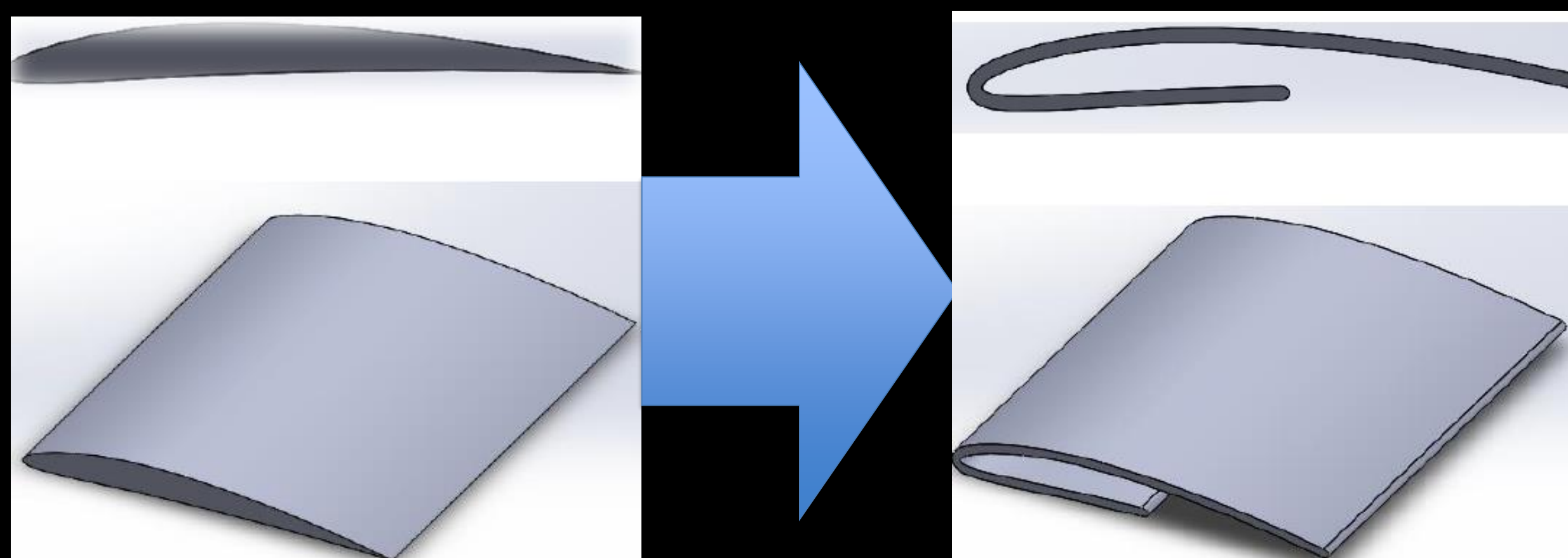


## OBJECTIVES

- Using both of Lift and Drag Forces into working in synchronization on a Vertical Axis Wind Turbine (VAWT). Therefore, combining the famous Drag-typed Savonius VAWT and the Lift-typed Darrieus VAWT.
- The combination of the models by applying the J-Shape concept will allow the Drag Coefficient to increase. Consequently, reducing the Starting Torque Coefficient, which is the main problem when it comes to VAWT.

## APPROACH

This is achieved by creating a J-shaped airfoil; by removing the plain teardrop shape and replacing it with the J-shaped model. The J-shaped model from its name looks like the letter J, with a certain thickness. This formation will allow the Lift Force to be applied on the outer surface of the airfoil, in addition to the Drag Force that will be applied to the J-shaped airfoil's inner surface.

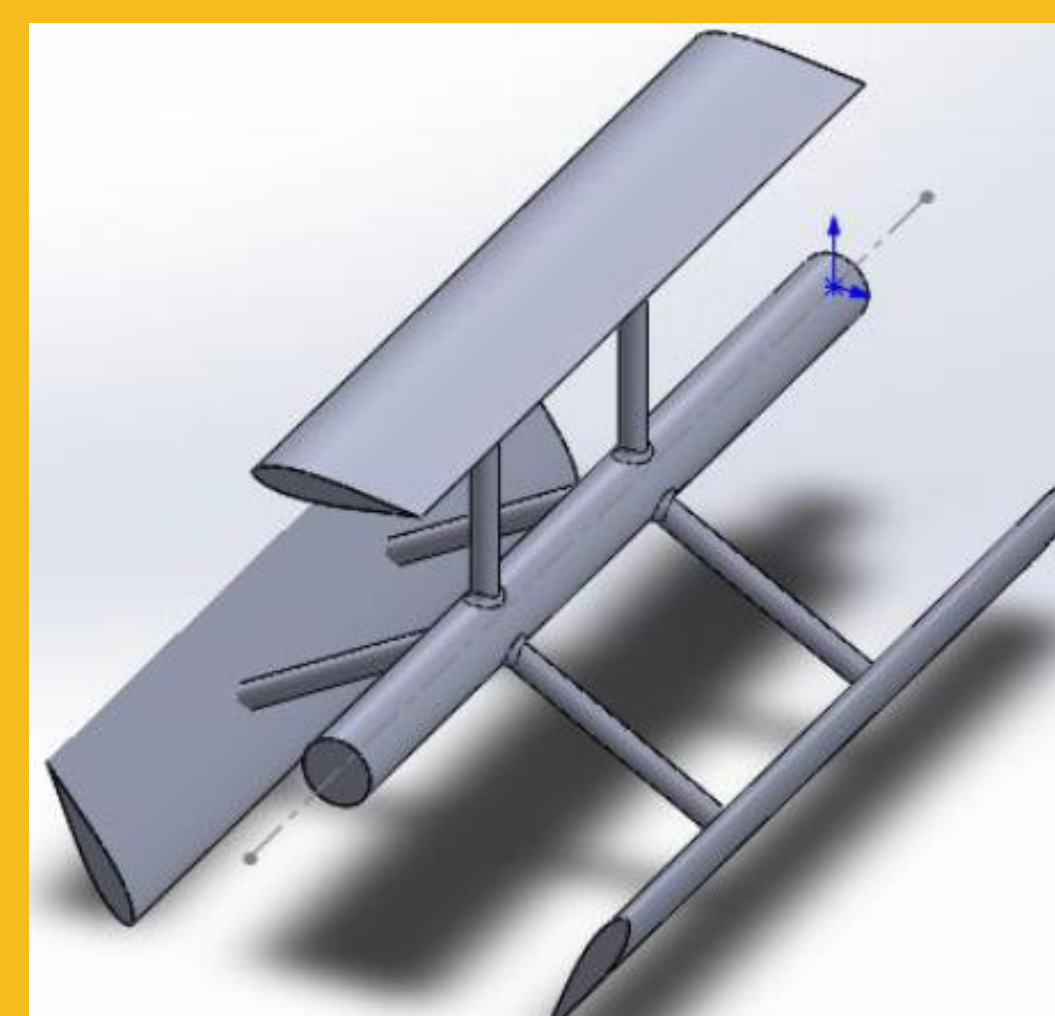


## CONTACT INFORMATION

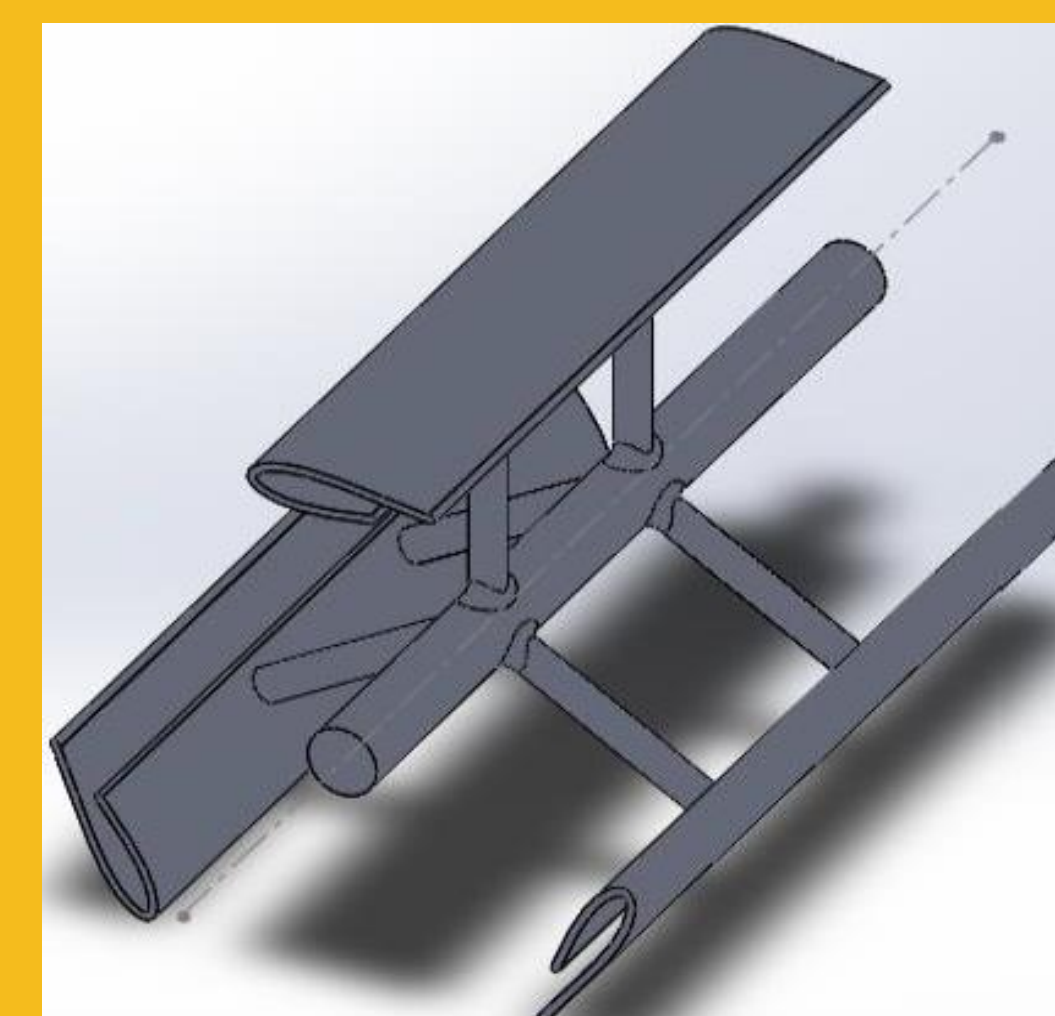
Omar Habash  
Email: [ohabash@uwm.edu](mailto:ohabash@uwm.edu)  
414-600-3093

## METHODOLOGY

- The J-shaped model was applied on the S1046 symmetrical airfoil. The S-1046 has a low Drag coefficient. The whole study is made by applying Computational Fluid Dynamics (CFD) using STAR-CCM+. Two VAWTs (Regular S-1046 Turbine & J-Shaped S-1046 Turbine) have been tested with the same parameters, in order to compare the Lift & Drag Coefficients (Cl & Cd).



Regular Turbine



J-Shaped Turbine

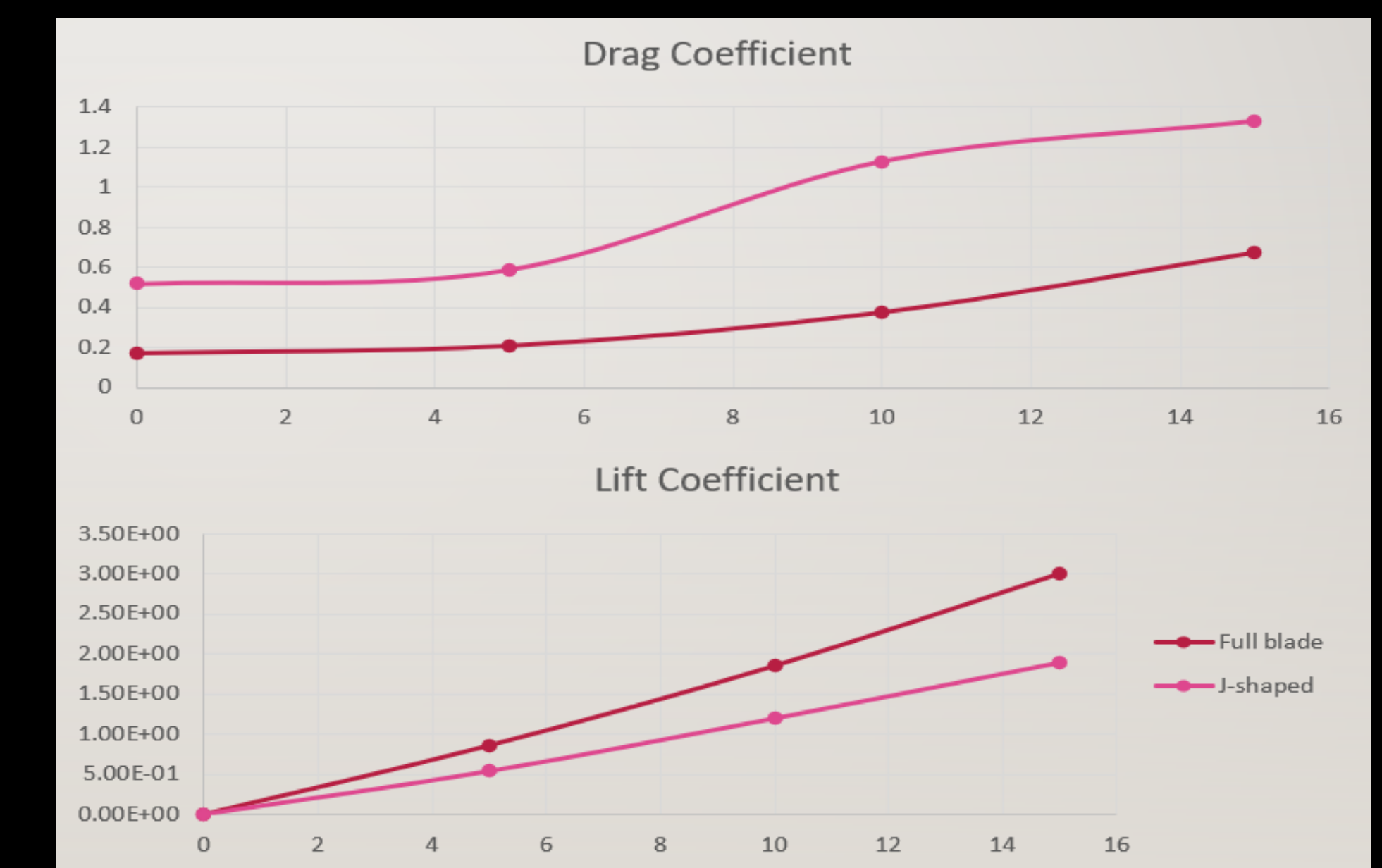
- The design parameters of the turbines are:

Chord	5 cm
Turbine D	19 cm
Main Shaft D	2 cm
Main Shaft H	28 cm
Side Shafts D	1 cm
Blades H	25 cm

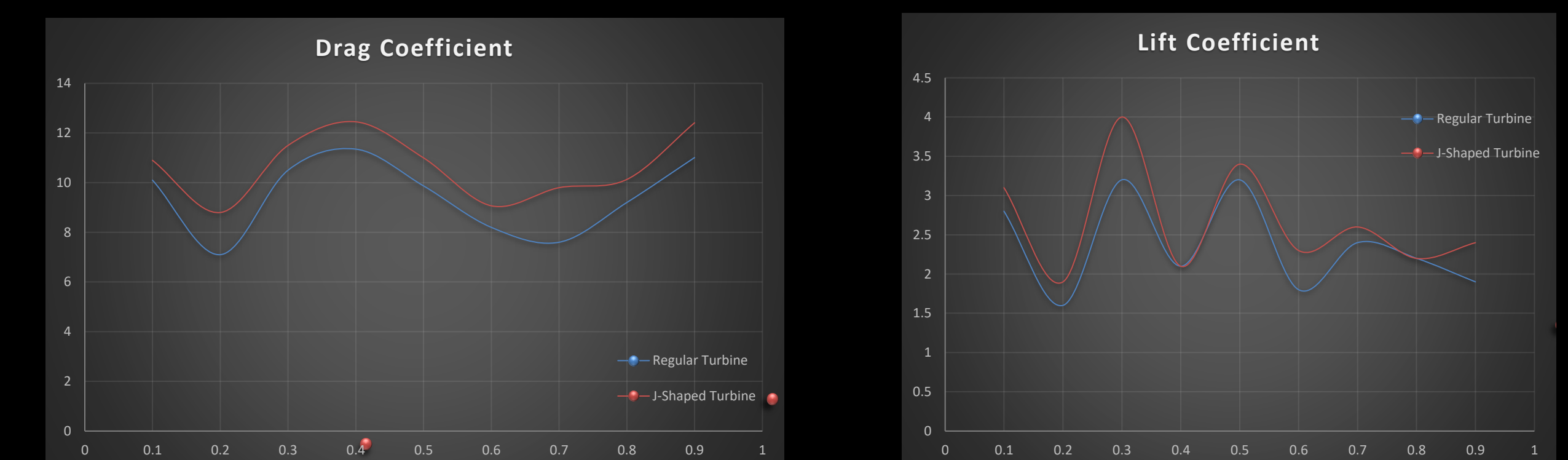
- The design parameters were selected to keep enough wall distances when testing experimentally in the UWM Wind Tunnel.
- Simulations were done at 4.5 million cells & 12 prism layers. Large Eddy Simulation Turbulence model was selected, wind velocity is 15 meter per second. TSR (Tip Speed Ratio) is 4.

## RESULTS

- Applying the J-Shaped concept on the S-1046 led to increasing Cd by 3 times and reducing the Cl by 1/3.



- For the Turbines, the results fluctuated due to the rotation. When applying the J-shape, Cd increased from 10% to 20%. However, for Cl went from 0% to 20%. Over the span of 1 second.



## CONCLUSION

- Although Cl decreased on the blades, it either stayed the same or increased compared to the regular Turbine. This indicates that the Power Coefficient will remain consistent or increase, which was a concern to begin with.
- J-Shaped concept has proven to showcase a remarkable increase in the J-Shaped Turbine's Cd, which automatically reduces the Starting Torque Coefficient.