TEAM- C-HELIX

EXHIBITIONS

OMNIDIRECTIONALWINDMILL

Proposed by: Pradeep Kumar.
Constructed by: Saniya Khurana and Nihal Raj.

ABSTRACT:

- A truly-omnidirectional, single-axis wind turbine especially suitable for apartment buildings facing chaotic winds in urban environments.
- Traditional wind turbines only capture wind travelling in one direction, but are very inefficient in cities where the wind is unpredictable and multi-directional. When wind blows through cities it becomes trapped between buildings, is dragged down to the street and is pushed up into the sky. This catapults wind into chaos, which renders conventional turbines unusable.
- Using a simple geometric shape, O-Wind Turbine is designed to utilize this powerful untapped resource, generating energy even on the windiest of days.

OBJECTIVE:

- The O-Wind, due to its unique design, makes use of wind approaching from all directions in 3 dimensions including wind in the vertical direction. This is not the case for other wind turbines in the market, with VAWT's being multidirectional only in the horizontal plane.
- O-Wind Turbine is made for high-density urban environments, instead of the open fields where turbines are typically placed.
- This is because the architecture of tall buildings throws wind flow into chaos, making conventional turbines, which are only able to capture wind travelling in one direction, close to pointless.
- In contrast, the O-Wind Turbine captures wind from all directions, and is designed to attach to balconies or the sides of buildings, where speeds are high.
- **O**-wind Turbine will improve the usability and affordability for people across the world. Making it easier to generate green energy, people will be encouraged to play a bigger role in conserving our planet

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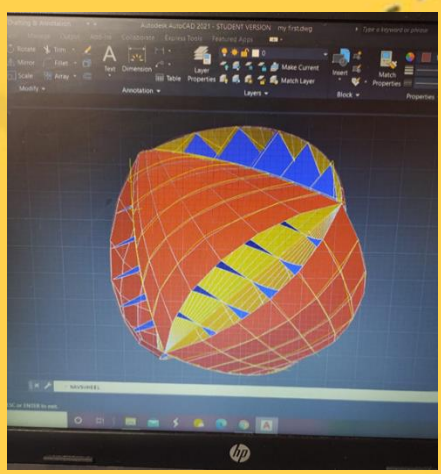
EXECUTION:



- The turbine is of a spherical shape with a single axis of rotation going through it. Its dimensions and shape mean that it is very suitable for small-scale energy production by individual apartment dwellers e.g. by being fixed outside balconies.
- The turbine makes use of Bernoulli's principle for its mechanical motion. The structure is lined up with vents which have large entrances and smaller exits for air. In the presence of wind, there is a pressure difference between the two terminals causing the turbine to move.
- The vents are placed all across the sphere making it receptive to wind from all directions in both the vertical and horizontal planes. The turbine will rotate in the same sense about a fixed axis regardless of wind direction.
- This turbine rotation is used to power a generator that can produce electricity, which can be fed into the national grid, hence providing financial incentive to users and improving the region's sustainable energy production.
- Design on Auto-Cad and output through video and graphs on MATLAB.

How it works?

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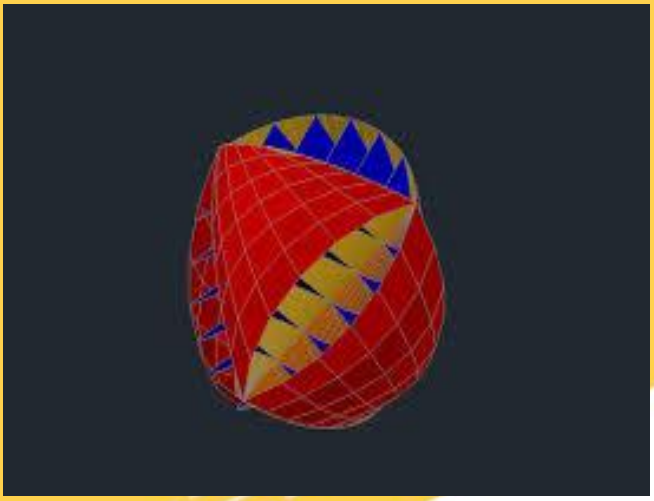


LEARNING OUTCOMES:

- It gives an practical applications of Bernoulli principal.
- It teaches how to optimise present technology to harness renewable energy.

SOCIAL BENEFITS:

- To produce electricity.
- The result is a wind turbine that has just one moving part, is much quieter than most other turbines and doesn't harm birds because they are too large to fit through the sidewall blades. It looks pretty cool as well. Can produce energy from wind blowing in any direction.

- Can work in turbulence too.
- Gives more output than conventional turbine.
- Can be installed along any direction unlike conventional turbine which requires vertical axis for installation.

Wind power and energy calculator

Wind power and energy potential :

$$Ec = \frac{1}{2}\rho * V * v^2 \quad [\text{Nm or joules}]$$

Kinetic energy

$$V = A * v \quad [m^3 / s]$$

Air flowing through area A in one second

$$P = \frac{1}{2}\rho * A * v^3 * A \quad [W]$$

Wind power

A : area swept by the blades

V : wind flow throught the area in m^3/s

ρ : density of air	1.23	kg/m³	
v : wind speed	11	m/s	***This wind speed is used to calculate instantaneous wind power output or to define the rated output of wind turbine (usually between 11 and 12 m/s.***
	39.6	km/h	
	24.75	mph	
Rotor diameter	7	m	
Area covered	38	m²	
kinetic power	**31,502**	W	(hypothesis of constant wind)
	32	kW	
Annual potential wind energy :	2,76,147	kWh	

Electric power in output of wind turbines :

Betz limit	59%	
Pmax according to Betz limit (16/27)	19	kW
Yield losses :		
Blades	67%	between 0,2 and 0,85
Gear box	90%	between 0,7 and 0,98
Generator	90%	between 0,8 and 0,98
Transformer :	95%	between 0,85 and 0,98
Rectifier :	100%	between 0,9 and 0,98 (1 if no batteries)
Batteries :	100%	between 0,7 and 1 (1 if no batteries)
Wire losses :	97%	between 0,9 and 0,99
Total yield losses :	50%	
Average performance ratio	0.30	

Power, losses included	9.3	kW	***instantaneous output power***

Annual wind turbine energy :

Average annual Wind speed	5	m/s
Capacity factor :	50%	

(In relation with angles of attack, turbulences, annual wind distribution, cut in, cut out...)

Real annual electricity prroduction :	40,891	kWh
Ratio kWh/kW/y	4,380	kWh/kW.y
Global wind turbine yield : Electric energy/kinetic energy		15%

- Electric power

The formula for the electric power is $P = \pi/2 * r^2 * v^3 * \rho * \eta$, one watt is calculated as $1\ W = 1\ kg * m^2 / s^3$.

- Performance:

To get a preliminary estimate of the performance of a particular wind turbine, use the formula below.

$$AEO = 0.01328\ D_2V_3$$

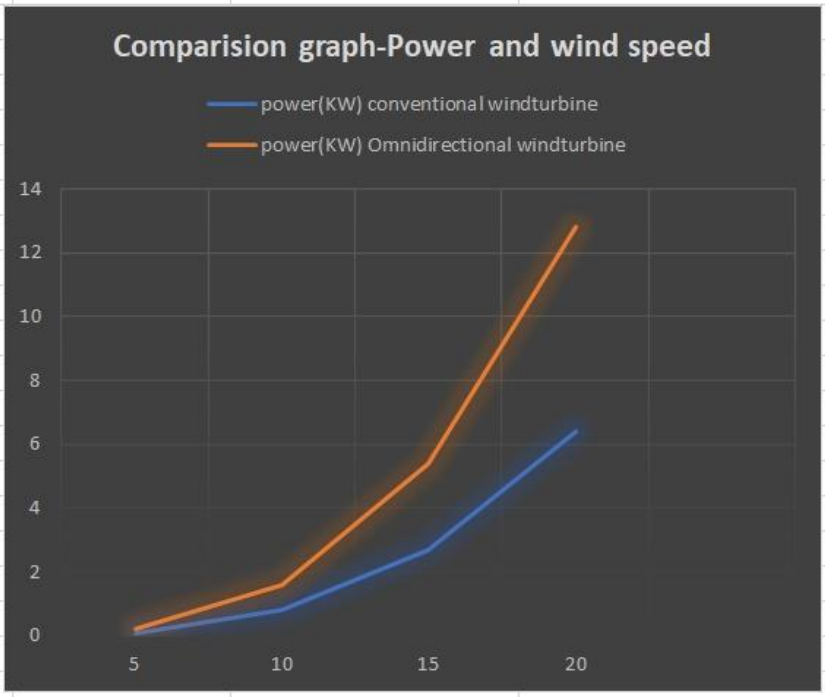
Where:
AEO = Annual energy output, kWh/year
D = Rotor diameter, feet
V = Annual average wind speed, mph

3. The Tip Speed Ratio (TSR) is an extremely important factor in wind turbine design. TSR refers to the ratio between the wind speed and the speed of the tips of the wind turbine blades.

TSR=tip speed of blade/wind speed.

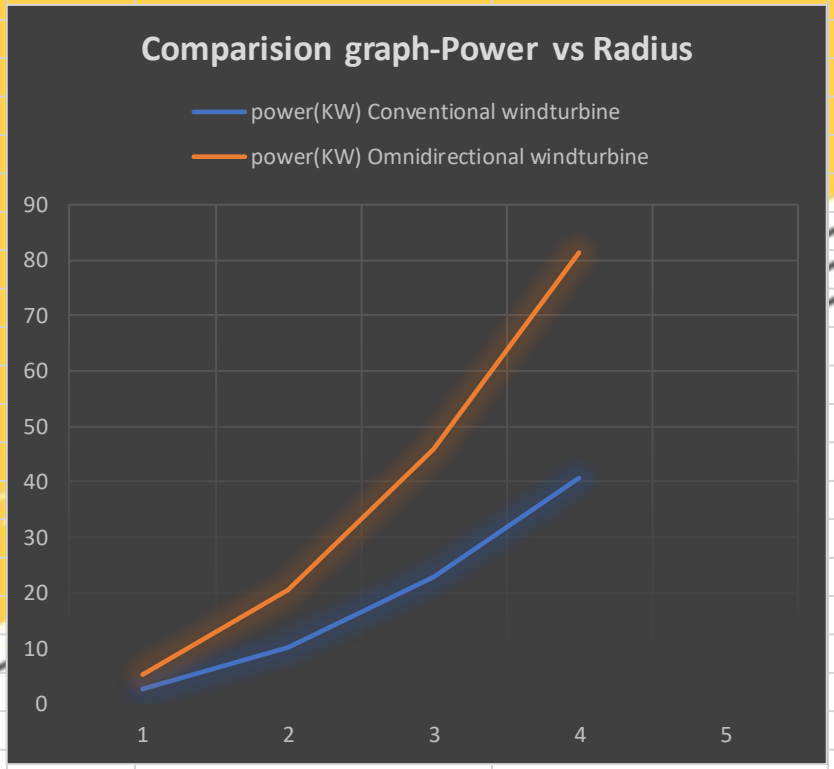
Graphs:

	power(KW)	
Wind speed (m/s)	conventional windturbine	Omnidirectional windturbine
5	0.1	0.2
10	0.8	1.6
15	2.7	5.41
20	6.4	12.81



For r=1 meter, density=1.2kg per cubic meter, efficiency=80%

	power(KW)	
Radius(M)	Conventional windturbine	Omnidirectional windturbine
1	2.54	5.087
2	10.17	20.398
3	22.9	45.8
4	40.7	81.392
5		



V=15m per sec, density=1.2kg per cubic meter, efficiency=80%

Result:

- Efficiency of o-wind turbine is almost double that of conventional windmill.
- From the above graph we can say that o-wind turbine gives more output than VAWT and HAWT.

Future plans: Further prototyping and test will be made in order to optimize its performance. Specialized facilities have been made available at Lancaster University for this purpose. Beyond this solution, the technology can be used for developing on-grid and off-grid alternatives for the urban market as well as for motor homes, boats and other stand-alone applications at different sizes. One particularly interesting possible application is wave energy generation, as under the waves it is also a chaotic situation with water flowing in every direction. In order for this technology to be used in that scenario, a greater R&D effort should be made.

How it is different from other turbines?

- The simplistic design of o wind turbine and use of a single axis of rotation mean that no steering is involved, hence requiring less maintenance and less costly than traditional wind turbines. Finally, the size and shape of the turbine mean that it can be placed in different kinds of environment compared to traditional turbines which require more space. It is a wind turbine that has just one moving part, is much quieter than most other turbines and doesn't harm birds because they are too large to fit through the sidewall blades. It looks pretty cool as well. Gives more output than conventional turbine. Can be installed along any direction need less maintenance unlike conventional turbine which requires vertical axis for installation,This turbine has less land requirements unlike conventional one which require more space .

WHAT IT DOES?

- O-Wind Takes advantage of horizontal AND vertical winds without requiring steering. Apartment dwellers could efficiently/effectively/sustainably generate electricity and independently make use of feed-in tariffs in nearly 80 countries.

BUDGETARY REQUIREMENTS:

Total Rs.2,305

S.NO.	ITEM	QTY.	SPECIFICATION	COST/ UNIT	COST
1.	GI Sheet	2	20 gauge(thin that can be easily folded)	800	1600
2.	Axle	1	Solid rod 10mm dia. Length 1mtr	500	500
3.	Bearing	1	Same dia. as axle	100	100
4.	LED	1	Red	5INR	5
5.	Dynamo	1		100	100

SOFTWARES REQUIREMENT:

S.NO.	SOFTWARE	SPECIFICATION	QUANTITY	COST /MONTH	COST
1.	After Effects	Crack Version	1	0	0
2.	Autocad	Free	1	0	0
3.	Blender	Free	1	0	0

Total Rs.0

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THANKYOU