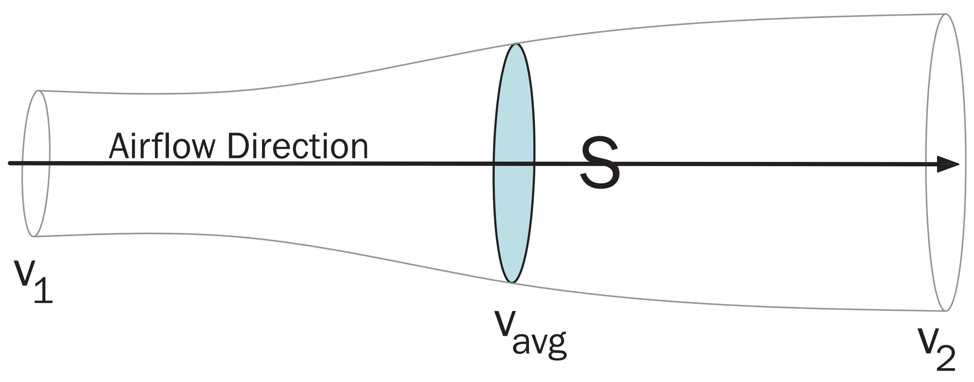
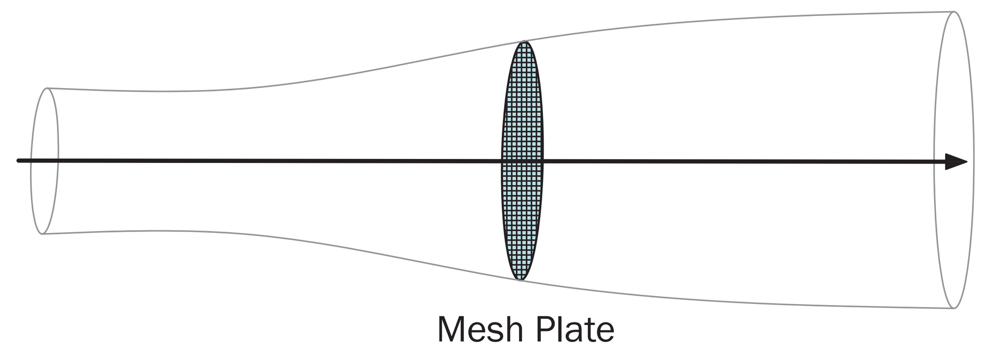
Turbine Research and Design

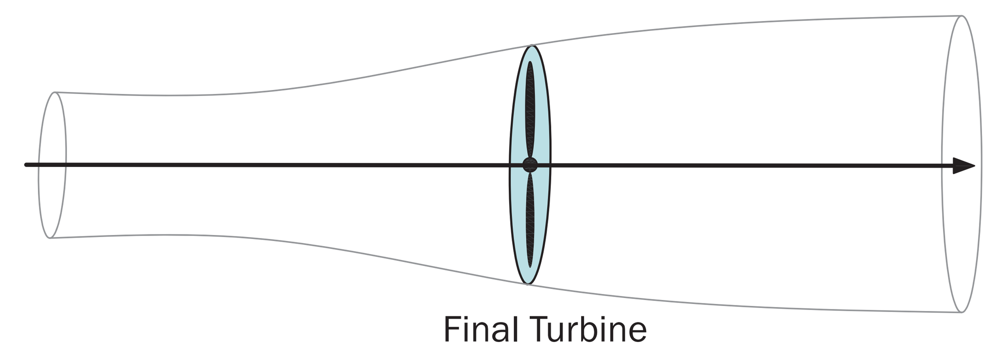
Ideal Turbine Characteristics



A wind turbine's ideal efficiency can be derived using Betz' Law. By analysing the fluid dynamics through a plate that provides the pressure drop associated with a wind turbine, one can calculate the most ideal power output of the turbine.

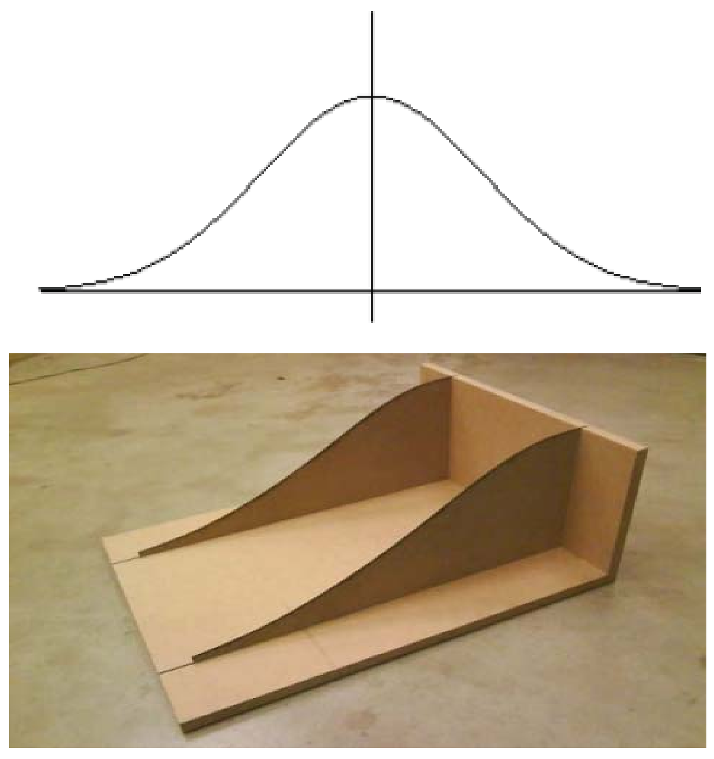


To determine the theoretical power output a of a turbine a mesh plate has been used during testing. Using this technique one can simulate the potential power output of a turbine.

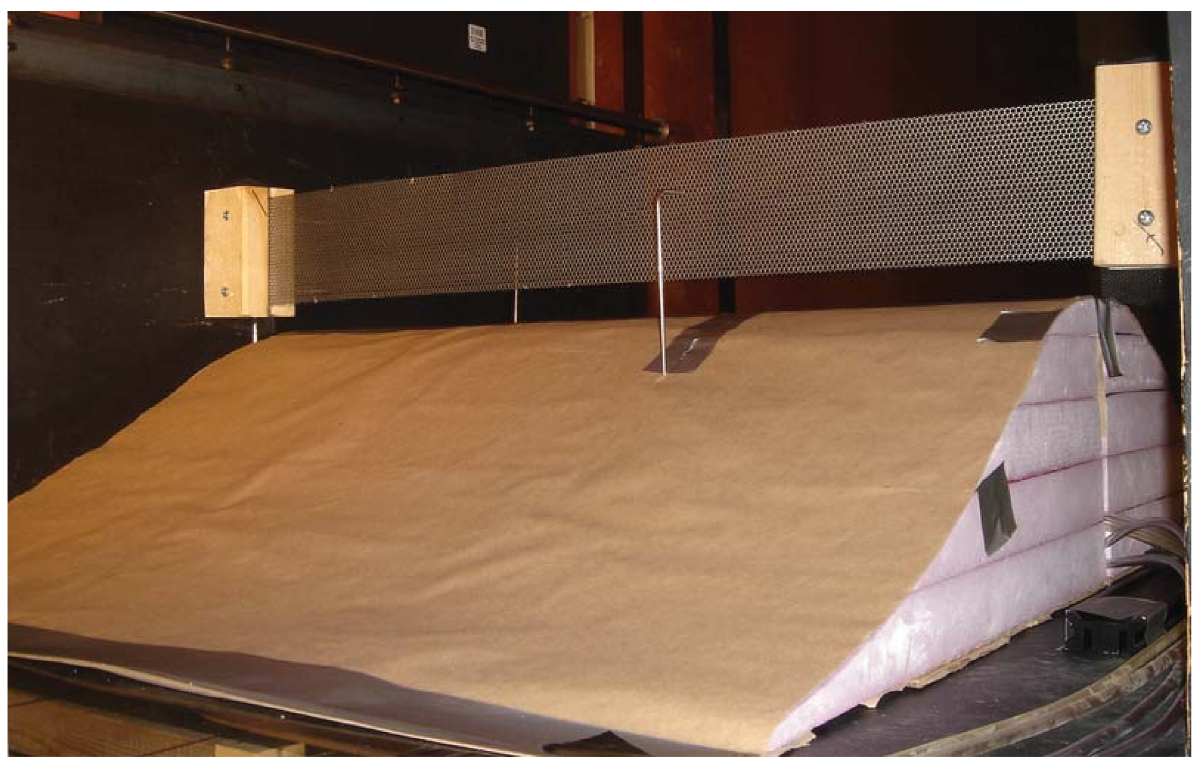


Once the power output is found through the testing of the mesh plate a turbine can be designed and further tested to create the ideal results that are desired.

Shape Design



Elevation view and half of the form used to create the Gaussian curve for mesh and surface testing



Final constructed shape with mesh attached mounted in the wind tunnel for testing. Located in the center of the picture is one of many pitot tubes used for date collection.

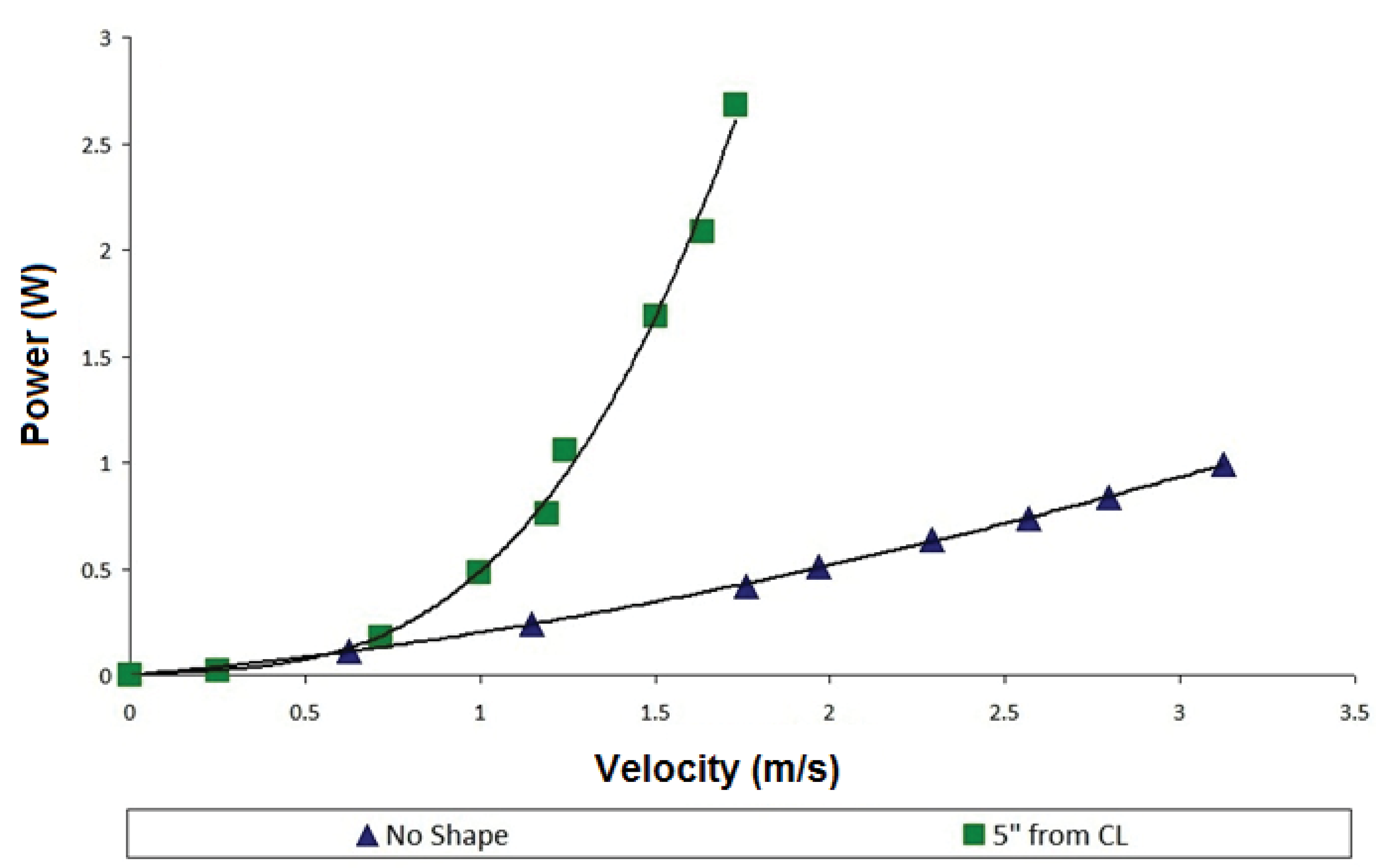
To increase turbine efficiency a shape was developed to increase the rate of airflow moving through the turbine

A Gaussian shape was chosen as the initial shape in which the mesh was to be mounted upon

The Gaussian curve provided an ideal starting point as research was readily avaibile to determine the behavior of airflow over the shape

Final Analysis and Conclusions

Expected Power Output vs. Wind Speed



By introducing a curved shape in which to alter airflow near a turbine the flow of air accelerates

The increase in airflow allows for a high power output from the turbine with a smaller initial velocity

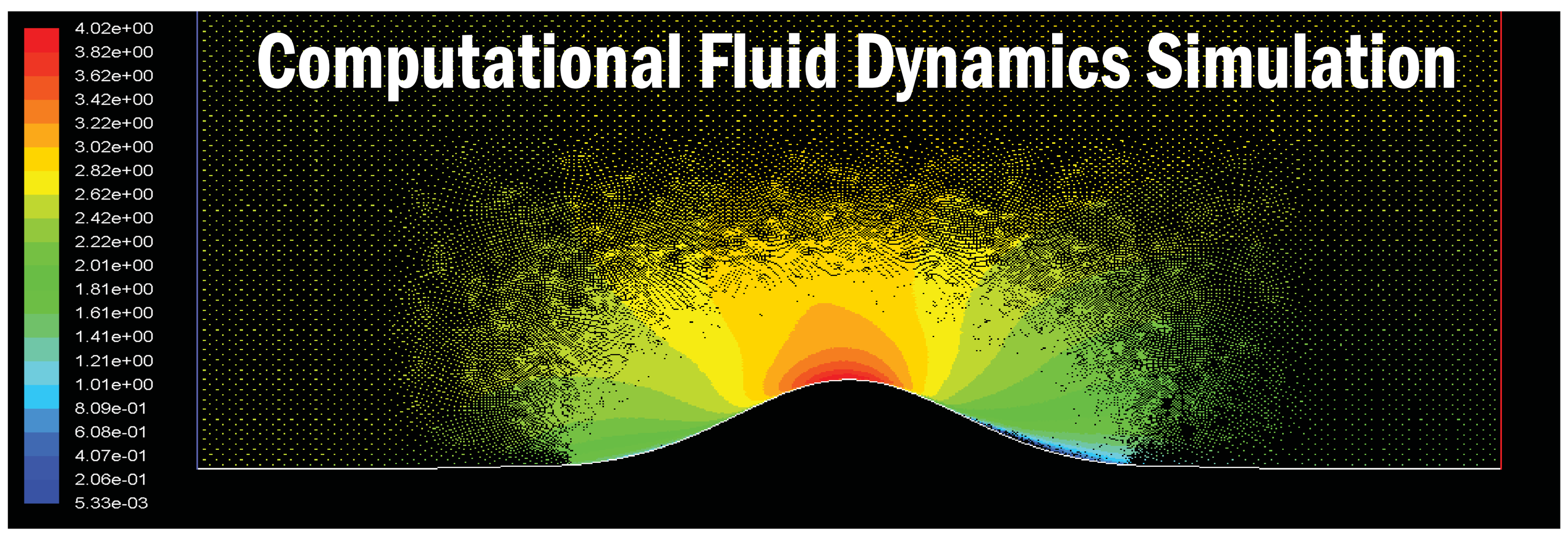
Calculated Power Output

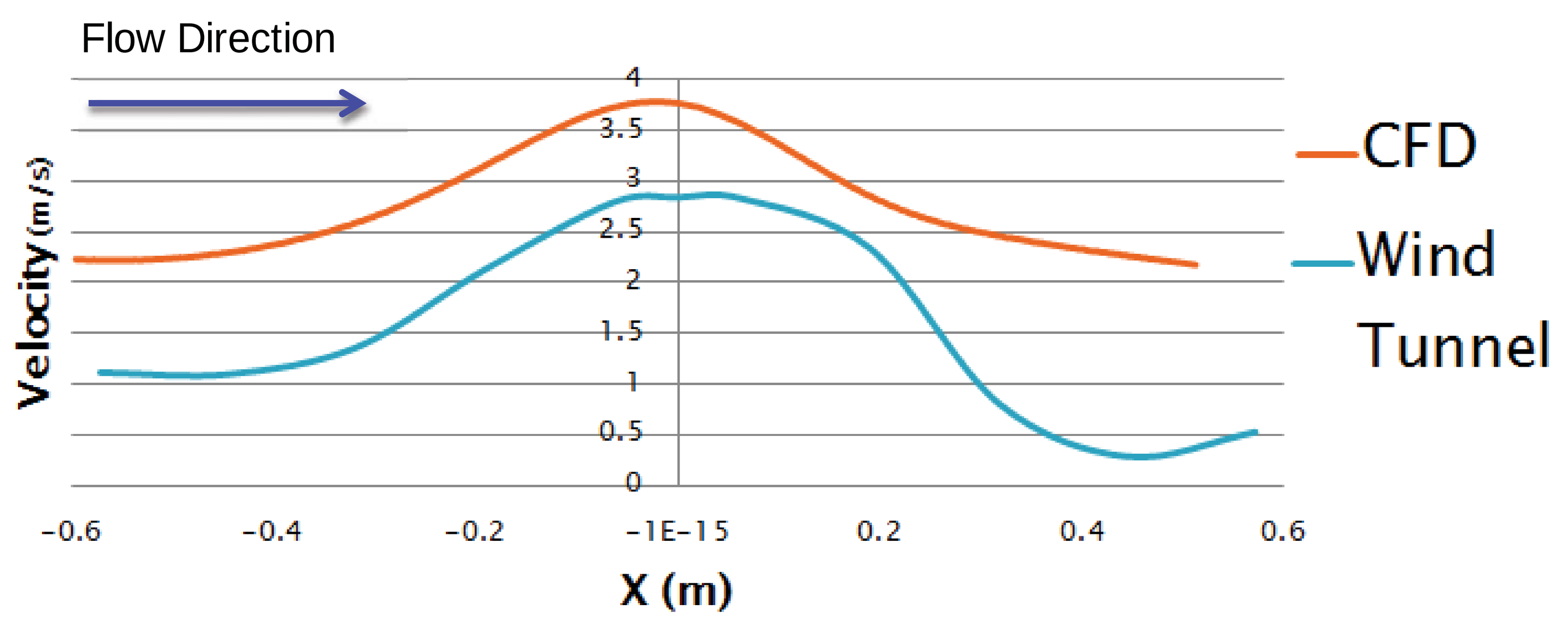
Power Output per Area:

Wind blowing at 5 m/s=11.2 mile/hr	398 kW-hr/m^2 annually
Wind blowing at 10 m/s=22.4 mile/hr	3182 kW-hr/m^2 annually
Wind blowing at 15 m/s=33.6 mile/hr	10,740 kW-hr/m^2 annually

Power Output for area of 0.137m^2=(6in *0.9m)

Wind blowing at 5 m/s=11.2 mile/hr	54.53 kW-hr annually
Wind blowing at 10 m/s=22.4 mile/hr	435.9 kW-hr annually
Wind blowing at 15 m/s=33.6 mile/hr	1471 kW-hr annually





Through the use of a computational fluid dynamics (CFD) simulation it was found that the velocity of the airflow reaches it maximum point at the top of the Gaussian shape

Along with data collected from the CFD simulation tests run on a similarly modeled shape also shows the airflow reaches its maximum velocity at the top of the curved surface

Estimated annual power production of a wind turbine mounted on a Gaussian curve

IPRO 323

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