Wind Lab Report

In this lab we will be looking to explore the effects of blade length, blade configuration, wind speed and blade pitch angle on output power of a turbine.

<u>Things to test:</u>

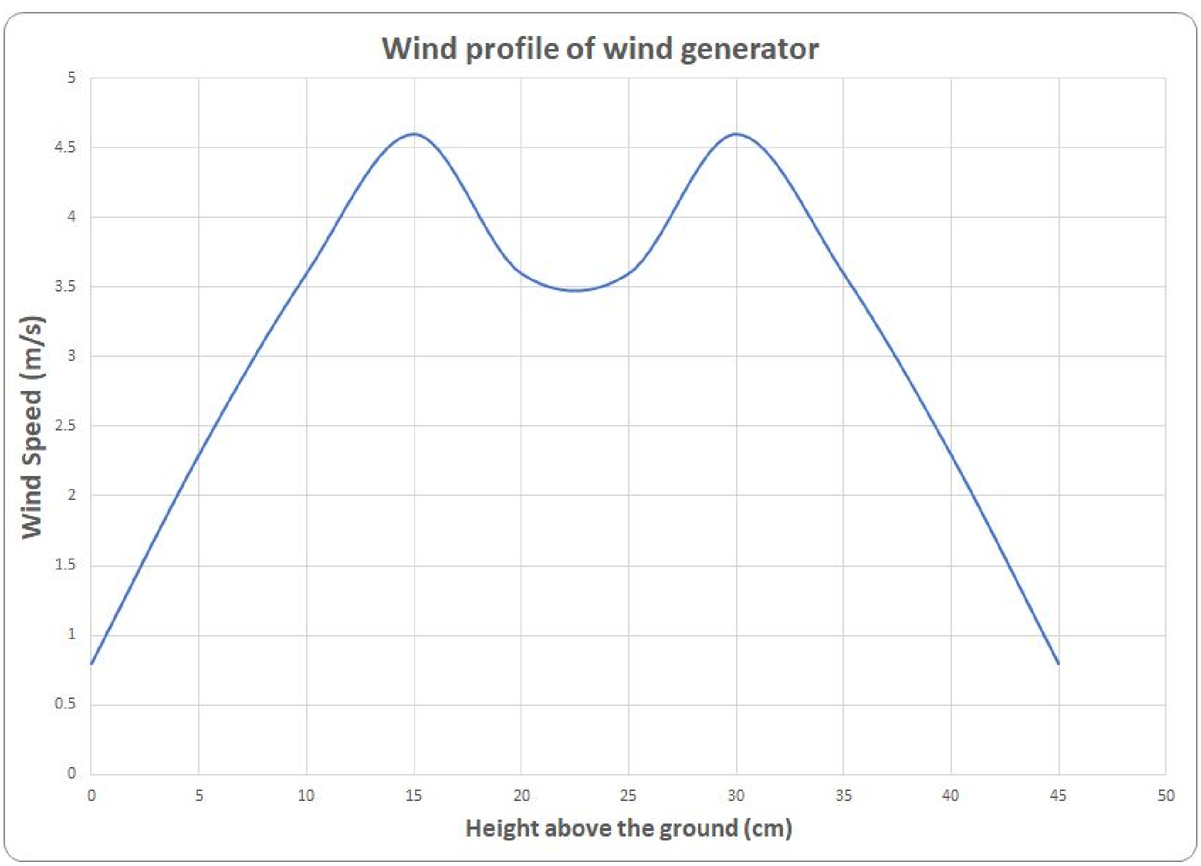
1. 3 blade lengths
2. 3 blade configs (2, 3, 6)
3. 3 angles (10,15,20)
4. 3 wind speeds

Method:

The relationship between the configuration of the blades (2, 3, or 6 blades) and its power output is not dependant on wind speed, pitch, or blade length (ass these values change there will only be a scaling of the curve, the shape will remain constant). Because of this, we will separately measure the three blade configurations once, and then move on to measuring the rest of the variables. We will begin with the largest blade length and a 20 degree blade pitch, we will then measure the voltage and amperage of the turbine for the three speeds in descending order. Then we will alter the pitch of the blade and repeat for pitches of 15, and 10 degrees. Once one blade length has been measured, we will switch the blades and repeat the process.

Wind speed profile

Using an anemometer, the wind speed provided by the fan at a distance of 0.5m was measured. These measurements begin at ground level, and progress upwards to the top of the fan.



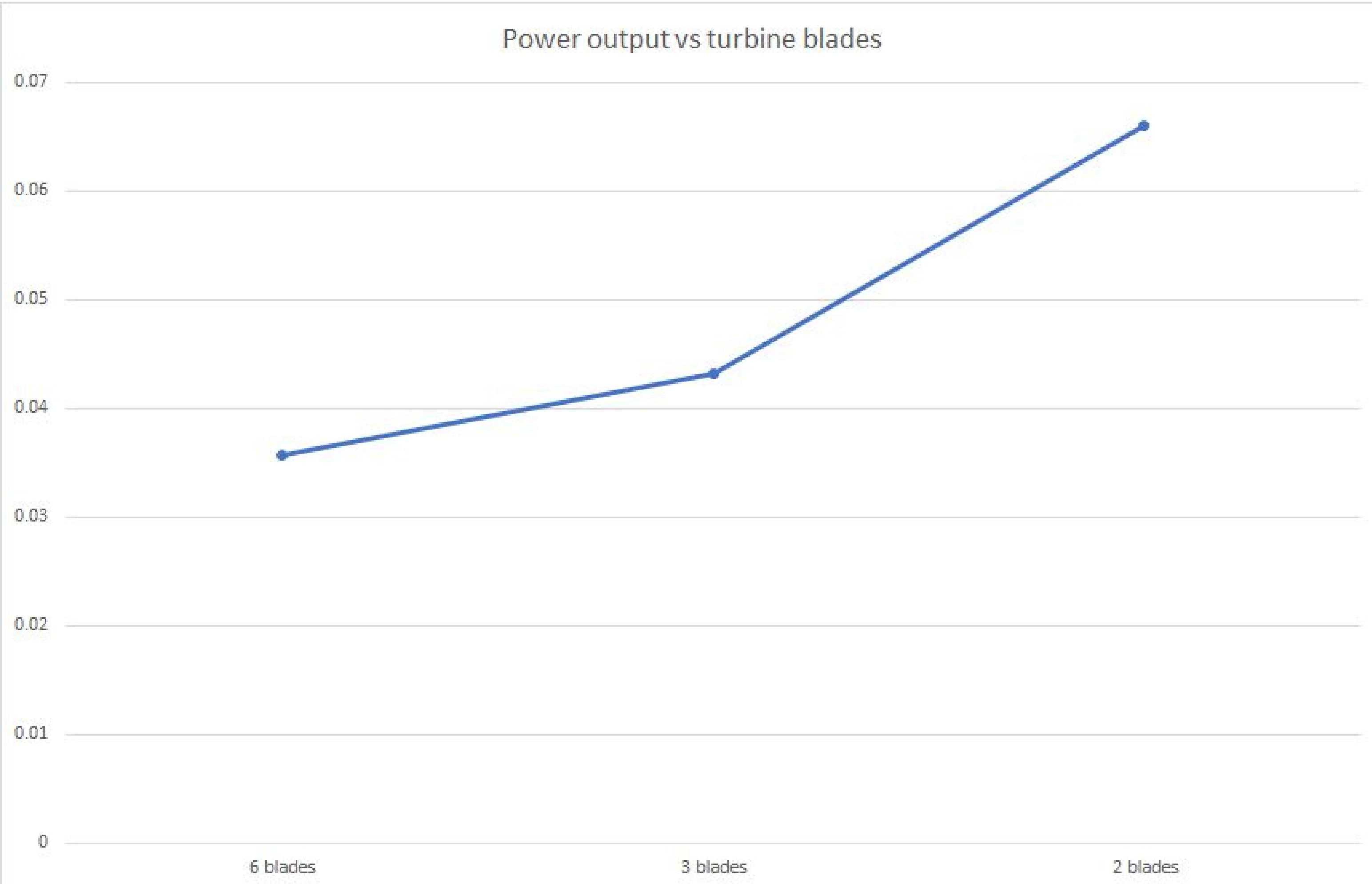
Wind speed vs Power output

Form the figure above, we can see that the smallest blade size output the largest power at all three wind speeds. This can be related to our wind profile of our fan. From this profile we can see that the greatest wind speeds are achieved at a height of 15cm and 30cm respectively, with a plateau directly in the middle of the fan, however on either side of the 15cm, and 30cm mark there is a rapid decrease in the wind speed. The small fan blades were situated directly in this area of highest wind speed, allowing for the greatest percentage of the blades surface area to be acted upon by wind. With larger blades that would reach beyond the central area of high wind speed, there is just an increase in the rotational inertia of the blade, but no increase in the force of the eair acting on the blade, and therefore there is a decrease in the power output.

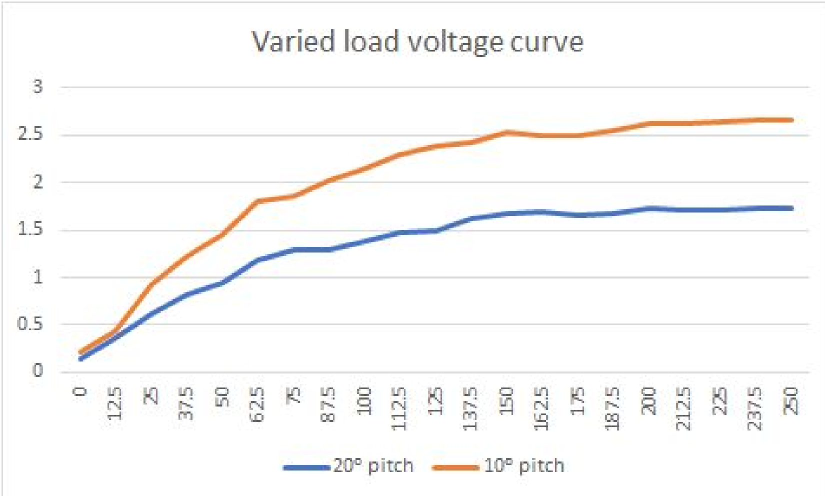
Angle of blades vs Power

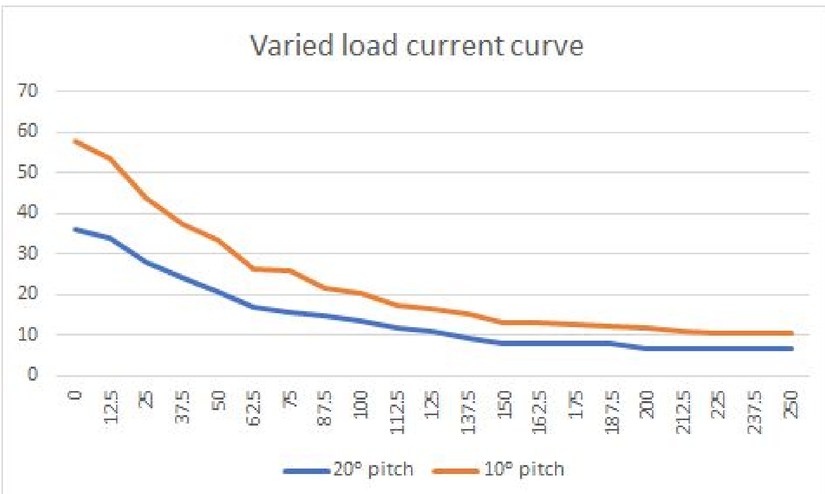
From the three tested angles, we can see that a pitch angle of 15 degrees was the most efficient, and output the greatest power. When going past an angle of 15 degrees, the power output drops drastically. This is because as you increase the angle of the blades you are effectively decreasing the total area of the blade on which the wind will act, and thereby decrease the power output. With angles less than 15 degrees, the kinetic energy stored within the wind is no longer effectively being converted into rotational kinetic energy as there is no clear path for the air to move in, which one again leads to a decrease in the power output.

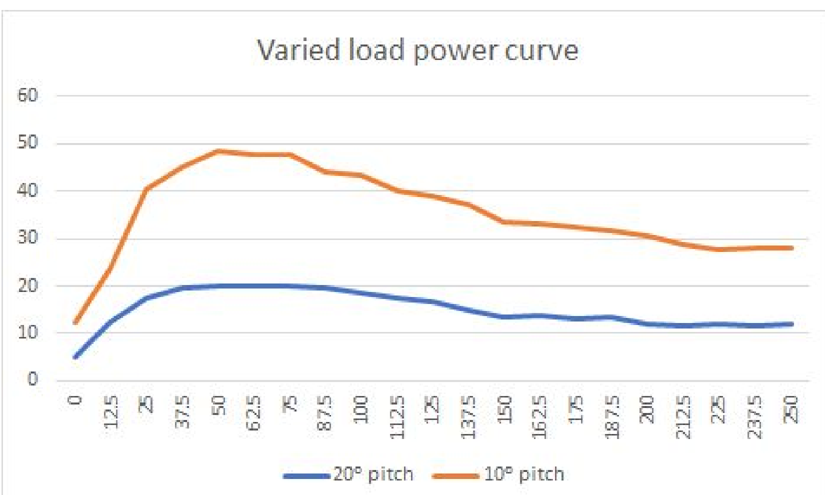
Blade configuration vs power



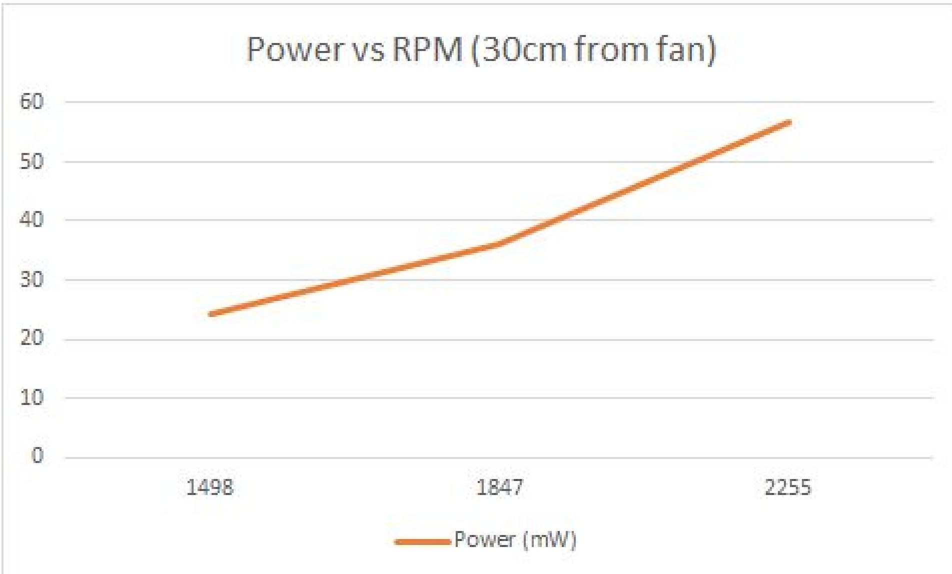
In the graph above we can see that as the number of blades on a turbine decreases, the power output of the turbine increases. It was also witnessed in the lab that as the number of blades decreased, the ‘cut in speed’ (the wind speed at which the turbine will begin to generate power) increased drastically. From this we can determine that within areas of high wind, a lower number of blades per turbine will output the largest power. And for areas of low wind speed, the only possible configuration will be to use multiple blade turbines.

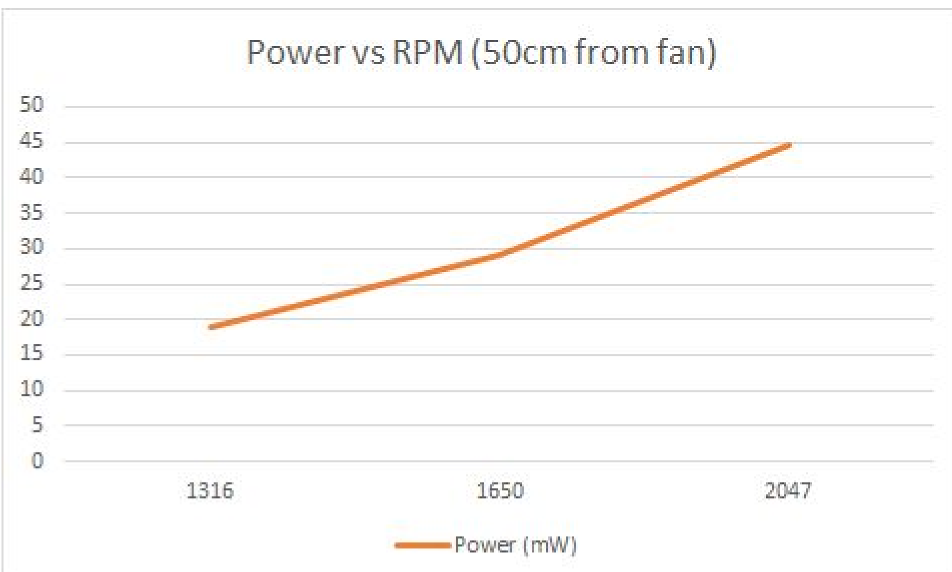






From the above curves, we can see that as the load on a system increases, the voltage across the load will increase, and the current through the load will decrease. This means that at the point where the voltage and the current are equal, there will be the highest total power output of the system. We can also see that with the 20° pitch, there is a much lower current and voltage within the system, and therefore a much lower power.





From these curves we can see that as you increase the fan speed, the RPM of the turbine will increase. We can also see that the close the turbine is to the fan, the higher the RPM will be of the turbine. From this we can say that the faster the RPM, and thereby the faster the wind speed, the greater the power output of the turbine.