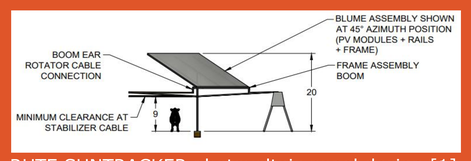
WIND FORCES ON PHOTOVOLTAIC PANELS

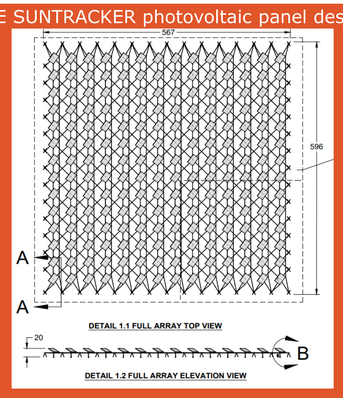
Computational Fluid Dynamics Model using Ansys Fluent

EXECUTIVE SUMMARY

- **Agrivoltaics -** the combination of photovoltaic (PV) panels on traditional agricultural land.
- **Convoy effect** - The reduction of wind force by blockage from a solid object
- Project analyzed wind forces on client's PV design: the RUTE SUNTRACKER array [1].
- First, calculations were done to estimate expected wind forces on PV panels, followed by modeling of those forces using the computational fluid dynamic (CFD) program Ansys Fluent.
- Initial model results aligned with original hypothesis & generally expected trends.
- Calibration & validation were unable to be performed due to time constraints—leaving model unreliable. Further testing must be done.



RUTE SUNTRACKER photovoltaic panel design [1]



RUTE SUNTRACKER array design [1]

PROJECT BY

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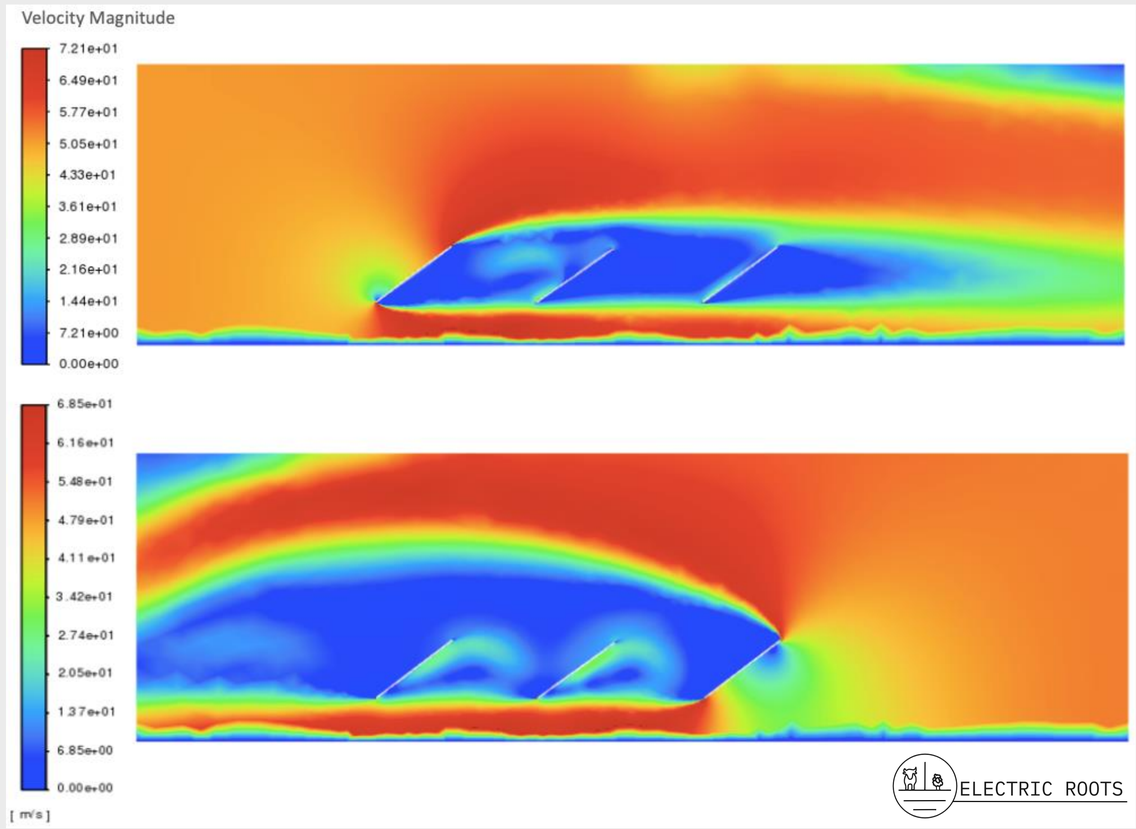
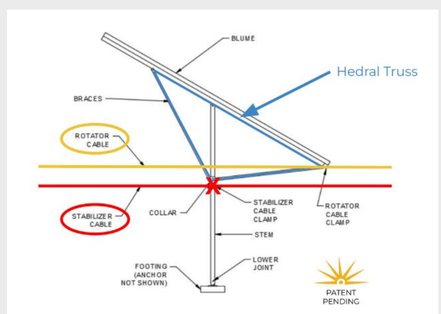


METHODS

Our project was completed in 5 steps:

- A study conducted by NASA Ames Laboratory was evaluated [2].
- Next, two wind loading equations were studied as a reference point for calibration and validation of models. The first was The American Society of Civil Engineers (ASCE) equations for wind loads on solar panels. The second was the drag force equation using force coefficients.
- Model of a single heliostat from the NASA Ames Laboratory study was developed for future calibration [2].
- A model of a single RUTE SUNTRACKER PV panel was built in Ansys Fluent 2D.
- Finally, a series of three RUTE SUNTRACKER PV panels were modeled in 2D using Ansys Fluent.



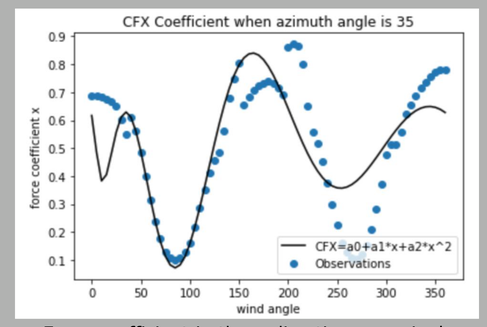
RUTE SUNTRACKER cable system [1]

RESULTS

8 trials were completed in Ansys Fluent:

Scenario	Wind Speed	Panel #	Wind Inlet	Wind Outlet
1	70 mph	1	Front	Back
2	70 mph	1	Back	Front
3	70 mph	3	Front	Back
4	70 mph	3	Back	Front
5	114 mph	1	Front	Back
6	114 mph	1	Back	Front
7	114 mph	3	Front	Back
8	114 mph	3	Back	Front

- Results of these scenarios are presented as velocity magnitude charts—like the one show to the left.
- Lower velocity areas are in blue, with the lowest velocities right behind the PV panel, which was what the team expected to find.
- The convoy effect can be seen by the areas of low velocity (blue) in the picture to the left.



Force coefficient in the x-direction on a single heliostat [2]

CONCLUSION

- If the convoy effect reduces wind forces on inner panels, the support cables and outer pitch poles of the RUTE SUNTRACKER array will experience lower than expected forces. The materials for interior panels, support cables, and pitch poles could then be scaled down to reduce manufacturing costs.
- Further calibrated modeling work is needed, and a 3D model is recommended.
- Our clients at RUTE are currently in the process of making a prototype SUNTRACKER array. We hope these findings can assist in future research and development decisions.

[1] RUTE Foundations. (n.d.). Rute SUNTRACKER. RUTE. Retrieved October 24, 2022, from https://www.rutefoundations.com/suntracker

[2]NASA Ames Fluid Mechanic Laboratory. (2011). *Heliostat Wind Tunnel experiments*. Retrieved February 3, 2023, from https://www.google.org/pdfs/google_heliostat_wind_tunnel.pdf