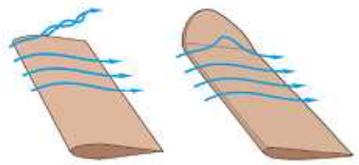
～Bellsion blades catch wind energy to the maximum extent possible～

Bellsion blades, derived from thinking outside the box, extract wind energy at high efficiency.
Accumulation of our many demonstration experiments based on our positivism created new blades called Bellsion blades.
The idea of Bellsion has already been applied not only to propeller wind turbines and vertical axis wind turbines utilizing clean energy, but also to energy conserving flying boats and screws.

Bellsion

What Bellsion means.
The name Bellsion is derived from the archaic meaning of "version" (turn or change of direction) to suggest the blades which bends the end of the wing inward and our policy of pursuing new ideas.

Changes in wind flow with blades of different specifications



New winglets created by thinking outside the box

Normally, winglets are on the side where the lift force occurs, but Bellsion blades have winglets on the other side. This enables Bellsion blades to hold the wind and thereby take in more energy.

Currently involved in a cooperative study with the Collaborative Research Center of Ashikaga Institute of Technology regarding 「Bellsion blades performance analyses」

Winglets that keep wind

Bellsion blades have winglets, normal blades with the tips bent inward.
Conventional straight blades allowed wind to escape from the tips. After repeated demonstration experiments, we successfully designed Bellsion blades with tips canted at a certain angle to generate a great amount of energy, not letting any wind escape. Bellsion blades cause little acoustic noise as the winglets prevent eddies (turbulence) and separation of the air at the tips of the blades.

Features of the vertical axis Bellsion wind turbine

Starts rotating at a wind speed of 1 to 1.5 m/s and generates electricity at a wind speed of 2.0 m/s or higher!

No need for wind direction control

The vertical axis Bellsion wind turbine is structured to eliminate the need for wind direction control. It can generate stable electric power even in areas subject to significant changes in wind direction.

Expanded blade area

The vertical axis Bellsion wind turbine has a reduced number of blades, and these blades have the optimum chord length and expanded blade area to effectively generate lift power (with high torque and the optimum rotor speed). The increased torque makes the blades stalling less likely, even under generator load. The blades can extract the force of the wind to the fullest by increasing the optimum rotor speed.

Inertia (ring) arms

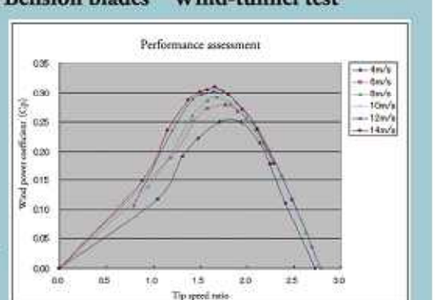
When a vertical-type (H-Darrieus) wing is made larger, the rotor speed changes with wind speed, creating a fictitious force and resulting in fatigue load on the root of wing arm. The Inertia (ring)-type wing arm method is adopted to solve this problem.

Space-saving design (Multiple-stage configuration)

The Bellsion wind turbine can be stacked as needed, to effectively utilize limited space. This significantly reduces not only the installation cost but also the foundation cost.

Performance of the vertical axis Bellsion blades　Wind-tunnel test

Date of test: July 26, 2004 (9:00 – 17:00)
Wind tunnel device: Device owned by Ashikaga Institute of Technology (open type variable-speed wind tunnel with an air outlet of 1.04 × 1.04 [m])
Wind speed measurement: Betz manometer and Pitot tube
Test wind speed: 4, 6, 8, 10, 12 and 14 [m/s]
The characteristics of the Bellsion wind turbine under test:
Radius 0.4 [m]; blade length 0.8 [m]; 2-blade type
Torque test: Device owned by Ushiyama Lab of Ashikaga Institute of Technology



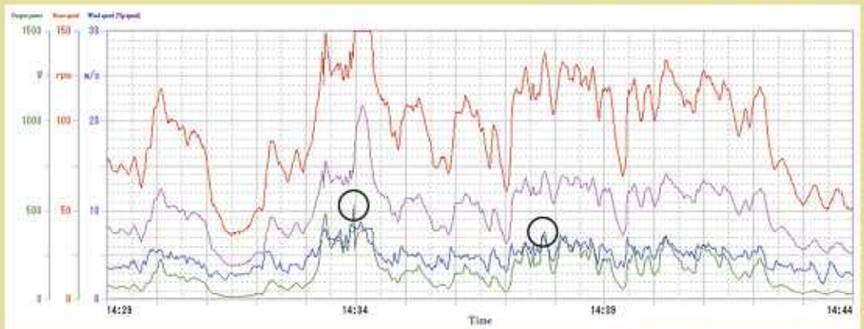
Wind speed [m/s]	Rotor speed [rpm]	Output power [W]	Wind power coefficient [Cp]
4	162	5.974	0.250
6	253	22.26	0.278
8	320	55.20	0.292
10	412	103.6	0.297
12	499	192.0	0.302
14	554	313.9	0.310

We evaluated the characteristics of the vertical axis Bellsion blades using the wind-tunnel device in the Ashikaga Institute of Technology and confirmed that the blades started rotating at a low wind speed and that the rotor speed increased even at high wind speed, while causing little acoustic noise. The test demonstrated that Bellsion blades delivered much higher performance than conventional types.

Achieved highly-efficient power generation even at low wind speed as a result of repeated wind-tunnel tests and field tests!

Field test on the vertical axis Bellsion wind turbine

Test site: Tochigi Laboratory of Global Energy Co., Ltd.
Date of test: July 5, 2007
Radius: 1.0 [m]; Blade length: 2.5 (m); 1-stage, 2-blade type



Time	Average for minute: Wind speed [m/s]	Tip speed [m/s]	Tip speed ratio	Rotor speed [rpm]	Voltage [V]	Electric current [A]	Output power [W]	Maximum for minute: Wind speed [m/s]	Rotor speed [rpm]	Voltage [V]	Electric current [A]	Output power [W]
14:30	4.1	8.1	1.98	77	52.7	1.60	82.3	5.8	108	53.3	2.97	158.3
14:31	4.7	10.2	2.19	98	53.5	2.61	136.7	5.7	118	54.4	4.28	232.8
14:32	2.9	4.8	1.63	46	52.1	0.58	26.5	3.9	80	53.0	1.60	84.8
14:33	4.0	7.5	1.88	72	52.4	1.43	71.7	5.5	89	52.8	2.10	110.9
14:34	6.5	12.6	1.94	121	55.6	5.12	282.5	8.1	149	58.2	8.38	535.1
14:35	5.9	14.0	2.36	133	56.3	4.24	243.6	8.8	208	59.4	6.89	406.5
14:36	4.6	9.7	2.11	92	53.4	2.28	122.1	6.0	113	54.2	3.62	196.2
14:37	4.6	10.0	2.18	96	53.4	2.46	130.8	5.8	114	54.0	3.73	201.4
14:38	5.5	11.6	2.12	111	54.5	3.87	212.3	7.2	138	56.3	6.74	382.0
14:39	6.1	12.8	2.10	122	55.4	4.73	264.4	7.3	133	56.4	6.19	349.1
14:40	5.2	11.0	2.11	105	54.1	3.23	175.6	7.0	124	55.1	5.09	280.5
14:41	5.7	12.2	2.15	117	54.8	4.08	226.9	7.1	134	56.5	6.42	362.7
14:42	5.3	11.6	2.19	111	54.5	3.62	198.1	6.4	128	56.0	5.51	307.4
14:43	4.2	8.8	2.10	84	53.4	2.04	107.4	6.1	119	54.7	4.32	236.3
14:44	3.2	5.9	1.86	57	52.3	0.83	41.2	4.3	84	52.4	1.02	53.4

We are testing the wind turbine in the Tochigi Laboratory for natural wind evaluation. The wave pattern of the wind speed and rotor speed is almost the same, as seen in figure, confirming that the blade is able to cope instantly with the strength and direction of wind. While in the wind tunnel test it reached maximum power output at the tip speed ratio as low as 1.7 for the wind power coefficient of about 0.3, the field test results confirmed that the wind power coefficient of more than 0.4 could be obtained at the tip speed ratio of 0.2. Wind power coefficients of more 0.4 are difficult to obtain, even with large high-efficiency wind generators of a propeller type.

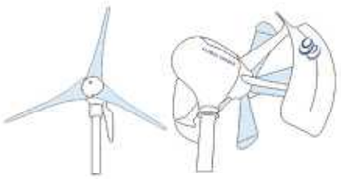
GLOBAL ENERGY

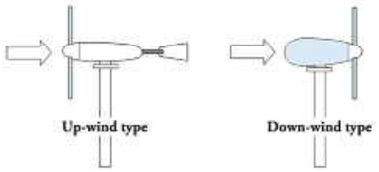
Features of the horizontal axis (propeller type) Bellsion wind turbine

Starts rotating at a wind speed of 1 to 1.5 m/s and generates electricity at a wind speed of 2.0 m/s or higher!

The increased number of blades with inversely tapered type and larger area

Typically, a standard propeller type wind turbine has three twisted blades with sharp tips.
They have no strong initial driving force due to the sharp tips and easily stall under the generator load. (This type focuses on a lower torque and a faster rotor speed)
The Bellsion propeller type wind turbine has a larger number of blades with a larger area and inversely tapered type. By collecting the wind force at points as far as possible away from the center axis, the wind turbine makes full use of the wind force with the increased torque conveyed to the rotation axis. (It focuses on a higher torque and optimum rotor speed)



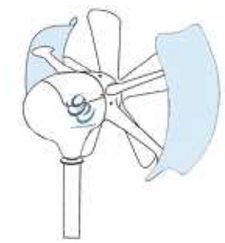


Down-wind type and nacelle structure drawing wind

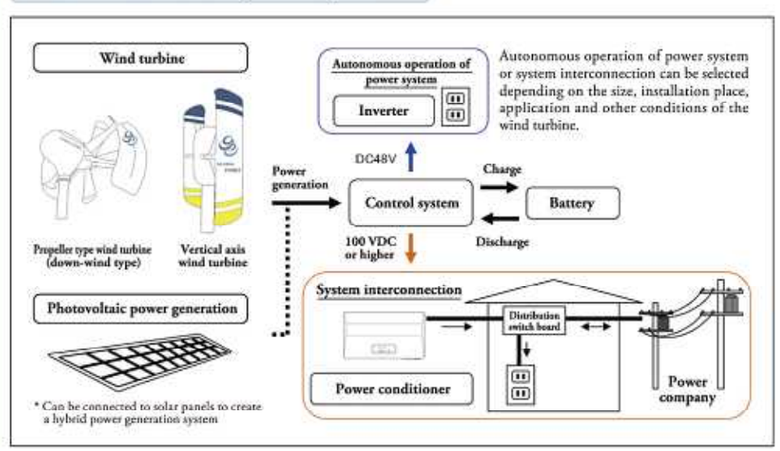
The Bellsion propeller type wind turbine is a down-wind type. The propellers are positioned downstream of the tower, so that they can quickly respond to changes in the wind direction. In addition, the rotating propellers are a safe distance away from the tower. It is said that any obstacle in front of propellers will reduce the efficiency. However, a tuna-shaped nacelle is attached to the wind turbine to draw wind through the propellers.

Rudder that instantly responds to changes in wind direction

Typically, a propeller small wind turbine has propellers in front and a rudder in back. Due to these relative positions, the entire wind turbine may rotate when it cannot respond to a sudden gust of wind or a sudden change in wind direction. The Bellsion propeller type wind turbine is designed to always face the direction opposite to the wind direction with an elaborate rudder shape and relative position to propellers in order to quickly respond to changes in wind direction. This design significantly improves the efficiency compared to conventional wind turbines. It also improves safety by covering the rotating propellers with the rudder.



Bellsion wind turbine generator system



Autonomous operation of power system or system interconnection can be selected depending on the size, installation place, application and other conditions of the wind turbine.