

# Electric Energy Generation by Magenn Air Rotor System (MARS)

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**Abstract** - The Magenn Air Rotor System (MARS) is the next generation of wind turbines with cost and performance advantages over existing systems. MARS is a lighter-than-air tethered wind turbine that rotates about a horizontal axis in response to wind, generating electrical energy. This electrical energy is transferred down the tether for consumption, or to a set of batteries or the power grid. Helium sustains the Magenn Air Rotor System, which ascends to an altitude as selected by the operator for the best winds. Its rotation also generates the "Magnus" effect. This aerodynamic phenomenon provides additional lift, keeps the MARS device stabilized, positions MARS within a very controlled and restricted location, and finally, causes MARS to pull up overhead to maximize altitude rather than drift downwind on its tether. It's become mandatory rather than option to go for the renewable source of energy today in the whole world. For the same requirements we need advance options for future, hence MARS proves its excellence to use for better future.

**Keywords** – Electric Energy Generation, Magenn Air Rotor System (MARS).

## 1. Introduction

MARS is a lighter-than-air tethered wind turbine that rotates about a horizontal axis in response to wind, generating electrical energy. This electrical energy is transferred down the 1000-foot tether for immediate use, or to a set of batteries for later use, or to the power grid. Helium sustains MARS and allows it to ascend to a higher altitude than traditional wind turbines. MARS captures the energy available in the 600 to 1000-foot low level and nocturnal jet streams that exist almost everywhere. MARS rotation also generates the "Magnus effect" which provides additional lift, keeps the MARS stabilized, and positions it within a very controlled and restricted location and causes it to pull up overhead rather than drift downwind on its tether.

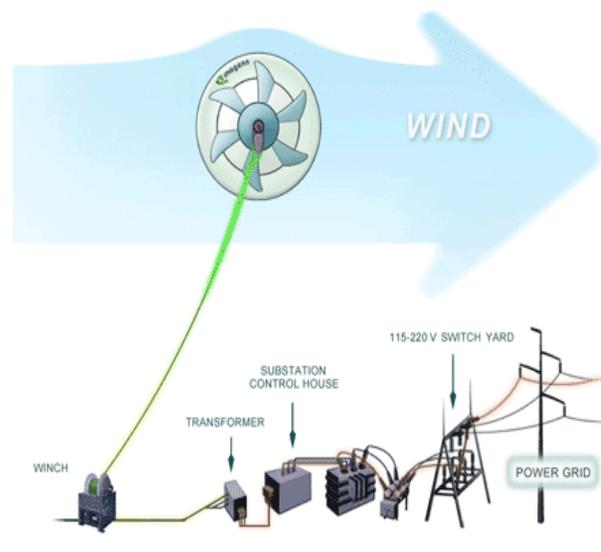


Fig.1 Magenn Air Rotor System (MARS)

All competing conventional wind generators use bladed two-dimensional disk-like structures and rigid towers. The Magenn Power Air Rotor system is a closed three-dimensional structure (cylinder). It offers high torque, low starting speeds, and superior overall efficiency thanks to its ability to deploy higher. The closed structure allows Magenn Power to produce wind rotors from very small to very large sizes at a fraction of the cost of current wind generators.

The system Magenn air rotor system (M.A.R.S.) is one of the types of Offshore Wind Turbine. This kind of turbine is lighter than the air. It uses the wind power to produce electric energy. The reason why it is possible to stay in higher level of atmosphere is the Helium that is used to fulfill the turbine. This helps the turbine to be in areas where wind has higher speed, than on the lower levels of atmosphere. The M.A.R.S. spins around the horizontal axis following the wind direction. This way is produced

more energy from the wind power, which is transferred to the surface transformer station using the cables. It has a lot of advantages comparing to the conventional OWT (Offshore wind energy) e.g. low cost of produced electric energy, lower noise, turbine is placed in higher location, lower constrains where it can be placed, high mobility level, and it is not required to use a heavy duty machines, lower risk to harm a birds or bats. The OWT M.A.R.S. can be taken out higher over the surface, than the conventional systems, so it can catch more power full wind. The conventional systems are placed in areas where the wind is higher over the surface e.g. coastlines or mountain terrenes. The most suitable areas are in national parks, areas far away from the consumers of the electric energy, which raise up the energy losses during the long-distance power transmission. This mentioned problems are able to be solved using the M.A.R.S.

## 2. Working Principle of MARS System

The Magnus effect or Magnus force is the phenomenon whereby a spinning object flying in a fluid creates a whirlpool of fluid around itself, and experiences a force perpendicular to the line of motion. The overall behavior is similar to that around an airfoil (see lift force) with a circulation which is generated by the mechanical rotation, rather than by aero foil action. In many ball sports, the Magnus effect is responsible for the curved motion of a spinning ball. The effect also affects spinning missiles, and is used in rotor and Flattener aero planes.

### 2.1 Magnus Effect

When a body (such as a sphere or circular cylinder) is spinning in a viscous fluid, it creates a boundary layer around itself, and the boundary layer induces a more widespread circular motion of the fluid. If the body is moving through the fluid with a velocity  $V$ , the velocity of the thin layer of fluid close to the body is a little less than  $V$  on the forward-moving side and a little greater than  $V$  on the backward-moving side. This is because the induced velocity due to the boundary layer surrounding the spinning body is subtracted from  $V$  on the forward-moving side, and added to  $V$  on the backward-moving side. If the spinning body is regarded as an inefficient air pump, air will build up on the forward-moving side causing higher pressure there than on the opposite side. Another explanation of the Magnus effect is since there is less (forward) acceleration of air on the forward-moving side than the backward-moving side, there is more pressure on the forward-moving side, resulting in a perpendicular component of force from the air towards the backward-moving side. This layer of spinning air,

however, is very thin, and it is more likely that most of the Magnus effect is due to the earlier detachment of the air flow on the forward-moving side, which results in a diversion of the flow (acceleration of air) with a perpendicular component towards the forward-moving side, coexisting with an opposing aerodynamic force with a perpendicular component towards the backward-moving side.

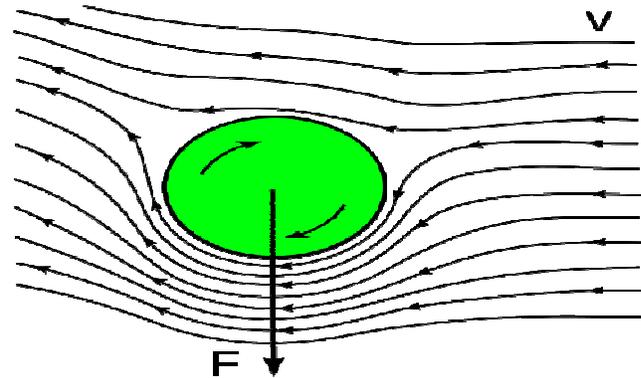


Fig. 2 Ball Producing Magnus Effect due to Rotating In Air

## 3. Calculation of Magnus Force

Given the angular velocity vector  $\vec{\omega}$  and velocity  $\vec{v}$  of the object, the resulting force  $\vec{F}_M$  can be calculated using the following formula:

$$\vec{F}_M = S(\vec{\omega} \times \vec{v}) \tag{1}$$

Where,  $S$  is dependent on the average of the air resistance coefficient across the surface of the object. The  $\times$  denotes the vector cross product.

### 3.1 An Example of Spin Ball in the Air

The following equation demonstrates the lift force induced on a ball that is spinning along an axis of rotation perpendicular to the direction of its translational motion:

$$F = \frac{1}{2} \rho v^2 A C_L \tag{2}$$

$F$  = lift force

$\rho$  = density of the fluid

$v$  = velocity of the ball

$A$  = cross-sectional area of ball

$C_L$  = lift coefficient

The lift coefficient CL may be determined from graphs of experimental data using Reynolds numbers and spin ratios. For a smooth ball with spin ratio of 0.5 to 4.5, typical lift coefficients range from 0.2 to 0.6.

### 3.1 Given Tables of 100 kW MARS System

Table 1 100 KW MARS System

MARS 100kW Performance Specifications	
Magenn Power Product	Model 100Kw
Rated Power	101,000 Watts
Size (Diameter x Length)	45 ft x 100 ft (plus blade height of 22 ft each)
Shipping Weight	Under 13,000 lbs
Volume of Helium	200,000 cubic feet
Tether Height	750 ft standard - up to 1,500 ft optional tether length
Start-up Wind Speed	2.5 m/sec - 5.6 mph
Cut-in Wind Speed	3.0 m/sec - 6.7 mph
Rated Wind Speed	12.0 m/sec - 26.8 mph
Cut-out Wind Speed	24.0 m/sec - 53.7 mph
Maximum Wind Speed	30.0 m/sec - 67.1 mph
Temperature Range	-40¼C/-40¼F to +45¼C/+113¼F
Generators	100 kW Total
Output Form	380 V 3 Phase 50 Hz, 480 & 600 V 3 Phase 60 Hz or Regulated DC
Warranty	One Year
Life Cycle	10 to 15 Years
Price (USD) (Estimated)	\$500,000 USD

## 4. Components Requires of MARS System

The various components of magenn air rotor system are listed below

- Air rotor
- Flexible cable
- Winch

- Air stabilizer, spark arrestor
- Generator
- Transformer

### 4.1 Rotating Balloon

MARS will be constructed with composite fabrics used in airships today. The fabric will be either woven Dacron or Veteran with an inner laminated coating of Mylar to reduce porosity and an exterior coating of Tedlar which will provide ultra-violet protection, scuff resistance and color. Dacron is used for boat sails, Mylar in silver toy helium balloons, and Tedlar is the plastic coating found in all-weather house siding.

Pictures below show older conceptual drawings of the Magenn Air Rotor System's balloon getting helium filling.

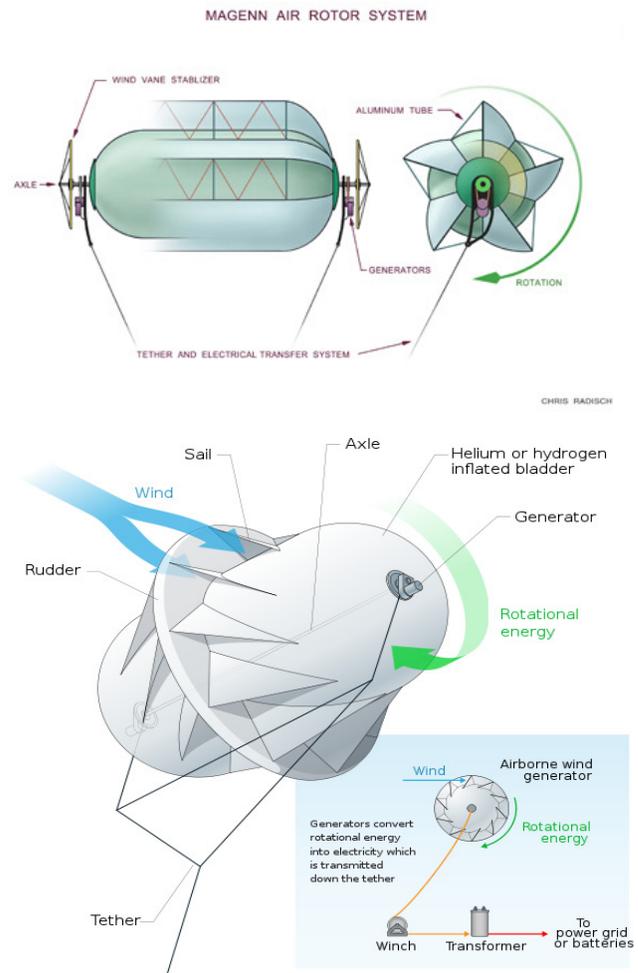


Fig. 3 Rotating Balloon

## 4.2 Flexible Cable & Winch

Helium-filled aerostats that are 400-ft in length and are tethered at up to 15,000-ft in altitude by means of flexible cable and cable is supported by the winch which will also help to change altitude of rotor.



Fig. 4 Air Stabilizer and Spark Arrester

Due to the inherent elegance of the design, the Magenn Air Rotors will always weather-vane properly. Regardless of wind direction, the deflection disk will ensure MARS units will automatically rotate toward the wind, with the Magnus aerodynamic effect creating additional lift. It is done by wind vane stabilizer.



Fig. 5 Air Stabilizer

## 4. Conclusions

MARS is most effective, cost effective, eco friendly, mobile, low maintenance way of generating electrical energy out of wind energy.

It would be an ideal for the country like India which is having vast varieties in geographical landmark to implement such power stations as it could be installed where it could be.

It is the best solution for the power-crises faced by the world

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