members: Toray Industries, Inc. (in charge of blade molding); NEOMAX Co., Ltd. (former Sumitomo Special Metals Co., Ltd.) (in charge of the power generator section); Yokogawa Electric Corp. (communication system and maintenance); NTN Corp. (rotating parts, including bearings); Unitec Corp. (motor); Nitto Kako Co., Ltd. (vibration control system); Moriyama Giken (body); Oume Denshi (electronic circuit board); The University of Tokyo, Graduate School of Engineering (observational study and basic engineering of the blade); National Institute of Advanced Industrial Science and Technology (basic engineering and practical experiments for the blade). Development was supported by the Ministry of Economy, Trade and Industry, and the (National) New Energy and Industrial Technology Development Organization.

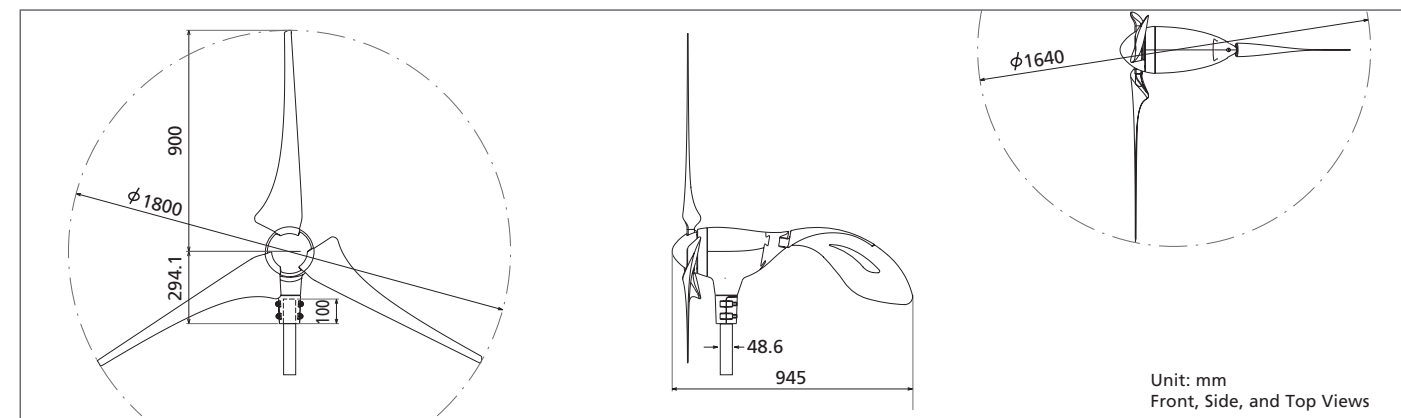
\*2 Sites or planned sites of the test: Mt. Nonoboriyama, Mie pref.; Akadake Tenbo-so at Mt. Yatsugatake; Miyagijima island, Okinawa pref.; Ashikaga Institute of Technology, Tochigi pref.; Ocher Plateau in China (by Yulin College); Kyusyu University; a house exhibition space at Sakura Josui, Tokyo; reclaimed land from Tokyo Bay in Odaiba (a test site operated by The University of Tokyo); University of the Ryukyus; Tarifa, Spain (a site facing the Strait of Gibraltar); Soria, Spain; Rimini, Italy; Shetland Islands, UK; Aberdeen, UK; Erimomisaki, Hokkaido; Tappisaki, Aomori pref. (by Department of Commerce, Industry and Labour from Aomori prefectural government); Ulan Bator, Mongolia; Takashimaya department store at Takasaki, Gunma pref.; Takashimaya department store at Yokohama, Kanagawa pref.; "Eco no Hotori" in Tokushima pref.

## Specifications

Model Name	Airdolphin Mark-Zero			
Model Number	Z-1000			
Wind Turbine Type	Horizontal axis, up-wind			
Rotor Diameter	1,800mm			
Mass	17.5kg			
Tower Diameter	48.6mm			
Number of Blades	3			
Blade Material	Carbon-fiber skin			
Blade Mass (per piece)	380g			
Blade Method	Interlock hub mounting			
Body Material	Aluminum diecast			
Body Construction	Screw-free joints (based on traditional Japanese handicrafts)			
Product Finish	Teflon-based paint			
Power Generator	Synchronous-type, three-phase power generator with permanent neodymium iron boron magnet			
Control System	Built-in Zephyr-Original Power Management System* (ZPMS) with: 1. Power-Assist Function 2. Stall Mode 3. Safety Control 4. Battery Charge Management 5. Data Communication System			
Protection Circuit	Built-in			
Data Logger	Built-in			
Yaw Control	Free yaw (360 degrees)			
Direction Control	Original Swing-Rudder System			
Output Control	Non-stop output control (incl. Stall Mode)			
Start-up Wind Speed	0m/s (Power-Assist Function)			
Cut-in Wind Speed	2.5m/s			
Cut-out Wind Speed	50m/s			
Survival Wind Speed	65m/s			
Rated Power	1,000W (12.5m/s)			
Rated Rotor Speed	1,250rpm			
Maximum Power	3,200W (20m/s)			
Maximum Rotor Speed	1,600rpm (20m/s)			
Mass per Watt	17.5g/W (at rated power)			
Power per Square Meter	393W/m <sup>2</sup> (at rated power)			
Power Generation Features	Normal Mode	Wind Speed (m/s)	Wind Speed (miles/hour)	Output (W)
		3.5	7.8	27
	6.5	14.5	170	
	10.0	22.4	620	
	12.5 (at rated power)	28.0 (at rated power)	1,000 (at rated power)	
	15.0	33.6	1,780	
	17.5	39.2	2,520	
	20.0	44.7	3,200	
	Stall Mode	10.0	22.4	380
		20.0	44.7	320
30.0		67.1	600	
40.0		89.5	400	
50.0		111.9	0	
Output Voltage (Normal Mode)	25V DC			
Braking System	Regenerative electromagnetic braking system			
Communication System (Signal Output)	RS-485			
Recommended Battery Capacity	Off-grid power system: 500 Ah or more / On-grid power system: 100 Ah or more			

\* This system will soon be incorporated in the unit.  
Design and specifications subject to change without notice.

## Outer Dimensions



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Ultra-Light Next-Generation Small Wind Turbine

# AIRDOLPHIN

## Mark-Zero



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## Mark-Zero

### Growing with the Wind — For Future Generations

State-of-the-art technologies for achieving sustainable development



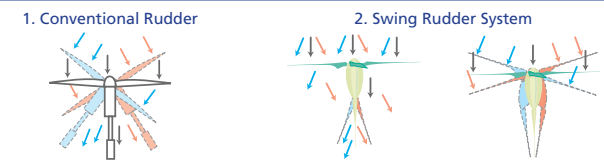
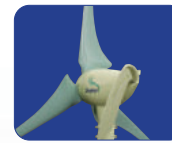
## 10 State-of-the-Art Technologies Inside Every Airdolphin

### 1 Extremely Low Mass

The total weight of the Airdolphin Mark-Zero is only 17.5kg. This means it weighs just 17.5g per generated watt (when the continuous rated output is 1kW). This is only 20% the weight per generated watt of large wind turbines. Thus, the Airdolphin Mark-Zero tracks wind better in turbulent flows, resulting in more efficient power generation. The light weight also allows the unit to be installed in a wide variety of places.

### 2 Newly-Designed Rudder

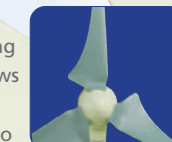
The rudder of the Airdolphin Mark-Zero uses the newly-developed Swing Rudder System. This system ensures the turbine's superior response to sudden changes in the direction of wind, improving the efficiency of power generation.



1. The wind force passes through the rotor disc to the tail, and the resulting inertia swings the rotor disc past the new apparent wind. This exposes the tail to the wind force on the opposite side, causing directional overshoot.  
 2. With our newly developed Swing Rudder System, the tail inertia is interrupted by the body joint, which swings the tail in the opposite direction. This ensures that the rotor disc is evenly balanced inside the wind force, without directional overshoot.

### 3 Newly-Designed Rotor

The Airdolphin Mark-Zero comes with a new rotor system consisting of: (1) Three ultra low-mass blades, reinforced by a carbon-fiber skin for superior rigidity. (2) A hub mechanism that uses the freshly-developed Multi-Stagger System (incorporating multiple airfoils and lift angles). This technology allows the turbine to capture the wind effectively and respond flexibly to changing conditions, from slight to stormy winds, freeing you from pitch controls.



### 4 An Innovation for Low Noise

The Airdolphin comes with the "Silent Disrupter Blade". This new blade has a number of thin grooves on its surface, which significantly reduces air flow noise. Our designers were inspired by the wings of owls that enables it to fly almost silently and unnoticed while approaching its prey.



### 5 No-Screw Robust Body

The robust body construction features a "no screw" assembly, inspired by traditional Japanese handicrafts. This construction ensures superb durability in a wide range of weather.



### 6 Power-Assist Function

For 10 seconds every minute, the Airdolphin Mark-Zero uses previously-generated power to spin the rotor. This allows the rotor to reach the cut-in point more quickly — even when there is near zero wind, allowing the unit to capture the wind effectively. The Power Assist Function also prevents freezing of the rotor due to low temperatures.

### 7 New Power Management System

The newly-developed Power Management System is aimed at optimizing the safety and efficiency of power generation.

#### Non-Stop Operation with Continuous Output

At its upper potential, the Airdolphin Mark-Zero can deliver a 2.5kW-3kW output (23m/s or more). During strong winds (23-50m/s), the Airdolphin automatically moderates its spinning speed and continues working at a reduced output. However, when the wind speed is over 50m/s, the turbine stops power output.



New Power Generator and Control Board

#### Safety Control

We applied several technologies to keep the turbine from disintegrating and allow it to control its output, even during overheating of the power generator, excessive spinning speed, and other negative situations.

#### High-Efficiency Operation

To maintain optimum efficiency at a variety of wind speeds, the turbine is controlled by a special computer programme coordinated with the Multi-Stagger System of the rotor. We also developed an ultra-lightweight rotor, a special propeller design optimized for varying wind speeds, and a power generator with superior efficiency.

#### Battery Charge Management

Management of the rechargeable battery, optimized for using the wind turbine as an independent power supply, is controlled by a system based on a 3-step battery recharge. Charge can be managed under a variety of conditions, from arctic to tropical weather. Management includes compensations for wire cable length, temperature, and even current (more than 100 amps of continuous power).

### 8 New Power Generator

For the Airdolphin Mark-Zero, we use a newly-developed heavy-duty power generator with a max. 4.5kW power output. The magnet used for the turbine is a neodymium iron boron magnet named "NEOMAX", which boasts of extremely high power.

### 9 Data Communication System

We have recently invented the Zephyr Communication System, which will soon allow you to connect the Airdolphin Mark-Zero to the internet. This way, you can check the wind strength, amount of generated power, and other information on your PC away from the turbine's location. You can also install a GPS receiver to the turbine for confirming the geographical location of each unit.

### 10 Fresh Design — Winner of the Good Design Award 2005

We designed the attractive body ourselves, using nature's animals as our inspiration. The sleek lines, high power, cleverness and playful responsiveness of this design inspired the name Airdolphin. Our turbine looks alive, eager and ready to catch the wind.

#### < Good Design Award 2005, Jury Verdict >

This is a lightweight wind turbine marked by high power generation efficiency. Careful design consideration is reflected in the details, such as the surface with no exposed screws. Unique ideas have been superbly integrated into this compact, high-performance turbine with superior technologies, resulting in a unique, impressive design. We would like to emphasize the importance of this.



## Wide Applications

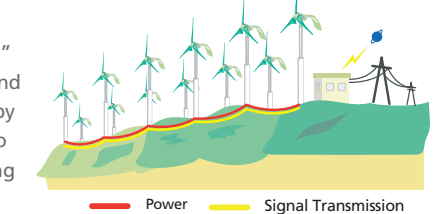
With its high power, low noise, and superior reliability, the Airdolphin Mark-Zero serves a broad range of needs with wide application possibilities. It can be connected to a power grid to supply additional power for household needs and more, or can be installed for stand-alone use in remote places, such as mountainous areas, river beds, or the ocean.



On-Grid Use: Cut down your electricity bill!  
 Off-Grid (Stand-Alone) Use: residences in remote areas; for pumping water; fishing boats, yachts, etc.; repeater stations; monitoring sites (web cameras, GPS receivers, wireless applications); streetlights (no need for utility electricity); public facilities (dams, weather observatories, etc.)

## Mini Wind Farms

Almost as soon as small wind turbines were conceived, the dream arose that someday they could be used to build miniature power plants. Now, this dream has become a reality. The Airdolphin Mark-Zero's compact dimensions and low mass let you connect a large number (10's, 100's, or 1,000's) of them in a field or facility. This makes it possible to build wind farms in cities (with a variety of installation options), on the tops of buildings, on remote islands, on hills and mountaintops, or on the ocean, without damaging the landscape. These "Zephyr mini wind farms" provide lower operating costs and higher efficiency than large wind farms that use mega-watt wind turbines. This is possible for two reasons: 1. Their high wind-energy conversion efficiency (higher by a maximum of 42% compared to large wind turbines) across the entire wind speed spectrum up to 50m/s. 2. Their superior wind-tracking ability, thanks to Zephyr's exclusive technologies — including the stall mode, which lets the turbine continue operation even at higher wind speeds.



## A Variety of Zephyr Towers for Installation

### 1 Guyless Tilting Tower

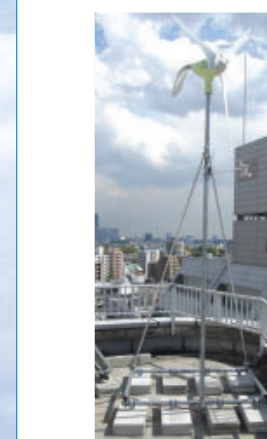
The Zephyr Guyless Tilting Tower is ideal for installation on wind farms, public facilities, company buildings, etc.



Lying down    Lifting with the specialized winch    Final position

### 2 Tower Kit

The Zephyr Tower Kit is ideal for installing the wind turbine on the roofs of buildings, including flat roofs on houses, etc.



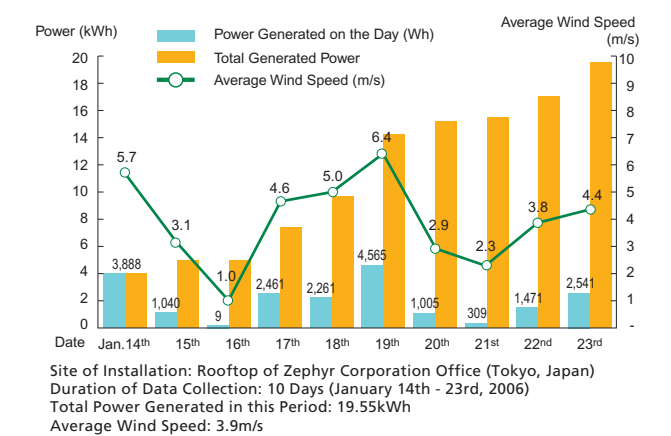
### 3 All-in-One Tower

The Zephyr All-in-One Tower permits installation in conjunction with a photovoltaic.

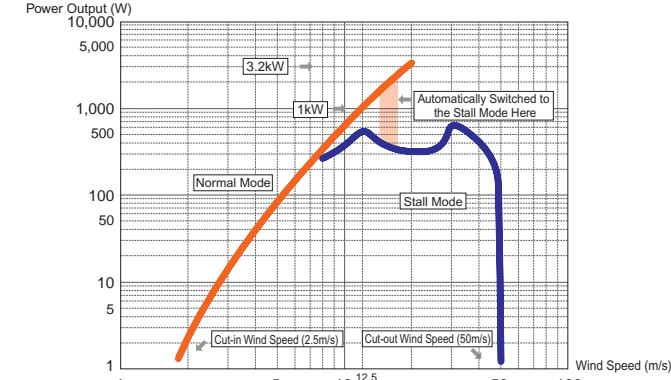


\*The photos above are for illustration purposes only.

## Power Generating Capability of the Airdolphin Mark-Zero



## Power Output Characteristics



**Cut-in:** The wind speed at which the turbine begins to produce power.  
**Cut-out:** The wind speed at which the turbine stops rotating and shuts down.  
**Stall mode:** This is Zephyr's new control technique for when power output is at the maximum level of 1.7kW to 2.5kW. The rpm is stall-controlled until the output falls below 600W, and power continues to be produced until a wind speed of 50m/s. After the wind speed falls below the rated wind speed, operation will automatically return from stall mode to normal mode.  
 Generally, a large wind turbine does not operate in strong wind speeds, cutting out around 20-25m/s. However, Airdolphin can produce 60% of its rated power at even 30m/s, making it especially efficient in installation sites with strong winds and gusts.