# Article Title: The uWIN - An "upside down" Wind Turbine

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**Date: April 5, 2020**

**April 20, 2020 rev. 03**

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**Keywords:** Wind energy extraction system, solar chimney, tornado-type wind tower.

## 1. ABSRACT

For many centuries, wind power has been harnessed to generate power. More recently, significant advances have been made in converting wind power into electricity. A novel new wind energy system design, the "uWIN", is presented in this article.

The uWIN system is an assembly of components which is comprised of a wind nozzle (funnel), a vacuum producing Venturi chamber, flexible vertical pipe (updraft wind pipe) and a balloon. The assembly is suspended in the air and connected to a compact, small diameter, ground-mounted wind turbine. The proposed system could be further enhanced by designing the vertical pipe such that it would enable creation of a tornado vortex within the pipe, increasing the efficiency of wind energy extraction considerably **[R-4].**

By mounting balloons to the system and hoisting the wind intake to higher elevations, this patented wind energy system would avoid the use of solid towers and associated massive and expensive foundations usually employed in wind power conversion systems. Consequently, considerable reduction of construction costs could be realized, along with a reduction of decommissioning costs.

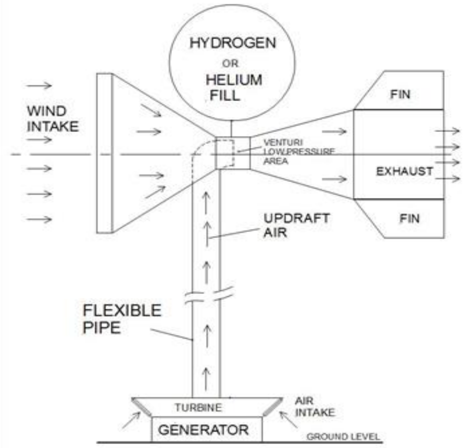


**Fig.1 uWIN simplified diagram (Concept)**

## 2. INTRODUCTION

### a. Foreword

This article presents a safer and more economical wind energy system, the "uWIN". It is an innovative and patented system intended to convert wind energy into electrical power without large rotating blades, gearbox or expensive inverter systems between the large blades and the corresponding generator and without the need for the tall steel towers.

### b. Disclaimer

This article is a synthesis of ideas and experiences not to be construed as conveying the intentions of representing any organizations or manufacturers. Opinions expressed in this article are those of the authors individually and, are not the opinion or position of any organizations, corporations, sponsors, or committees.

### c. Background

Throughout human history, considerable interest has been given to wind power, including its efficiency to convert the movement of the wind into mechanical and electrical energy. Most of the developments and advancements have been focused on the improvement of the aerodynamics of propeller-type turbines, known as wind turbines or windmills. In conventional wind energy systems, turbine-generator systems are mounted on top of tall steel towers, with tower height corresponding to higher prevailing wind speed for any given location. Electrical power generated from a wind turbine is proportional to the cubic order of the velocity of the air entering the turbine. Longer turbine blades produce more power, however, these long blades are costly and, due to their relatively low speed, necessitate the need for having a gearbox between the blades and the generator[1]. Both the blades and the gearbox frequently fail due to limited access and resulting inadequate maintenance. High noise and vibration levels from the rotating wind turbine blades can also result in numerous complaints by nearby residents.

Overall, current wind power generation technology exhibits high first capital costs, unpredictable failures, excessively high noise and vibrations. Recently, to take advantage of high wind speeds, large wind farms have been installed at sea. These sea-based systems suffer from even higher capital and maintenance costs than the land based wind energy systems; the wind turbine foundations installations are usually deep under water and continuous exposure to salt water speeds up corrosion of components.

[1] It should be noted that wind turbines with direct drive design recently began to be manufactured. These direct drive designs are equipped with low-speed generators (instead of the conventional high-speed generators) and consequently do not require gearbox. (This change was made with the intent to improve reliability of the wind turbine system by eliminating the need for a gearbox.)

d. The uWIN System

Similar to a conventional wind turbine, the uWIN will generate electrical power regardless of weather conditions, as long as the wind is blowing. During periods of low/no wind, the uWIN system will continue to generate electrical power, as long as there is a sufficient updraft due to the stack effect within its flexible vertical pipe. The balloon and all the elevated uWIN components will be water repellent and snow adhesion and ice forming will be minimized. The ground mounted turbine and electric generator will be housed in a weatherproof enclosure.

The advantages of the uWIN wind energy system design, when compared with a conventional wind system are highlighted below.

- Large, expensive, solid towers and associated tower foundations are **not required** (uWIN wind intake is light weight and elevated by a balloon);
- Large rotating turbine blades located at high elevations are **not required** (uWIN turbine generator and heavy equipment are located on the ground and large turbine blades are not part of the uWIN.)
- Gearbox at the generator is **not required** (uWIN turbine generator is not limited by the slow rotational speed.); and
- Reduced capital and decommissioning costs when compared with traditional wind turbines.

**The novel uWIN system design allows the power of stronger winds at higher altitude to be harnessed without the need for solid towers, expensive tower foundations, large blades or gearboxes.**

The uWIN balloon hoisted wind energy system is flexible to build and easy to install. The design eliminates large bulky turbine blades, eliminates low frequency thumping noise and does not interfere with the radio frequency signals used for communication transmission and broadcasting. The elevated uWIN wind intake is not limited by the height of the tower. In addition, maintenance access for the turbine and for the generator is at the ground level, which promotes safety and lower operating cost. Over-speed turbine protection against the high wind speeds is greatly simplified.

Also, as the heavy parts of the uWIN system are located at the ground level, the light elevated portion of the uWIN system will not present danger to anyone on the ground should it descend due to balloon helium leaks.

## 3. TECHNICAL CONCEPT OF THE uWIN

a. Overview

**Wind power:** Wind power accounts for about 8 percent of the electricity produced in North America. With over 50,000 + large wind turbines cranking out power throughout the continent. These massive wind turbines, some of which are as tall as 100 meters, capture energy in the wind and convert it to electricity that people use to run their dishwashers, air conditioning and lights. The share of the market attributable to wind continues to grow, with huge new wind farms accounting for thousands more megawatts of capacity are in the development.

**Trouble in the wind industry?** Conventional wind turbines with large blades have been met with opposition due to their impact on local communities and to local environments. Animal habitats are disrupted and wildlife is often driven out of areas where wind farms are established. Noise and vibrations have been reported to cause human health problems. Home values and real estate prices are also often adversely impacted.

**Is there a "Solution"?** The solution presented in this article is an **environmentally friendly uWIN *updraft* turbine [R-5], [R-3]**

**How does the uWIN work?** In conventional wind turbine design, large diameter blades, turbine-generators and other heavy equipment are mounted on the top of a tall tower. Conversely, the uWIN wind turbine system, utilizes a small diameter turbine-generator located on the ground, thus eliminating many shortcomings of the conventional wind turbines where most components are located on top of tall towers. In the uWIN system, the only elevated components are the balloon, intake, exhaust and the connecting flexible pipe. All major components with moving parts are installed on the ground. The balloon's function is to lift the air intake, where the wind speed is faster and the air is cooler.

The wind intake is made of light materials and incorporates a Venturi type system (Figures 2. and 3. below). A lightweight flexible pipe connects the Venturi system with the ground mounted turbine generator. Wind, harnessed through the Venturi effect **[R-2]**, induces the ground level air updraft to turn the turbine in the turbine generator. In addition, a natural updraft, based on the pressure and temperature differences between the ground level and the balloon level, helps to produce some of the updraft even when there is no wind (i.e. the chimney effect **[R-1]**).

The balloon based uWIN system makes conversion of wind energy to electrical power safer and more economical in the long run.

b. Patent

**The uWIN invention (an excerpt from Canadian Patent 2,808,001 [R-5]):** The purpose of the system is to collect energy generated by airflow from the wind, extract it and convert it to electricity, or some other form of energy. A lighter than air helium filled balloon is used to lift air intake portion of a wind energy conversion system in order to harness the wind energy. The turbine and the generator are mounted on the ground. The intake nozzle assembly is configured to receive and to accelerate wind. The accelerated wind creates a low air pressure area in the Venturi piping downstream of the balloon. This point of suction is where a lightweight reinforced piping connects to allow the air from the ground to be drawn in the upward direction. The resulting air movement spins the ground mounted turbine and the generator. The mounting of the generating system on the ground allows economical maintenance due to relatively easy access of the moving components.

**MAIN COMPONENTS OF THE uWIN SYSTEM**

The system shown on the drawing below is a proprietary system registered in Canada for patent protection, and includes the following main components (Fig.2.):

- Base
- Generator
- Turbine
- Flexible pipe
- Outer shell
- Balloon
- Helium fill (in the balloon)
- Venturi (piping) assembly

Wind enters the outer shell of the wind concentrator, which is mounted on the helium balloon, (Fig.2.). The concentrator is shaped similarly to jet engine intake. Due to the laws of the physics the wind speed will increase as the pipe diameter decreases. The increased air speed creates an area of lower air pressure due to the Venturi effect (Fig.3.). This becomes the connection point to the vertical pipe which leads to the turbine and the generator mounted on the ground.

The lower air pressure causes a high velocity air to flow up in the pipe from ground intake to the Venturi. This high velocity air movement causes the turbine to spin. A generator, connected to the turbine converts the mechanical spinning motion of the turbine into electricity. A high strength cable system extends from the ground to the balloon to ensure the mechanical integrity under the worst weather conditions (i.e. temperature, precipitation, wind). The system turns towards the wind with the help of the stabilizer fins[2]. The initial operating altitude of the system will be approximately 10 to 20 meters, subject to local bylaws. In rural areas the air collection system could be elevated to 100 meters or beyond, and take advantage of the higher wind speeds usually found at higher elevations.

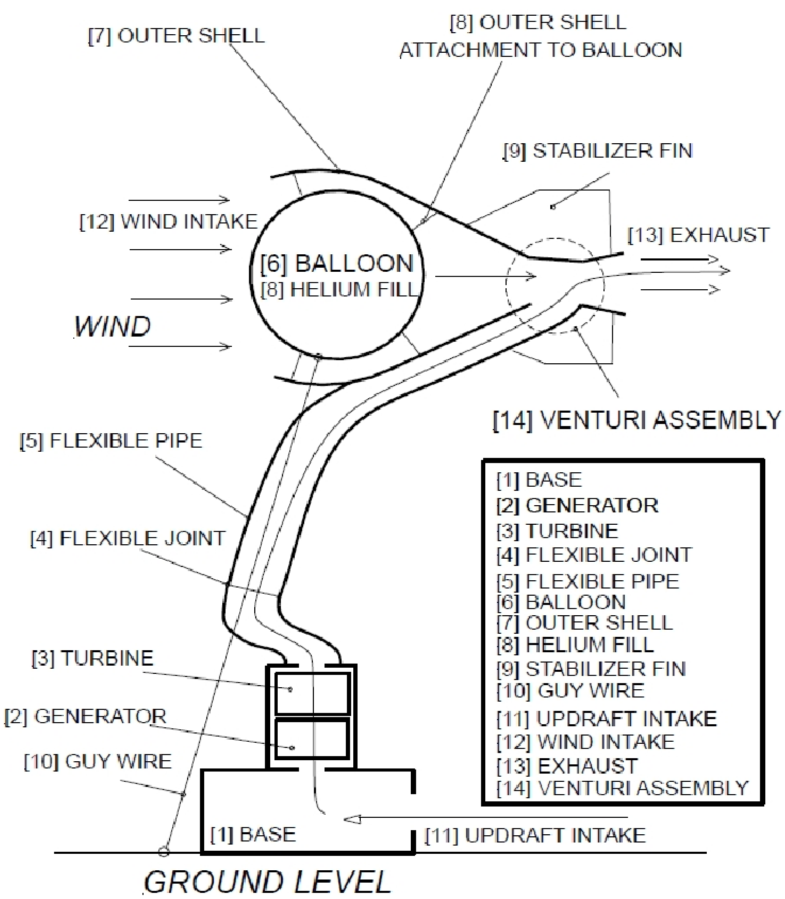

**Fig. 2. WIND ENERGY CONVERSION SYSTEM -** Canadian Patent CA2808001

[2] The fins main function is to keep the device level and in-line with the prevailing wind.

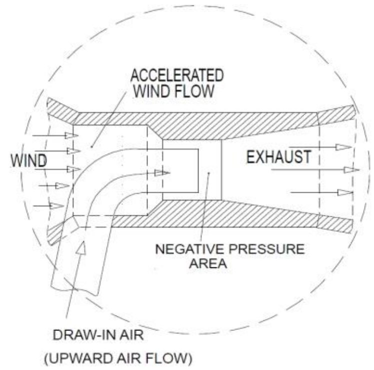


**Fig. 3. VENTURI ASSEMBLY –** single stage shown for clarity (item14 from Fig.2. above)

## 4. COMPARISON WITH CONVENTIONAL WIND TURBINES

### a. Conventional Wind Turbines Background

Conventional wind turbine is made of several major components (Fig. 4a.):

- **Tower**: The tower is built so it absorbs the heavy static loads applied due to wind's varying power.
- **Rotor blades**: The rotor blades are primarily composed of reinforced carbon-fibre plastics or glass fibre. The blade profile is similar to that of aeroplane wings.
- **Nacelle (enclosure)**: All turbine machinery is held in the nacelle (enclosure) located on the top of the tower. Since the nacelle is designed to rotate in the direction of the wind, it is connected to the tower through bearings.
- **Gearbox (needed for most turbines): G**earbox is needed to speed up the relatively slow rotations of the blades to an appropriate level required by the generator.
- Generator: Generator converts the rotational energy into electricity.

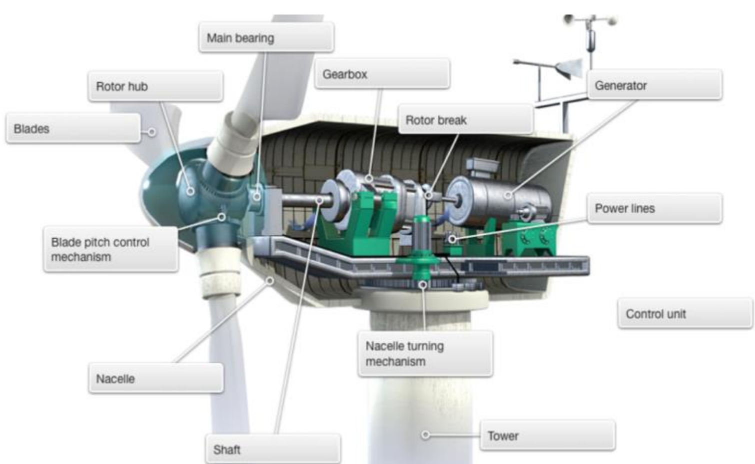


**Fig. 4a. Cut-out of a typical nacelle (enclosure) [R-6]**

Wind turbines are primarily composed of large amounts of steel, composites, concrete, aluminum and copper. Once components are constructed, the next challenge is to transport these large components to the installation site (Fig. 4b. below).

The installation phase of wind turbines uses heavy duty machinery to lift, place, and to connect the various turbine components.

**Fig. 4b. Transport of wind turbine blade**

Wind turbines come in various sizes, and are increasing in size over time. Overall costs of purchasing, installing and integrating turbines into grids depend on the turbine size. Examples of relative proportions of the costs are indicated on the graph below (Fig. 5.).

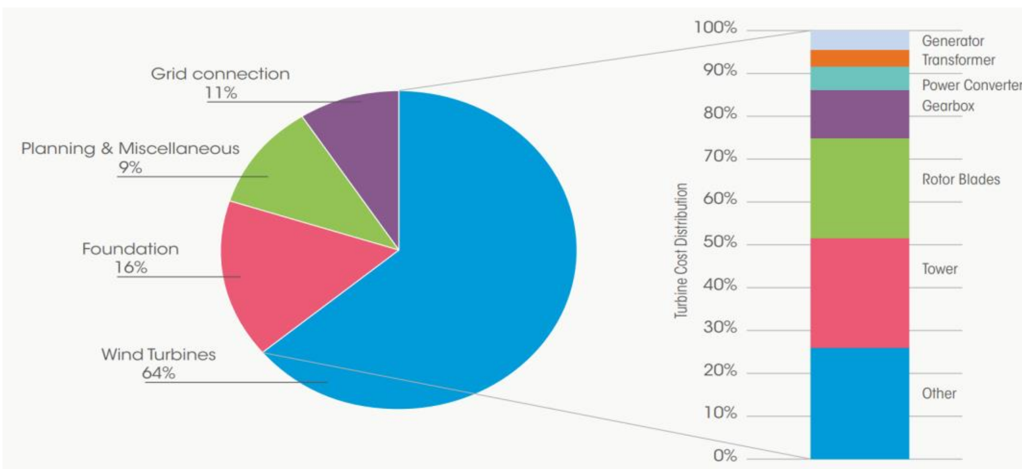


**Fig. 5. Relative cost of Installed wind power project ([R-7], [R-8]**

b. **Comparison of** uWIN Design with Conventional Horizontal Wind Turbines

The uWIN design consist of several major components, which are schematically depicted in Figure 2, above. These include Base, Generator, Turbine, Flexible pipe, Outer shell, Balloon, Venturi (piping) assembly and Helium fill (in the balloon).

| **Horizontal wind turbine (HWT) vs uWIN** | | | |
|---|---|---|---|
| | | **HWT** | **uWIN** |
| **Rotor** | | | |
| | Blades | On the tower | On the ground |
| | Hub | On the tower | N/A |
| | Pitch mechanism & bearings | On the tower | N/A |
| | Nose Cone | On the tower | N/A |
| | | | |
| **Nacelle** | | | |
| | Drive train | On the tower | N/A |
| | Bearings | On the tower | N/A |
| | Gearbox | On the tower | N/A |

| | | | |
|---|---|---|---|
| | Mechanical brake | On the tower | N/A |
| | Generator | On the tower | On the ground |
| | Variable speed electronics | On the tower | On the ground |
| | Yaw drive | On the tower | **(5)** |
| | Nacelle enclosure and frame | On the tower | N/A |
| | Electrical connections | On the tower | On the ground |
| | Hydraulics, Cooling system | On the tower | On the ground |
| | | | |
| **Tower** | | **(1)** | **(2)** |
| | | | |
| **Foundations** | | **(3)** | **(4)** |
| | | | |
| **Notes:** | | | |
| **(1)** | Solid fixed height | | |
| **(2)** | Balloon hoists uWIN to flexible height | | |
| **(3)** | Large, expensive foundation | | |
| **(4)** | Relatively inexpensive foundations to place small diameter turbine and generator | | |
| **(5)** | Simplified equivalent to the yaw drive will be part of the uWIN design to facilitate the optimum diffuser orientation (i.e. diffuser to face the wind direction) | | |

**Table1: Comparison of uWIN design and horizontal wind turbine**

The above table compares the various components of the conventional horizontal wind turbine and uWIN design.

## 5. CONCLUSIONS

The uWIN compares favourably with a conventional wind turbine. Its height is adjustable, its design is scalable to produce different electrical outputs, the foundations are relatively inexpensive, maintainability is relatively easy and its decommissioning is relatively simple and inexpensive.

## 6.0 FUTURE TASKS

In order to advance the uWIN design further, it is expected that at least four (4) possible applications are likely to evolve. These potential applications are presented below:

(1) SCALING UP: The height (length) and the diameter of the flexible tube, diameter of the intake and the generator output can be varied while maintaining the same design concept.

(2) MARKET: A unique market for installations in the soft soils and in arctic permafrost may be explored.

(3) VORTEX: The uWIN system lends itself for ***direct*** production of heating or cooling air, using vortex tube (Ranque-Hilsch) **[R-9]**. For this potential application turbine and electric generator would not be required.

(4) TORNADOES: There are indications that further research and development of artificial tornadoes may lend itself to achieving a release of high mechanical energy from within the flexible pipe.

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## 8. ACKNOWLEDGEMENTS

The authors would like to gratefully acknowledge the advice of Bluma Heimlich, eitan Dehtiar and Russ Houldin.