VAWT ALONG RAILWAY TRACKS

THEME : SUSTAINABLE SOLUTIONS

MADE BY : BHUVAN BAGWE

Problem Statement

Railway locomotives travel at an average velocity of 90-110 km/h (outside station areas) which results in generation of high speed slipstream due to atmospheric drag faced by the locomotives. This results in the generation of high speed winds reaching speeds of up to 22-25 m/s. The wind energy generated from these locomotives can be utilized to generate electricity.

Our Objective

The objective of this project is to design a vertical axis wind turbine that can be strategically placed along railway tracks or along express highways to address the issue of wasted energy resulting from aerodynamic drag. By harnessing the power of the wind generated by passing trains, we aim to create an innovative and environmentally-friendly solution for generating electricity. Through this approach, our ultimate goal is to minimize carbon footprint and contribute to the transition towards sustainable energy sources.

Motivation

While travelling via train you must have felt a strong wind breeze, that breeze inspired us of finding ways to utilize it. Our motivation with this project is to optimize current infrastructure to minimize carbon footprint

Potential application

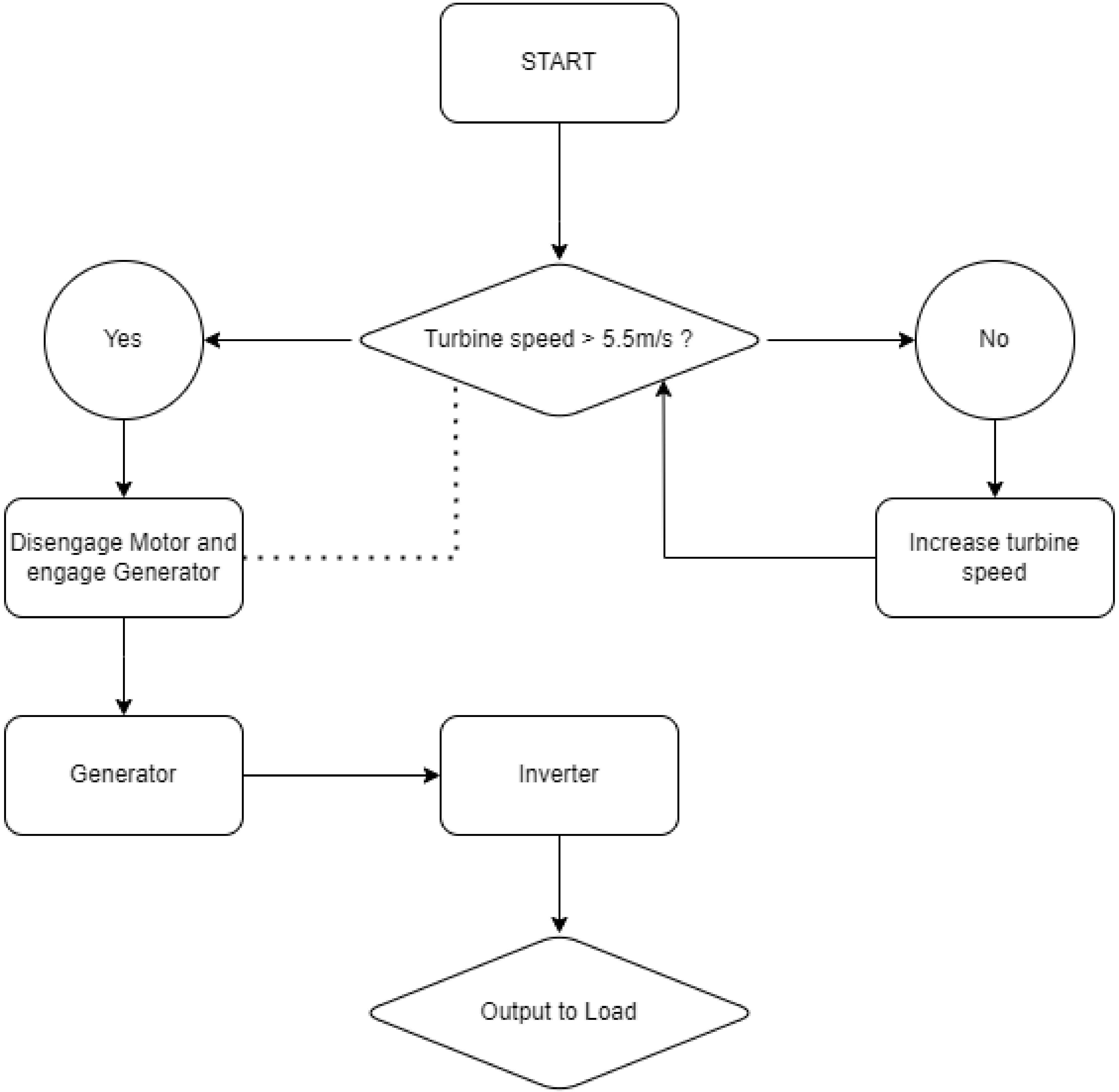
Our design has limitless applications, from places along railway tracks to expressways, our design can be used as a power unit for communication towers in remote areas. or as a power unit. Smaller versions of our design can be used in powering sensor systems for monitoring and surveliance

Market Survey

Vertical axis wind turbines have been tested and used on various highways across different countries

Block Diagram

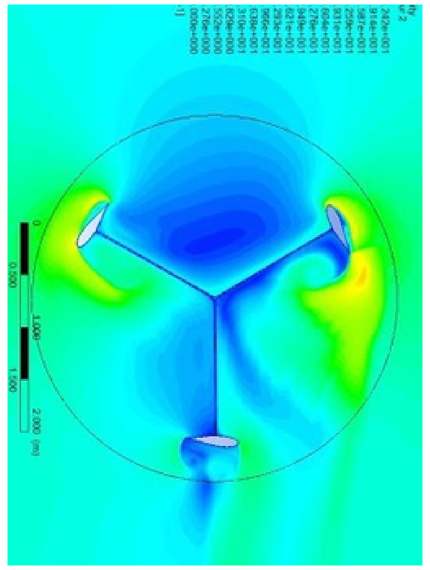
Our system uses a hall effect sensor with ESP8266 microcontroller to continuously monitor turbine speed. If the turbine speed is less than 5.5m/s. Our custom designed assembly engages the motor to increase turbine speed. Once the turbine speed is greater than 5.5 m/s the generator unit is engaged. This thereby drives the generator and the DC output is then fed into the inverter system to generate AC output suitable to drive the load.



Methodology

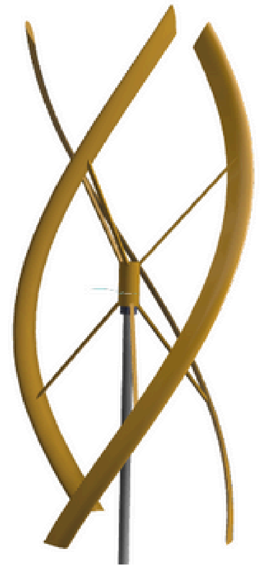
Firstly, a vertical axis wind turbine was selected as the most suitable option based on criteria such as available space for safe placement between tracks and expected wind speeds.

To determine the power output of the turbine, Autodesk Simulation was used for computational fluid dynamics analysis of various design variants. This enabled the selection of the design with the best power coefficient and other key metrics.



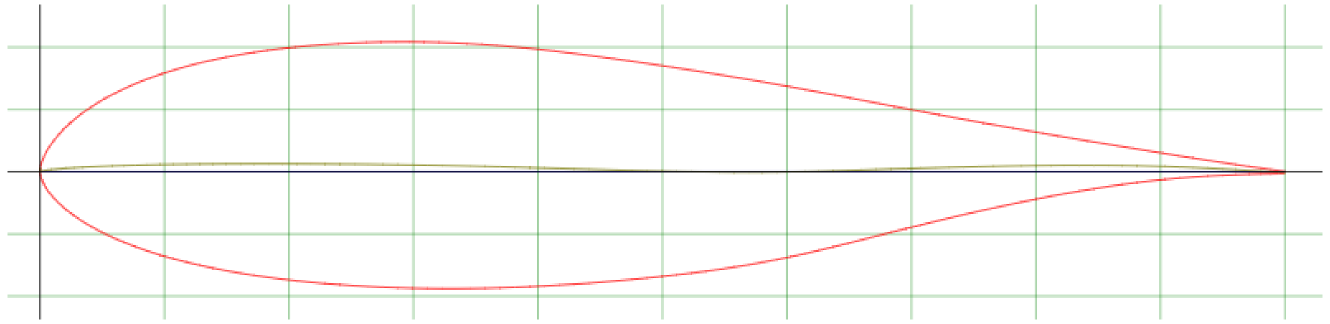
Next, a three-blade helical vertical axis wind turbine was designed based on factors such as airfoil type, number of blades, angle of attack, cross-sectional area, diameter, and height. In order to ensure that the design could withstand the required shear strain, a number of materials were shortlisted.

Finally, a printed circuit board (PCB) was designed to implement the entire system for stable output with a custom inverter design. This methodology allowed for a comprehensive and effective approach to designing and implementing a vertical axis wind turbine along railway tracks to harness wasted energy.

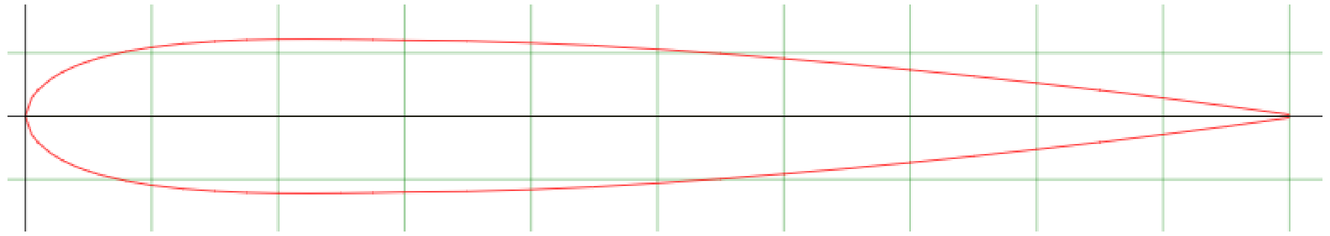


Aerodynamics

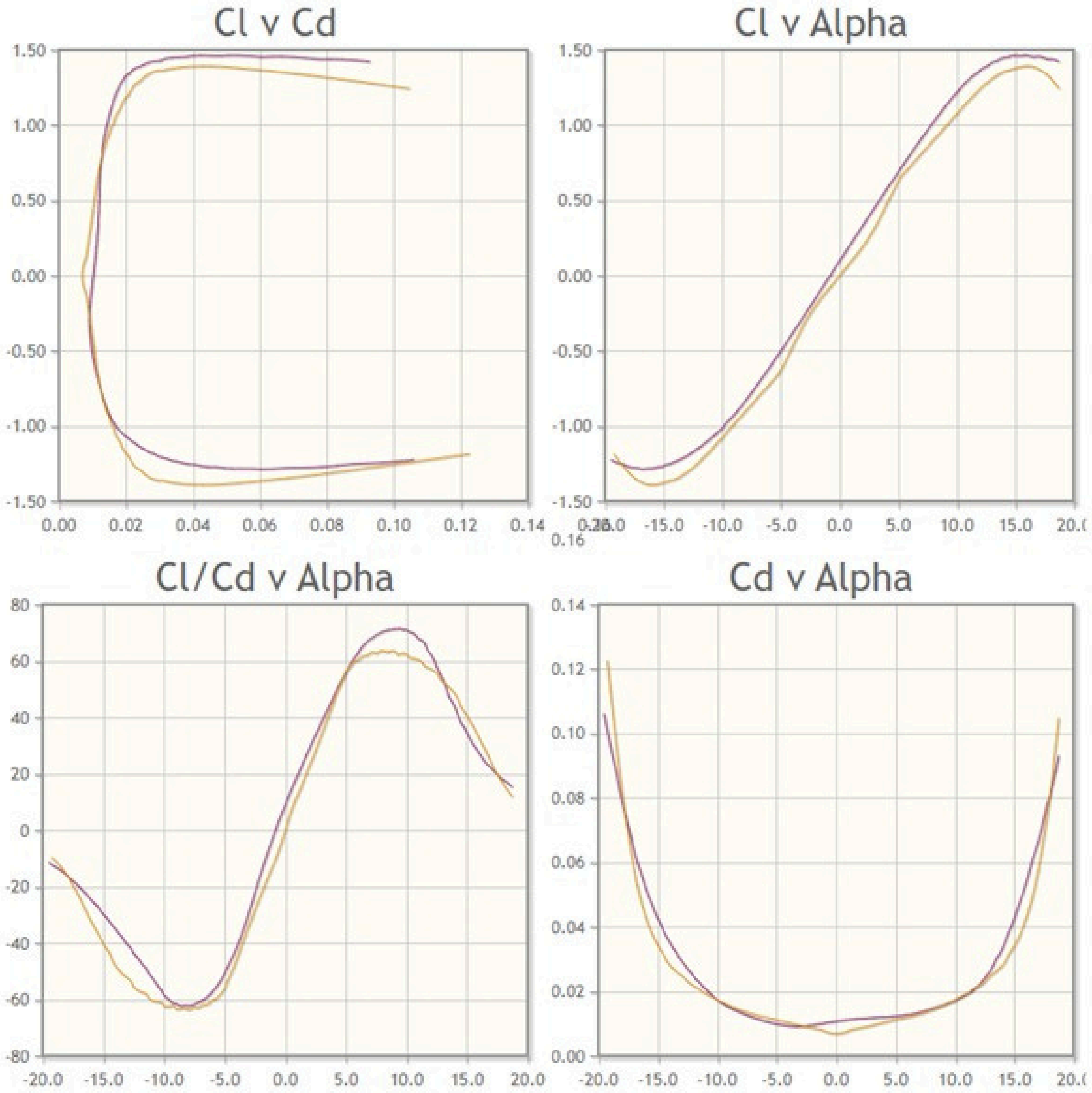
The two most compatible airfoils for VAWTs are (du06-w-200-dt) DU 06-W-200 VAWT airfoil and (naca0012h-sa) NACA0012H for VAWT from Sandia report SAND80-2114.Following an analysis and comparison of both airfoils, it was determined that the lift to drag ratio of the DU 06-W-200 VAWT is superior for the purposes of this design and was so employed to create our design.



DU 06-W-200 VAWT airfoil



NACA0012H for VAWT



DU 06-W-200 VAWT airfoil is represented by
NACA0012H for VAWT is represented by

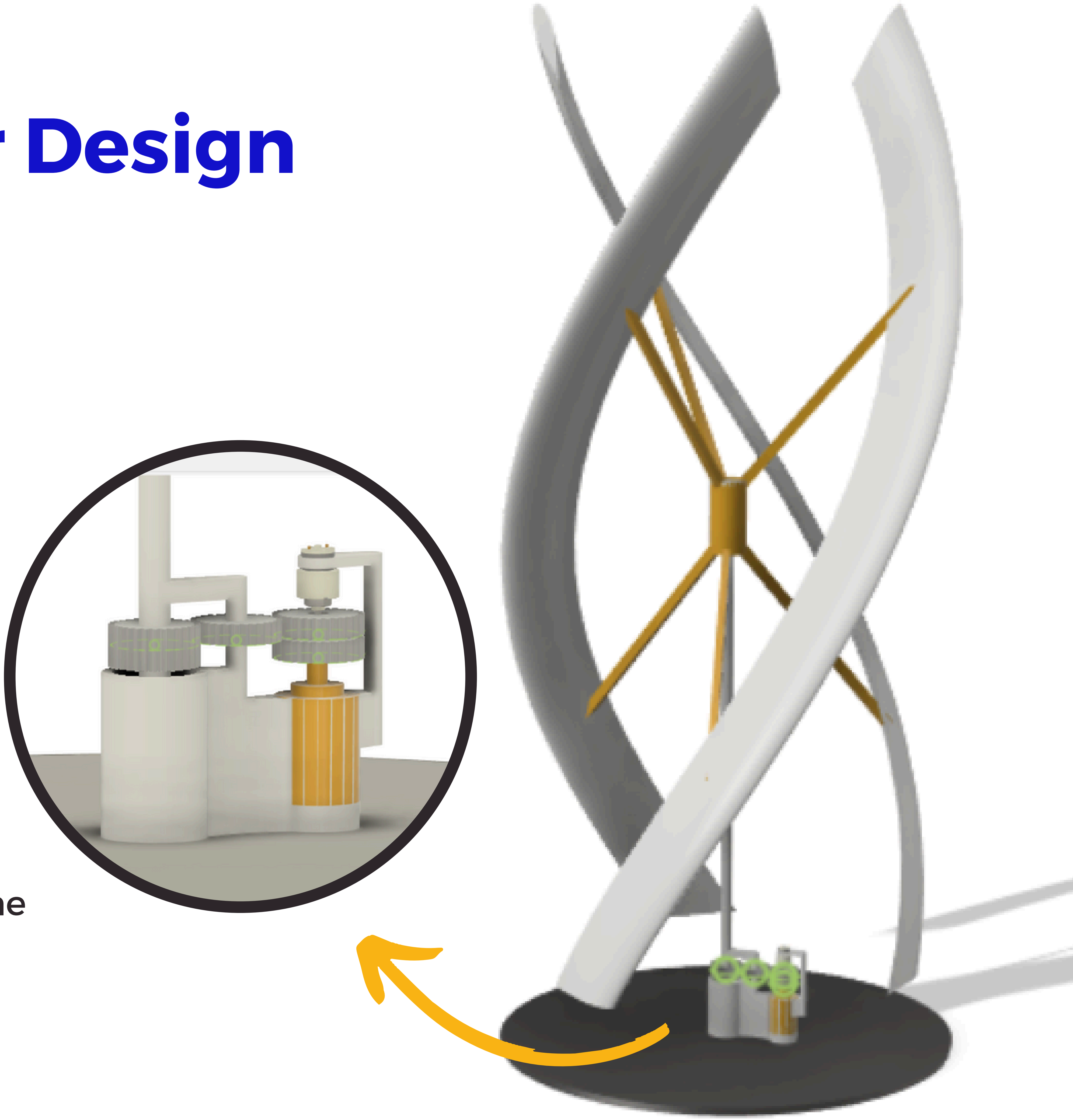
~source : Airfoiltools.com

Unique features of our Design

We have designed this turbine while keeping all safety measures in mind. The most efficient airfoil, DU06W200 has been selected with optimal chord length of 250mm,

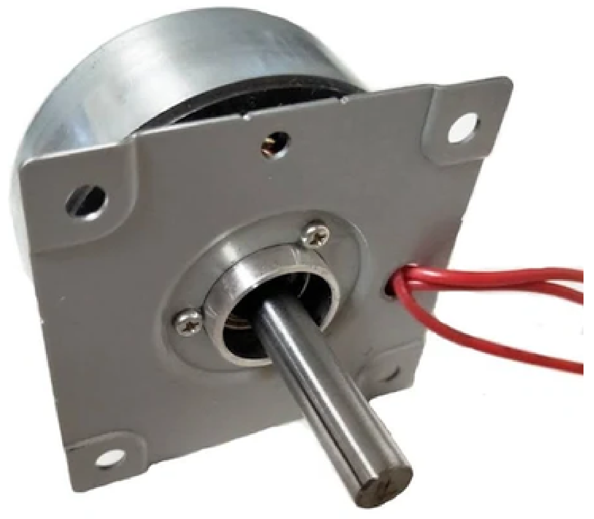
Turbine Type : Helical Lift Type
Diameter : 1000.0 mm
Height : 2500.0 mm
Swept Area : 2.5 m^2
Number of blades : 3

A custom starting mechanism for our Vertical axis wind turbine, which uses a hall effect sensor with a microcontroller and a motor unit to keep the turbine operational at a minimum velocity of 5m/s.



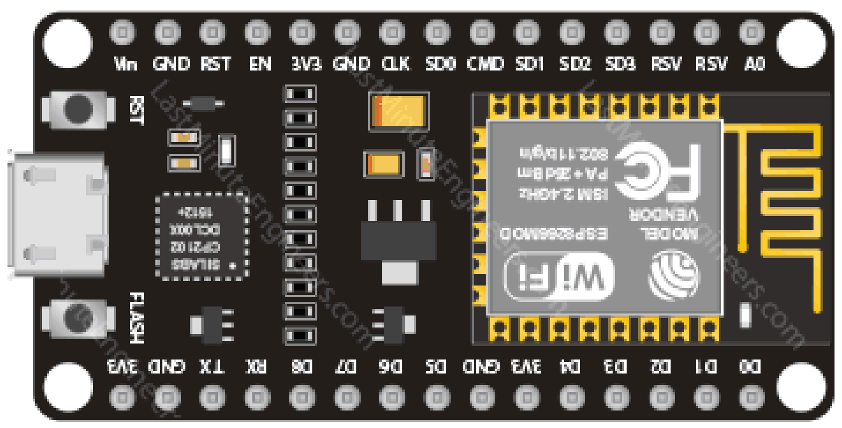
Tentative Budget





Blades fabrication cost : Rs. 2074
Generator unit : Rs. 700
Start circuit motor : Rs. 125
Support Structure (PVC and Steel pipes) : Rs. 700
Bearings : Rs. 400
ESP8266 Microcontroller : Rs. 185
Hall Effect Sensor : Rs 50
Wiring Cost : Rs 50
TowerPro Servo : 200
Miscellaneous : Rs. 500
Total Budget : Rs. 4904



Scope of Project

The scope of vertical axis wind turbines has been recognized by the renewable energy market, and such systems have been successfully implemented in UK, South Korea, etc. Many VAWT designs were placed along highways to generate energy and are running successfully.

The VAWT can be integrated with existing railway infrastructure at minimal costs since this does not induce land acquisition costs. Further the system can be integrated with cameras or motion detection sensors to auto trigger and indicate movements along the railway tracks, saving lives of animals and people crossing by.

A single turbine is expected to generate a power output of ~450W and with 1 such turbine at a distance of 50 meters we can generate a energy output of 1MW over a distance of 10.2km track, by simply optimizing current infrastructure.

Our research will also enable to optimize current designs and help in development of vertical axis wind turbines

Common Questions

Q: Innovative concepts
A: We have created a novel airfoil design with a new self starting mechanism, which has never been tried

Q: How related to electronics
A: One of the important parts of the design is our generator unit with the use of permanent magnet synchronous generators

Q: Viability and Existing solutions
A: Existing solutions ensure the viability of our system and our unique placement location for the turbine can result into higher power coefficients

Q: What changed, to enable this.
A; Advancement in additive manufacturing techniques has enabled us to fabricate such a complex design to increase energy output