

Development of Vertical Axis Wind Turbine with Flexible Solar Cell Blades

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Research Background

Solar and wind energy are two major renewable energies that have been applied in many cities. Common solar cell integrated wind turbine is made by conventional solar cells and Horizontal Axis Wind Turbines (HAWT). However, the drawback of HAWT is that it is limited by the wind direction. On the other hand, Vertical Axis Wind Turbine (VAWT) can collect wind energy from different directions. In this project, a VAWT with flexible solar cell blades is developed.

Objectives

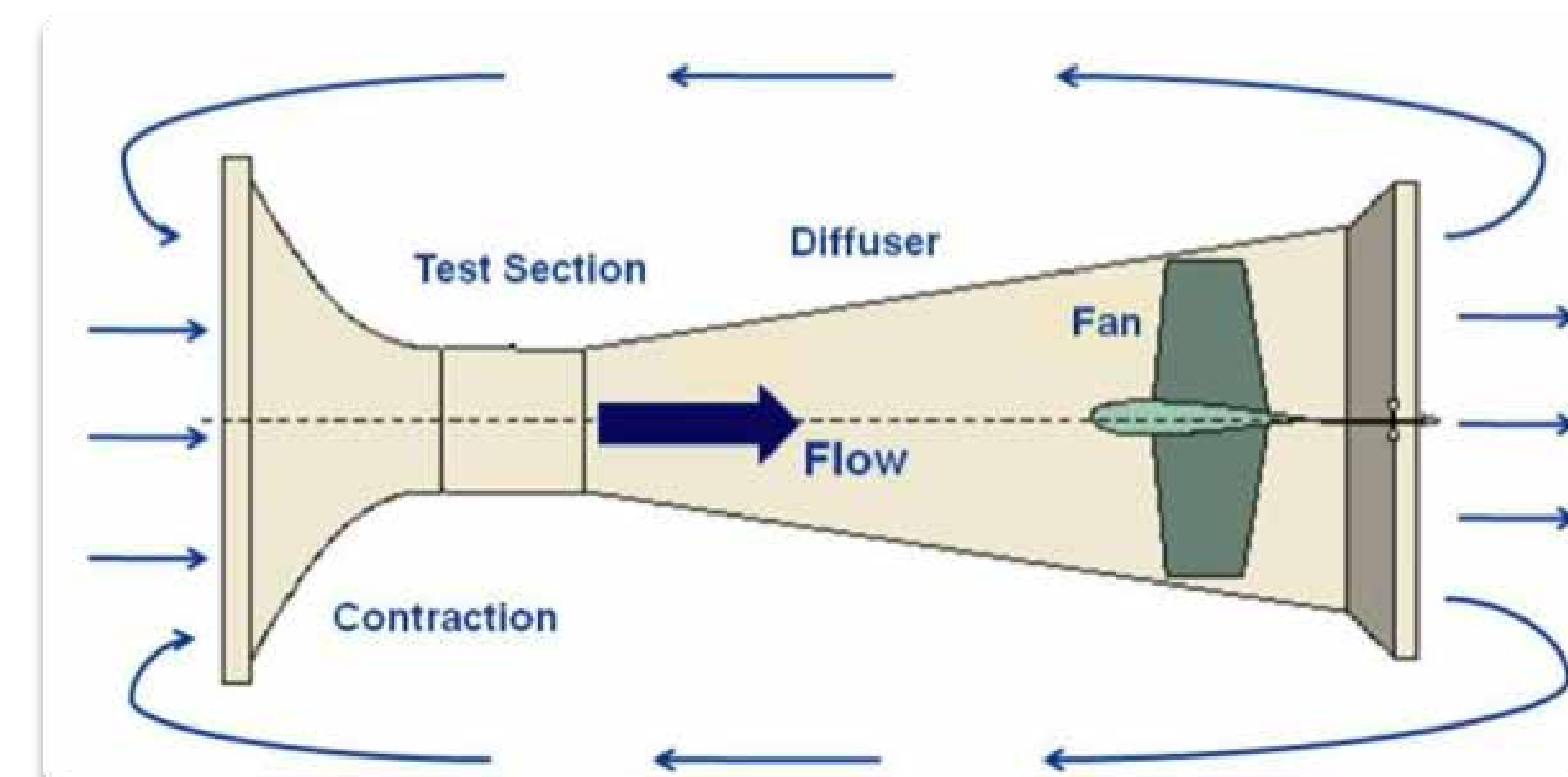
This study aims to develop a novel flexible solar cell integrated VAWT for renewable energy generation. Designs of VAWT with different blades and diameters will be investigated. Physical modeling is conducted to find the optimal angle of the blade.

Methodology

The design of the wind turbine is created by "SolidWorks" and "Fusion 360". The blades and other physical components are made by the 3D Printer. The fabricated wind turbines undergo the wind tunnel and solar panel tests to determine the optimal tilt angle of the blade, and the optimal point between the wind turbine and the solar panel.



Vertical Axis Wind Turbine

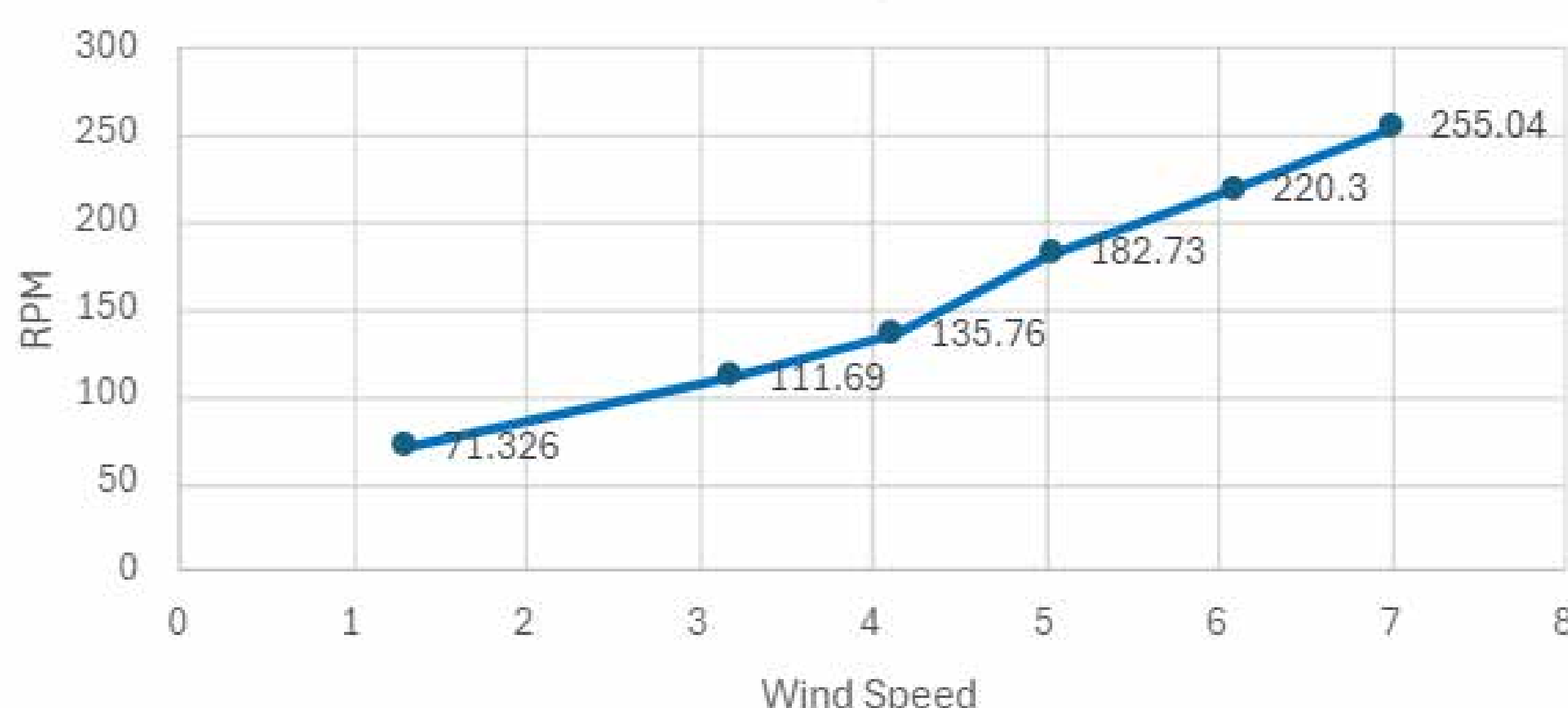


Wind Tunnel Test

Findings

75 Tilt angle	Wind speed m/s	RPM (Revolution per minute)
	1.3	71.326
	3.18	111.69
	4.11	135.76
	5.03	182.73
	6.09	220.3
	7	255.04

75 Tilt angle



Relationship between Wind Speed and RPM

When wind speed = 5m/s					
Tilt Angle	90	75	60	45	30
R.P.M	166.94	182.7	156.3	0	0

When wind speed = 6m/s					
Tilt Angle	90	75	60	45	30
R.P.M	203.5	220.3	192.6	91.5	0

When wind speed = 7m/s					
Tilt Angle	90	75	60	45	30
R.P.M	241.1	255.05	225.61	133.6	0

The effect on different tilt angles with the same wind speed

180 curvature	tilt angle 30	tilt angle 45	tilt angle 60	tilt angle 75	tilt angle 90
Voltage	7.93	7.99	7.89	7.84	7.71
UV situation	1274	1282	1172	1024	1184

120 curvature	tilt angle 30	tilt angle 45	tilt angle 60	tilt angle 75	tilt angle 90
Voltage	7.91	7.84	7.87	7.89	7.82
UV situation	1108	1264	1612	1667	1712

90 curvature	tilt angle 30	tilt angle 45	tilt angle 60	tilt angle 75	tilt angle 90
Voltage	8.05	7.93	7.85	7.89	7.81
UV situation	1159	1276	1185	1256	1362

Voltage of different tilt angles with same curvature space plate

Conclusion

Although a lower tilt angle may reduce the lift force on the blade, it may also decrease drag and turbulence, potentially improving the wind turbine efficiency. After testing, the optimal point between the wind turbine and the solar panel is determined. On a cloudy day with high wind speed, the optimal tilt angle VAWT is 75-degree; while on a sunny day with low wind speed, a 30-degree tilt angle VAWT is more proper.