

The Future of Wind technology



BY:

Aerostatic Enterprise

Founder and CEO

Don Harwood

**Inventor Don Harwood introduces the future of alternate energy
technology through a revolutionary hybrid design:**

The Aerostatic Wing with Slipstream Turbine.

Executive Summary

The Aerostatic Wing with Slipstream Turbine combines aerodynamic forces with the fundamental physics of an Impulse Turbine. The symmetric airfoil doubles the aerodynamic forces that establish the 'slipstream'; the Slipstream Turbines, then complete the hybrid design by capturing maximum impulse energy from this improved aerodynamic flow.

Understanding this revolutionary design required extensive research that led to a breakthrough in the fundamental physics of free-flowing hydrodynamic power -- turning a hundred-year-old theory upside-down. The paper: "Wind Power Derived from Dynamic Pressure", published by Mr. Harwood under separate cover, establishes a new paradigm in understanding the true limits of extracting energy from a natural flow-stream. From Newton's fundamental laws he achieved a holistic power model redefining the foundation from which all future designs will emerge.

While the study was held to strict fundamental principles, free of design assumptions, it concluded by establishing the Impulse Turbine Model as being capable of maximum efficiency in contrast to the current horizontal systems with thirty percent true maximum potential efficiency. This hybrid system will out-perform any other fluid harvesting system when compared on the same foundation and will excel beyond the fail-safe conditions of horizontal axis wind turbines.

This design was approached from outside-the-box; human, environmental and cost were fundamental concerns applied through Mr. Harwood's extensive graphical engineering background with the goal to "keep it simple." The simplicity is; perfectly balanced with fundamental physics, harmonious between man and nature, multi-fluidic and very inexpensive.

Aerostatic Enterprise is eager to demonstrate and verify these claims by constructing a utility-scale prototype to be tested against industry standards. With the prime goal of a commercially viable system ready for deployment into the global market.

If a hybrid wind turbine design came along that was significantly more efficient, cost-effective, and versatile than horizontal-axis turbines, clearly it would be an unprecedented investment opportunity in a growing industry. This is that design.

Industry Snapshot

Roadmap Action Area focus:

Wind Plant Technology Advancement, the Wind Vision Study Scenario.

<http://www.energy.gov/eere/wind/maps/wind-vision>

- DOE projects that 10% of the nation's end-use demand will be supplied from wind by 2020, then 20% by 2030, and 35% by 2050.
- further declines in wind power costs along with; improved reliability, elimination of environmental dangers, expanded deployment and improved efficiency are needed to maintain current market valuations let alone compete with traditional electricity sources.
- A levelized electricity cost reduction of 24% by 2020 is required to substantially reduce or eliminate the near- and mid-term incremental cost increases defined in the *Study Scenario*, followed at 33% by 2030, and 37% by 2050 for land-based wind power technology and 22% by 2020, 43% by 2030, and 51% by 2050 for offshore wind power technology.
- ❖ No projections are presented for offshore subsurface hydrodynamic technology, currently an untapped resource in the multi-Terawatt potential.

U.S. Wind Industry Fourth Quarter 2015 Market Report

American Wind Energy Association

- The American wind energy industry installed 5,001 megawatts (MW) during the fourth quarter of 2015, the second highest quarterly activity on record. The 8,598 MW total capacity installed during 2015 represents a 77% increase over total installations during 2014. The U.S. now has an installed wind capacity of 74,472 MW with over 9,400 MW of wind currently under construction and an additional 4,900 MW in advanced stages of development.
- There are now 74,472 MW of installed wind capacity in the United States and more than 52,000 operating wind turbines, averaging 1.4 MW per installed turbine.

UPI News Report Jan. 2016.

- International expenditures in the alternative energy market for 2016 are projected to be in excess of 360 billion dollars -- an increase of 35% from 2015, of which wind technology and research will inefficiently consume 60%.

Why are they wasting money on old, unreliable, inefficient and grossly complex systems?



Because, they don't understand the true nature of Wind Energy.

Our new hybrid design is first of its kind, representing everything the others are not.

It will sweep the market like a fire storm as news spreads.

The Aerostatic Wing with Slipstream turbines

Where other wind generation machines have failed to meet expectations, this design efficiently turns turbulence, pressure, and the dynamics of wind into accessible Power.

Overview

With its profile — like an aircraft wing turned vertical — and without wildly spinning blades, this design is environmentally benign. These towers will not require broad safety zones around them because they have no potential for catastrophic failure, allowing for installation even in close urban settings. The support structure is simply a sturdy pole and foundation. The aerostatic wing primarily mounts and casters on a single thrust bearing located in the top cowling, with guide bearings spaced downward. The wing will caster into the wind of its own accord, with no tracking control mechanism required, eliminating two of the four madatory subsystems of curent market tecnology, blades and tracking controls.

The Aerostatic Wing is a symetric airfoil composed of several subcomponents that, when combined, establish a smooth slipstream flow from semiturbulent fluids, whereby the Slipstream Turbine Assembly, through the aplication of Newtonian Impulse physics ^[1], extracts maxamum power. Replacing the third complex subsystem of gearboxes and transmutations with simplicity at much smaller proportions.

The multifluidic nature of this hybrid design adds a completely new level of achievment by opening an untaped power suply, -- an unobtainable goal for curent market tecnology.

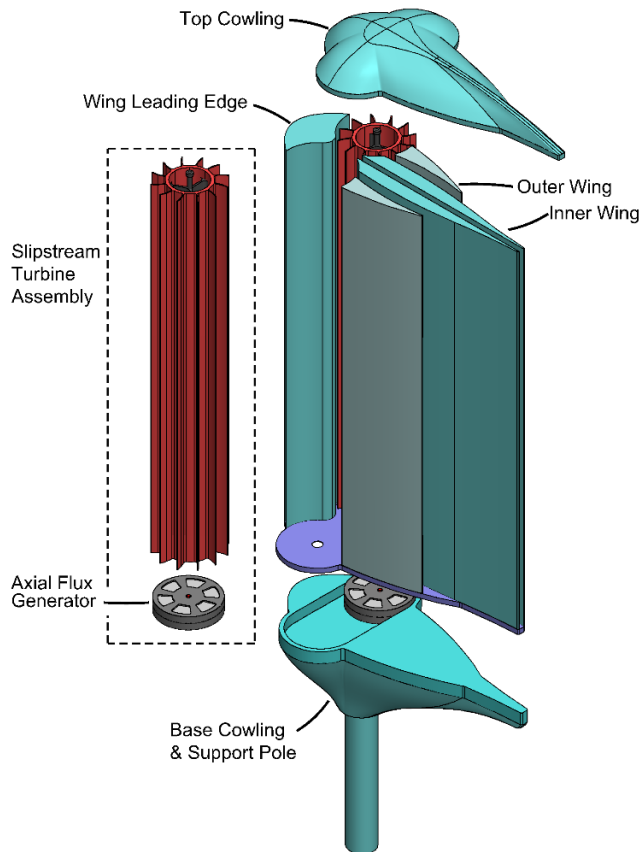


Figure 1. Aerostatic Wing with Slipstream Turbines, expanded view.

The simplicity of this design, along with a perfectly defined physical model ^[1], make it the “Genesis Form” for all future systems spawning a revalution in tecnology and application.

The Aerostatic Wing

The Aerostatic Wing is an enhanced symmetric Airfoil in a Static application, thus the name ‘Aero-Static’. Our patented Aerostatic shape controls the turbidity of a fluid approaching the wing then additionally enhances the low pressure behind the turbine for greater efficiency of operation by maintaining a laminar flow along the outer surfaces as the fluids pass.

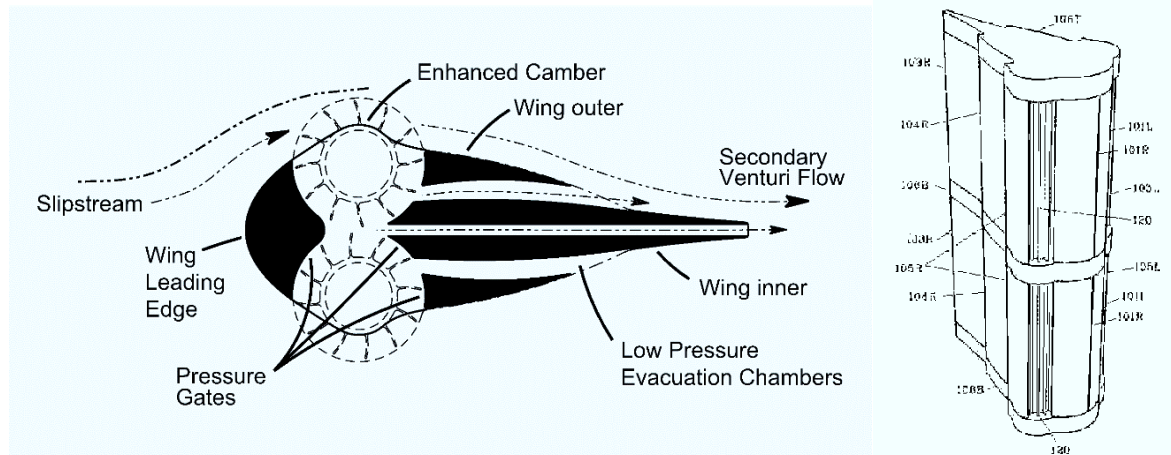


Figure 2. Aerostatic Wing, Cross Section and Profile.

As a fluid approaches the leading edge it is divided into two “Slipstreams” by the vertical stagnation flow channel created by the leading edge, reducing turbulence. As the slipstream moves past the enhanced camber of the airfoil it increases velocity, that under normal conditions would result in lift. Replacing the high camber surface of the airfoil with a rotating drum eliminates the lift force on the airfoil structure, leaving a higher velocity fluid flow that is then captured by the travelers causing the drum to increase rotational velocity whereby maximum enhanced power is extracted.

The overall structure, being Static, absorbs the aerodynamic Drag forces allowing the maximum camber enhancement in turn increasing the lift potential. As the fluid passes a turbine it becomes turbulent without the outer wing surface to stabilize and direct the flow. Stabilizing this flow allows the secondary benefits of the venturi effect to be utilized for further reducing the pressure on the back side of the turbine.

The fluid flowing around or trapped in the turbine traveler pockets is at stagnation pressure. The pressure gates act to separate the slipstream flow from the two consecutive low pressure evacuation chambers. These chambers employ the secondary venturi flow of the re-stabilized slipstream to evacuate stagnant mass maintaining a stable pressure gradient.

As the flow now passes the trailing edge it will become rhythmically turbulent. Again, the Static nature of this design is not effected by parasitic tip vortexes or trailing turbulence, in fact, the greater the total aerodynamic Drag on the Static Wing structure the grater the maximum potential power at the turbine.

Wind tunnel testing of an idealized model verify a range of slipstream velocity increase from 10% at wind speeds below 4 m/s (8 mph) up to 25% at 30 m/s (67 mph). Modifications made to the model during testing indicate that optimizing the proportional parameters of the wing, turbine and fluid system could achieve a slipstream velocity increase of over 40%.

The Slipstream Turbines

The twin counter-rotating turbine runners in the vertical axis position eliminate the gyroscopic counterforce of tracking the wind and will act to stabilize the tower through lateral movement. This natural balance eliminates the destructive force of gyroscopic procession and centripetal explosiveness.

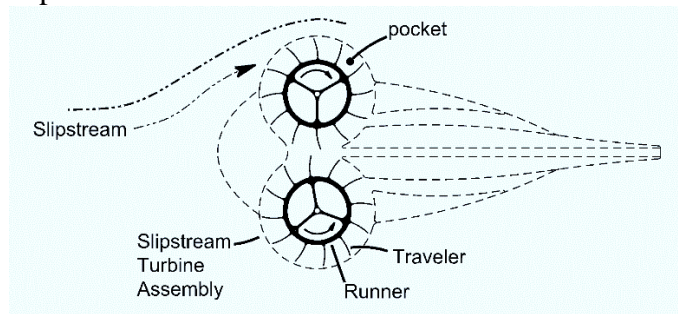


Figure 3. Slipstream Turbines, Cross Section

A highly cambered symmetric airfoil placed statically in a fluid flow is of little use, --Without the uniquely intuitive design of the Slipstream Turbine. The patented turbine design is itself a hybrid blending of several existing designs, primarily the Pelton Wheel and the Savonius Turbine.

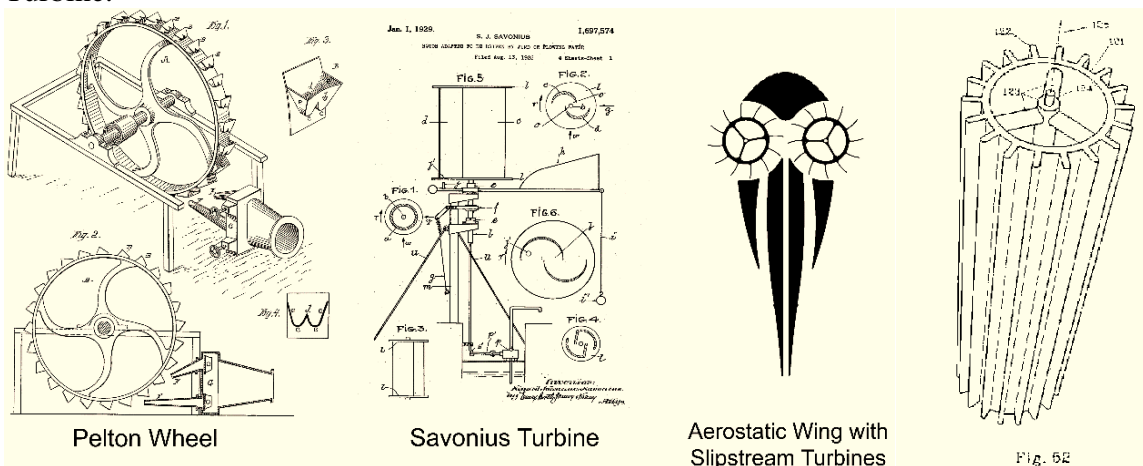


Figure 4. Design Comparisons

The Savonius turbine is an incomplete design that has had many attempts to improve the efficiency of which shielding is the most obvious. All past attempts missed the key elements and no successful attempt was ever made to define the fundamental physics behind the machine. --Mr. Harwood's physics paper closed that gap ^[1].

The Pelton Wheel is, on the other hand, a very successful design used in hydroelectric applications worldwide. This wheel uses a high pressure jet of water to push the traveling buckets that are attached to the running rim of the wheel transferring energy by Impulse. This design is however limited to that application and would not be suitable in a free-flowing fluid environment. The Pelton design did an analysis of the physics, with preconceptions specified by the machines function, completing a restricted model of an impulse turbine. -- Again, Mr. Harwood's physics paper ^[1], by removing all assumptions, has created a fundamental model of the impulse turbine that is the foundation for understanding all designs past or present.

Through rigorous study and experimentation; combined with, a full understanding of the Pelton model, the deficiencies of the Savonius turbine and the fundamental principles of physics Mr. Harwood achieved a perfect combination of concept, intuition and function in the Slipstream Turbine that redefines the current theory of wind.

Auxiliary subcomponents

Each Aerostatic Wing will be composed of multiple modular units. Dividing the vertical length into predefined modular units eliminates the twisting forces caused by wind shear at different elevations of a single long turbine. Each modular wing unit will contain two Slipstream Turbine Assemblies; a left-hand and right-hand counter rotating self-contained assembly.

An Aerostatic Wing composed of five modular units will therefore have ten generators producing the total output. Distributing the load to smaller generating units has multiple proven benefits beyond that of cost reduction.

The Slipstream Turbine Assembly is composed of the turbine connected directly to an axial flux permanent magnet generator and the framework containing the alignment bearings. The modular turbine assembly will be aligned, balanced, synchronized and tested on the factory floor, not 300' in the air. With specially designed hoisting mechanisms this modular assembly can be removed and replaced within hours not months.

The axial flux generator is of current market level technology with some design specific upgrades. By using permanent magnets, we eliminate the parasitic exciter coils simplifying the internal electromechanical components thereby reducing fire hazard potential and cost.

The turbine velocity control system will be the most complex element of the Aerostatic Wing with a very simple function; measure the slipstream velocity using a Pitot static tube, maintain turbine velocity at one third the slipstream velocity by adjusting the centripetal governor. The centripetal governor controls the turbine velocity by changing the inertial mass of the turbine drum converting speed into greater torque. As wind speed increases so does the strength of the fluid impulse against the now heavier turbine capturing the widest potential power range. The inertial mass governor provides this design with the capability of maintaining output in winds well above 45 meters per second (100 mph).



Image 1. oops!

The only common component between the Aerostatic Wing and other systems is a sturdy pole, -- the other systems apparently have difficulty getting this correct.

The total structure load will be very large with a rotational moment in the direction of the changing winds. – not the perpendicular moment caused by gyroscopic torque.

The twin counter rotating turbines will have a much smaller gyroscopic effect that will counter some of the structures rotational moment. The turbine axis being parallel to the tracking rotational axis of the wing that is also vertical and parallel to gravity completely eliminates the catastrophically destructive forces found in horizontal axis wind turbines.

The Aerostatic Vision

[Transcribed from initial interview with Mr. Harwood dated 1/7/16]

During a preliminary study of wind energy systems, I was struck by the inconsistent design based theories of how things work. The airfoil lift-based systems claim superiority by way of tip speed ratios while the 'American farm wind mill' has greater static torque at the same wind speed. This dichotomy seems to defy the laws of conservation; -- *How can an airfoil extract more energy from the same potential source than the very similar design of the 'American farm wind mill'?* The 'blade' or 'airfoil' design-cross-section is the key difference between the two systems that must be related to a common explanation in some way. By considering the forces on the two systems held at rest while the wind flows past them I began to grasp the reasons for their distinct modes of interaction. My extensive background in the graphic arts naturally included multiple sketches and force diagrams relating the strengths and weaknesses of all current systems of horizontal and vertical orientation. These sketches sorted into three categories according to the current explanation of the driving forces; lift, drag and impulse. I however do not consider drag a motivating force, it is the friction related to aerodynamic motion and cannot be identified as a separate force. Therefore, I categorized my drawings into the two primary forces; Lift and Impulse, of which I believe Impulse to be superior. While I was working on the airfoil force diagrams I drew a symmetric airfoil attempting to establish the correct resultant force vector directions relating the airfoil orientation and its direction of rotational motion. As I applied vectors to this drawing, I was dumbfounded by what was developing into the first sketches of the Aerostatic Wing.

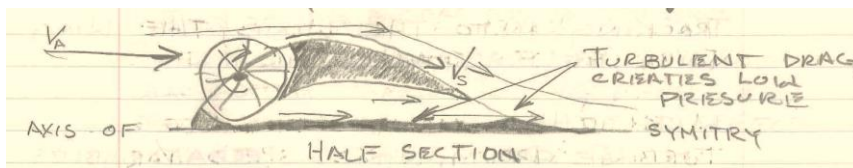


Figure 5. Original Logbook Excerpt

This drawing visualizes a very large symmetric wing, as in the size of a 747 jumbo jet, placed vertically in a flowing fluid that would create twice the lift in opposite directions and then place a modified turbine in the fat part of the wing. As the wind moves past the wing the turbines convert lift into power. My intuitive recognition of the potentials hidden in this sketch began a multi-year study of the design and how to explain the hybrid physics behind an impulse turbine with aerodynamic enhancement.

Developing this sketch into an idealized working model was accomplished by using the Golden-Mean Rectangle to establish proportional dimensions based on natural harmonic ratios. The Golden Ratio, found throughout nature, is considered the most pleasing shape when applied to structural or artistic works making this design visually more acceptable to the human eye. The vertical dimensions use the same ratio to define the modular units maintaining continuity of visual proportions.

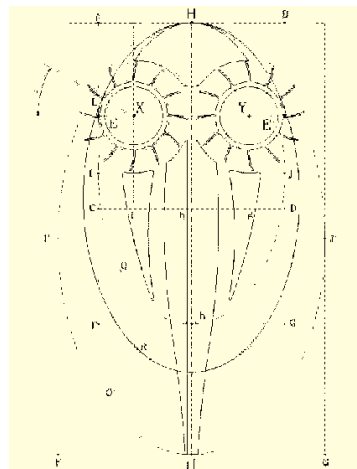


Figure 6. Golden Mean Proportions

Test Results

The Aerostatic Wing with Slipstream Turbine is a radical form of vertical-axis wind turbine that draws more energy out of the wind than standard horizontal-axis wind turbines of any design ^[1]. The installation represented here reflects the experimental results from extensive wind tunnel testing by drawing maximum energy from the wind with minor limitations from subcomponent efficiency.



Photograph 1. Aerostatic Wing with Slipstream Turbine, Seagull-120

The Static nature of this design, in that there are no long spinning blades connected to a school bus 300 feet in the air, creates a pleasing visual structure that is bird safe, efficient, weather resistant and simple to install or maintain.

| Aerostatic Wing with Slipstream Turbine | | | | | | | | |
|---|------------------------------|------|--------------------------|--|--|----------------------|-----------------------|------------------------|
| Wind Velocity V_w | Slipstream Velocity V_r | | runner velocity V_u | Max Potential Power $1/8\rho AV_r^3$ | Max Extractabel Power $2/27\rho AV_r^3$ | Potential Efficiency | Beta Test measurments | Operational Efficiency |
| m/s | increas | m/s | m/s | Watts | Watts | C_p | Watts | C_o |
| 3.0 | 10% | 3.3 | 1.1 | 24 | 14 | 59.3% | 10 | 40.9% |
| 10.0 | 13% | 11.3 | 3.8 | 982 | 582 | 59.3% | 450 | 45.8% |
| 16.0 | 14% | 18.2 | 6.1 | 4,130 | 2,447 | 59.3% | 2,300 | 55.7% |
| 20.0 | 17% | 23.4 | 7.8 | 8,720 | 5,167 | 59.3% | 5,000 | 57.3% |
| 28.0 | 20% | 33.6 | 11.2 | 25,816 | 15,298 | 59.3% | 14,900 | 57.7% |
| 34.0 | 22% | 41.5 | 13.8 | 48,571 | 28,783 | 59.3% | -- | |
| 39.0 | 24% | 48.4 | 16.1 | 76,970 | 45,612 | 59.3% | -- | |
| 45.0 | 25% | 56.3 | 18.8 | 121,124 | 71,777 | 59.3% | -- | |
| Specs based on : | | | | 120 square meters of exposed turbine surface with a runner radius of 0.66 meters optomum runner velocity is 1/3 Slipstream Velocity Slipstream Aerodynamic enhancement ranges from Minamum of 10% to maxamum tested at 20% | | | | |

Table 1. performance results, Seagul-120

The Operational Efficiency increases as the ratio of base line friction to potential power decreases approaching maximum extraction potential, far exceeding anticipated results. Some difficulty was experienced holding turbine velocity down to the correct ratio, by adjusting the inertial mass governor at higher wind velocities this was neatly overcome.

We also recognize there are numerous other designs that claim to be superior to the industry-standard. We encourage everyone to reassess all designs using the Pitot Power Equation and Model, which will finally allow for a verifiably consistent rating system.

Design features

From this hybrid design combined with the underlying physics many new and innovative applications may be imagined beyond this simple beginning. Where does your imagination take you? ...

Offshore Installations

An outstanding and completely unique feature of this hybrid design is that it is fluid dynamic, capable of subsurface offshore installations. While wind is a variable, inconsistent source of energy, offshore currents are constant flows of potential energy, thus a network of submerged wings could be a reliable and controllable source for powering the grid. Consider that all coastlines have a 3 to 5-knot current. And 90 percent of the world population lives near the coast. We see the potential for generating terawatts of power with minimal environmental cost. The wing may be submerged to variable depths by modular units, allowing control of output capacity similar to the control rods in a nuclear reactor. This low-maintenance design can withstand the rigors of the marine environment.

Inland Waterways

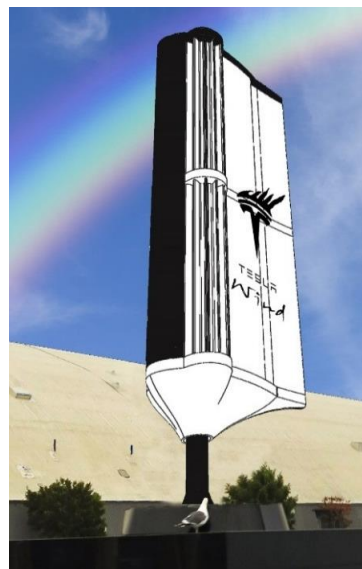
A second hydrodynamic potential is found in large rivers that meander through multiple bends. The outer banks of these rivers have a higher flow velocity that causes scouring. Erosion and property damage, particularly on navigable waterways, are being controlled with rock or concrete abutments. With proper flow modeling, these abutments may be contoured to incorporate the Slipstream turbines at consecutive points along the outer embankment drawing power from an untapped source in the low megawatt range. Man-made channels or aqueducts may also incorporate Slipstream Turbines at optimum locations.

Clean water, Power & Fuel

The offshore potential is enhanced by being a multipurpose system. The power generated could also be used for clean water desalination as well as hydrolyzing sea water for transportation fuel. all from a single offshore installation.

Battery charging

Personal transportation is a key market for the design. The towers can be installed near existing fuel stations, creating electric charging stations that are grid independent. The rectified DC current can be used to recharge replaceable battery packs in vehicles, a rapidly developing and viable technology, spearheaded by the Tesla Motors Corp. By uniting these systems, we could free personal transportation from fossil fuel. By combining this battery pack with hydrogen fuel-cells commercial transportation may also become fossil free.



Graphic 1. Conceptual Rendering

Architectural Enhancements

Buildings may also incorporate the Slipstream Turbines in the corners or ridgeline, creating a whole new design venue for large architectural projects. These turbines would be in the upper kilowatt range for average city structures with mid-megawatt potential in the larger 'super-structures' found worldwide.

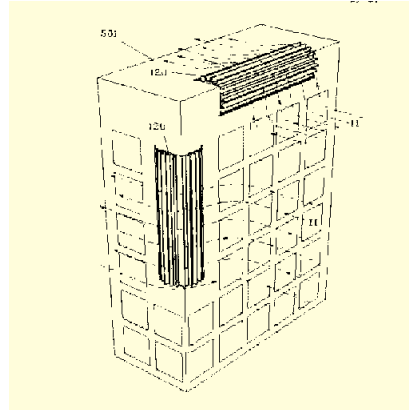


Figure 7. Structure with Slipstream turbine.

Remote and Grid-Independent Installations

Small townships may install moderate wind farms, freeing remote locations from the transmission losses of the grid. Extremely isolated locations may be powered by airlifting modular units from an accessible staging area.

Schools and factories are safe with this design and could become grid independent

Sound

The optimum turbine velocity is one third that of the slipstream velocity. At a slipstream velocity of 80 mph the runners' linear velocity will only be 26 mph. The tip speed never approaches the sound induction threshold. The system will have a sound, as do all machines. We predict a very low decibel low-frequency sound. Final engineering and materials will determine the audible qualities.

Harmonious and Cost-Effective

The design was held to one necessary axiom: "keep it simple." Its organic form expresses a natural simplicity that not only defines the power of wind, it returns multiple dividends, from inexpensive manufacturing and installation to minimal operating costs and a potential 50-year life expectancy.

The wing will be vertically large, however, the proportional dimensions are based on the golden ratio of nature – resulting in a pleasing overall shape. The surface contours are organic in flowing lines that may be artistically stylized beyond the fundamental form. Of course this surface may also be painted to blend with the surrounding environment or leased for advertising.

No fragile blades.

Compared to a large HAWT, there is less material fatigue and vibration, so the system will last longer. The physical stresses on very large rotors are enormous; only NASA-worthy engineering and expensive material keep them from blowing apart. The balanced and compact Slipstream Wing, on the other hand, has fewer forces acting against the turbines and support structure, so the design does not require heavily engineered structural solutions and consequently can be constructed with inexpensive materials.

Bird and Human Friendly

A large HAWT requires a quarter mile of open land around it for safety should the rotors fail, which does on occasion occur ^[2]. This safety zone however does not apply to birds that are being swatted out of thin air by enormous rapidly moving foils and killed by the thousands. The Slipstream Wing never exceeds the current wind speed and has no long flailing blades.

Institute for Energy Research, April 29, 2015

According to a study in the Wildlife Society Bulletin, every year 573,000 birds (including 83,000 raptors) and 888,000 bats are killed by wind turbines — 30 percent higher than the federal government estimated in 2009, due mainly to increasing wind power capacity across the nation ^[2]. This is likely an underestimate because these estimates were based on 51,630 megawatts of installed wind capacity in the United States in 2012

Approaching the Slipstream Wing, bird species will fly or be swept past them in the wind. The aerostatic wing is just that: static. It will have the appearance of no motion, it will be a visibly stationary solid easily avoided. Some design considerations may be prudent regarding nesting, because bats and various bird species may find the chambers habitable

Weather

This system is stable and durable in all-weather conditions and environments. Icing may occur however this will lock the turbine down, not throw refrigerator-sized chunks of ice over a quarter of a mile distance as large HAWT's have been known to do. Directing nominal internal power to heating elements around the bearings and across critical sections of the internal walls of the Wing will minimize freezing conditions and moisture buildup.

Other turbine designs must account for dangerous forces in front of and behind the structures caused by turbulent winds. The Wing stabilizes sudden wind gusts and turbulence, by aerodynamically shaping the flow stream and reducing fluctuations through the inertial mass of the turbine runner. The wing will caster into the wind of its own accord, adjusting itself like a weather vane, without any control mechanism allowing tighter grouping of towers increasing the power per acre of land or sea.

Applied Economies of Scale

The full design is based on modularization comprising a fully involved concept that controls all aspects of the perfect system design, making it Plug & play.

- ✓ Materials
- ✓ private capital & infrastructure
- ✓ manufacturing scale
- ✓ transportation
- ✓ public infrastructure
- ✓ application, air or water land and sea
- ✓ Location, expanded sighting potential
- ✓ installation
- ✓ visual public approval
- ✓ environmentally safe and friendly
- ✓ serviceability, unit interchangeability
- ✓ extended life, incremental upgrade
- ✓ decommissioning, why?

Benefits

Where other wind generation machines have failed to meet expectations, this design efficiently turns turbulence, pressure, and the dynamics of wind into accessible Power.

- The slipstream turbine extracts more energy from the wind than conventional, rotor turbines—providing more power per acre than any other system.
- The design is simple, so manufacturing and installation costs are low.
- While the world average for electrical generation is 18- to 25 cents per Kilowatt hour, the target for the Slipstream Turbine is 4- to 8 cents per Kilowatt hour.
- By employing the physics of inertial mass to capture more of the power in the air stream, the design allows the Slipstream Turbine to operate at higher wind speeds than conventional turbines, providing consistent and reliable energy generation in all winds.
- The failure mode of this design is to ‘seize up,’ not ‘run away.’ Even in the case of a runaway turbine, it would only reach current wind speed.
- Multi-fluidic, providing a new horizon for natural power extraction technology.
- This new horizon includes clean water and transportation free of fossil fuels and pollution.
- High rise buildings that generate their own power.
- Remote or isolated locations may be powered by grid independent installations.
- Pleasing proportional dimensions that are artistically pliable. Artfully harmonizing machines with nature is a human desire and environmental necessity.
- Visibly Static, Vertigo-free and intriguingly easy to watch as it lazily casters like a weather vane on a barn naturally seeking the wind.
- Safe for man and the birds who own the air.
- Quiet, this design will not approach the sound barrier with amplified tip speeds. The strength of wind is found in lower turbine velocities working against the true potential power of the fluid flow.
- Balanced fundamental forces eliminate catastrophic failure.
- A pure Physical and Mathematical model exquisitely defining the dynamic potential of not only this perfect hybrid design but includes all other sub-classes such as horizontal axis lawn art. –being that they do *laydown* an awful lot.



Image 2. Horizontal Lawn Art...

Can a 63-meter or 120-foot horizontal turbine airfoil be made in 20-foot units? Transported in standard shipping containers? Moved on public roads without permits? Can a HAWT be installed under water? On a school playground? On extremely remote mountain tops? Repaired and upgraded without extensive cost?

Anticipated Critiques

It is just a shielded Savonius.

At first glance, the Slipstream Wing may appear to be simply a shielded Savonius turbine housed in a cleverly designed airfoil. Probably the oldest wind turbine design, a Savonius is a vertically mounted turbine with a shape to catch wind, such as the cup rotor on an anemometer. It becomes obvious that the wind also pushes against such a turbine on its return orbit unless the “back side” is shielded.

The Slipstream Wing, however, is a *Shielded Impulse Turbine*. Its shape not only eliminates the drag on the “back side” of the turbines, it directs the wind so the maximum kinetic energy may be extracted. It unifies aerodynamic forces with the impulse turbines efficiency, becoming the definitive solution to clean inexpensive energy.

No vertical turbine design is more efficient than a horizontal axis design.

No VAWT has *yet* been tested to IEC61400-12 standards that has efficiencies in the upper range of large HAWT ^[3]. “Common knowledge” claims a vertical design can only achieve about 20 percent efficiency. Industry leaders claim efficiencies for HAWTs in the region of 50 percent or greater.

First, the Harwood paper with Pitot’s power equation ^[1] show these claims to be exaggerated, as these machines actually extract about 30 percent of the power from the wind. The industry-wide biased attitude against Vertical Axis Drag Turbines are based on faulty assumptions and incomplete models, along with the oversimplification of Newton’s laws and errors regarding conservation of energy, applied force, and power. Second, the VAWT bias will be rapidly discarded when the Slipstream Wing is tested. We anticipate 85% overall true efficiency.

You cannot approach 100% of the Betz limit.

By the erroneous calculations based on the assumptions of the Betz idealized rotor model, the Betz momentum theory as widely used simply *does not apply* to VAWT design. However, the Harwood power model ^[1] independently confirms that the limit does indeed exist, just not for the theoretical reasons that have been assumed for decades. It is true that no turbine can capture more than 16/27 (59.3%) of the kinetic energy in the wind. However, by taking full advantage of fluid dynamics, the Slipstream Wing is capable of 100 percent of the coefficient limit, minus friction and other structural limitations.

An accurate analysis of the potential power extractable from a free-flowing fluid is critical to the understanding and development of alternate energy sources. A method of analysis that replaces conjecture with known quantities is now available ^[1]. By combining fundamental Newtonian equations with a known value derived from Pitot’s stagnation pressure, the analysis redefines the potential maximum power of fluids and show lift-based turbines to be extremely inefficient by finally establishing the true limit implied by the Betz theorem. Preconditions on the model or the environment are not required, in contrast to other methods. The solution revealed by this method has deep implications affecting nearly all fields related to the wind power industry.

The strongest rebuttal to any criticism is the truth. Mr. Harwood’s paper establishes a truly fundamental understanding of free-flowing fluidic power extraction derived from known values, --not supposition or suppositories. Thorough examination of his paper will prove the claims presented. --the future starts here...

Don Harwood Bio

Mr. Harwood's intuitive graphical skills come from over 40 years as a senior draftsman where he achieved Master status by having over 60 drawing exhibits accepted by the U.S. Patent Office in conjunction with the application of two patents on this design.

Mr. Harwood's experience and educational background also ranges from the machine shop to the Physics laboratory. Both through hands on experience and formal education he has achieved; Master Draftsman with 3-dimensional CADD/CAM fluency, Journeyman tool-&-die/CNC Machinist, a collage certificate in 'Drafting and Engineering Technology' (SBVC88) and an 'Associate of Science in Physics' degree (SBVC89).

Mr. Harwood's unique ability to visualize and manifest imagination into reality using; skills, tools, knowledge, intuition and common sense, has set the stage for a new future in energy technology through a beautifully fundamental model redefining the Physics of Wind and the hybrid design of the Aerostatic Wing with Slipstream Turbine.

Mr. Harwood owns the fundamental patents from which all future designs will be developed.

Patent Pending Status

Utility Patent, 'Wing with Slipstream Turbine' Pub. No. US 2016/0053742 A1. Feb. 25, 2016
Design Patent, 'Wing with Slipstream Turbine' Pending No. 29/499,923 final action 2016.

Proposed Deployment Stages

1. Fabricate and test a functioning scale prototype under laboratory conditions.
2. Fabricate a commercial-scale prototype to be tested by the NREL to IEC 61400-12-1 standards. Establishing a marketable product design.
3. Initial deployment to a commercial grid with high impact visibility.
4. Apply the demonstrated efficiencies while expanding to worldwide operations.

Contact:

Don Harwood, CEO Aerostatic Enterprises
1847 Dean St.
Eureka, Ca. 95501

Don@Bombuli.com

References:

1. *Wind Power Derived from Dynamic Pressure: A Return to Fundamentals*. Don Harwood, 2016.
2. *Wind turbine collapses in Northern Ireland*. [The Telegraph](#). Emily Gosden, Energy Editor. Jan. 4, 2015
3. Wind Power Program. <http://www.wind-power-program.com/betz.htm>