U.S. DEPARTMENT OF ENERGY

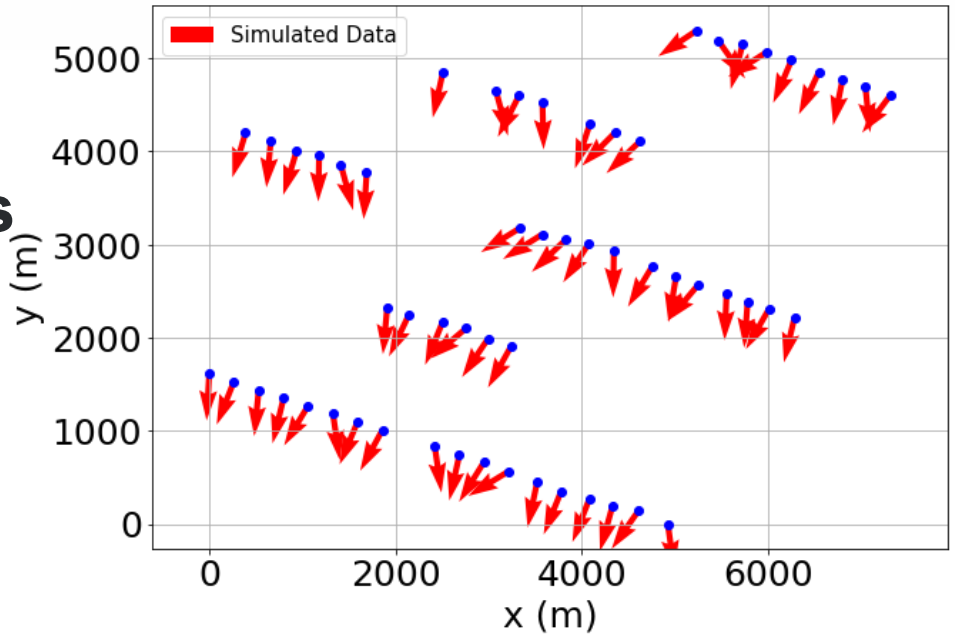
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Project Title: Small Business Vouchers – WindESCo

Project ID #T22

Paul Fleming, Jennifer King

Presenter Organization



FY17-FY18 Wind Office Project Organization

"Enabling Wind Energy Options Nationwide"

Technology Development	Market Acceleration & Deployment
Atmosphere to Electrons	Stakeholder Engagement, Workforce Development, and Human Use Considerations
Offshore Wind	Environmental Research
Distributed Wind	Grid Integration
Testing Infrastructure	Regulatory and Siting
Standards Support and International Engagement	
Advanced Components, Reliability, and Manufacturing	

Analysis and Modeling (cross-cutting)

Project Overview

T22: Small Business Vouchers - WindESCo

Project Summary

- NREL and WindESCo investigated the application of NREL's consensus yaw control at a site where WindESCo hardware for wind farm control is being deployed. A hybrid analysis using data collected by WindESCo showed the potential for a more than 2% increase in annual energy production (AEP) if consensus control is deployed.

Project Objective & Impact

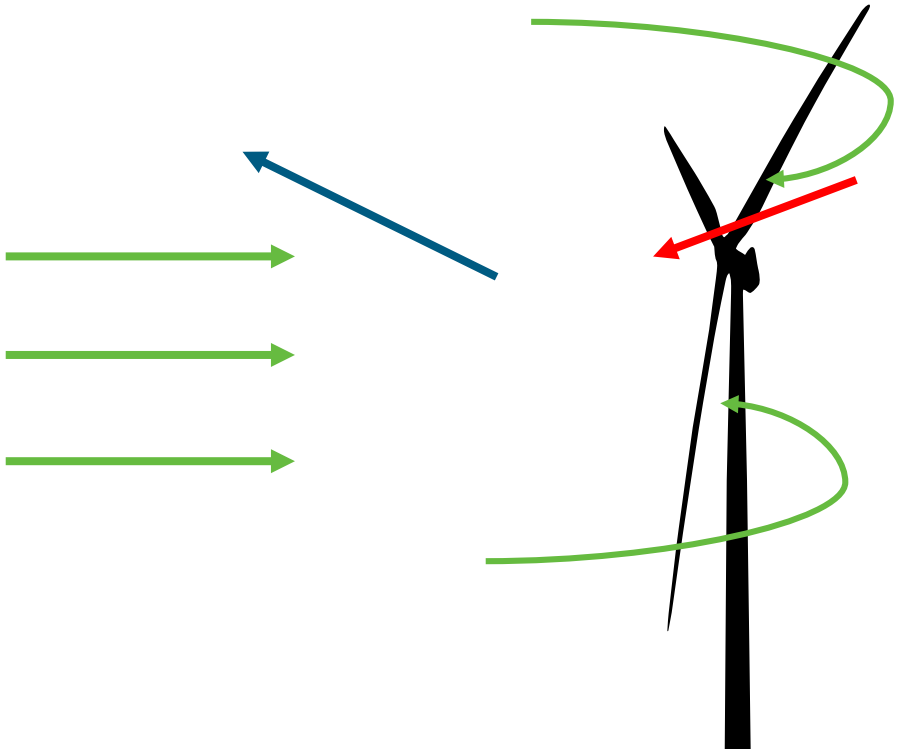
- Wind farm controls have the ability to increase wind farm power production, reduce loads, and increase certainty and reliability. In this project, consensus control—a technology developed by NREL—is investigated for application at a commercial wind farm.

Project Attributes

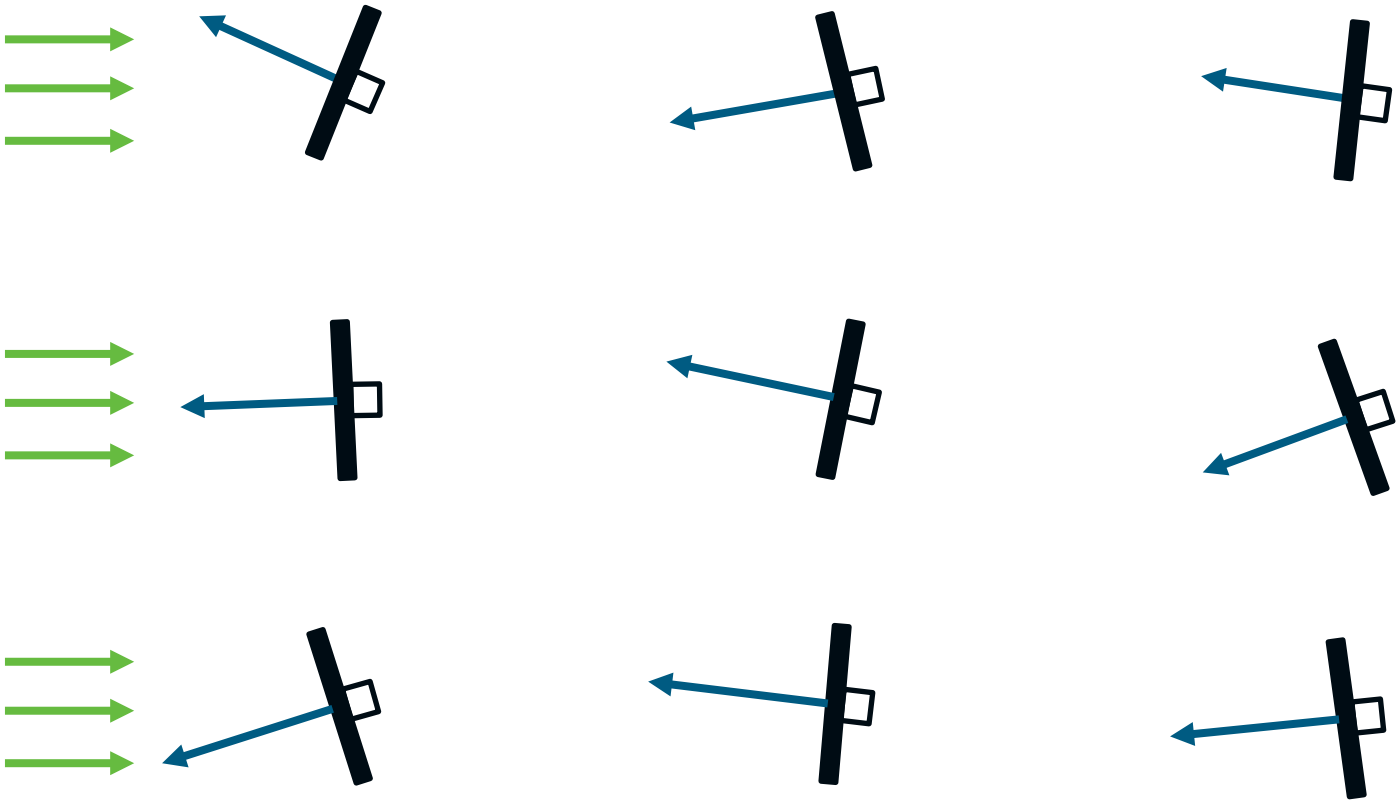
Project Principal Investigator(s)
Jennifer King
DOE Lead
Mike Derby
Project Partners/Subs
Nathan Post - WindESCo
Project Duration
Oct. 2017–Dec. 2018

Technical Merit and Relevance

- Turbines operate individually, optimizing their own performance.
- Yaw position is determined by a wind direction sensor on the back of the nacelle.
- This sensor is often noisy and can lead to yaw misalignment of the turbine.



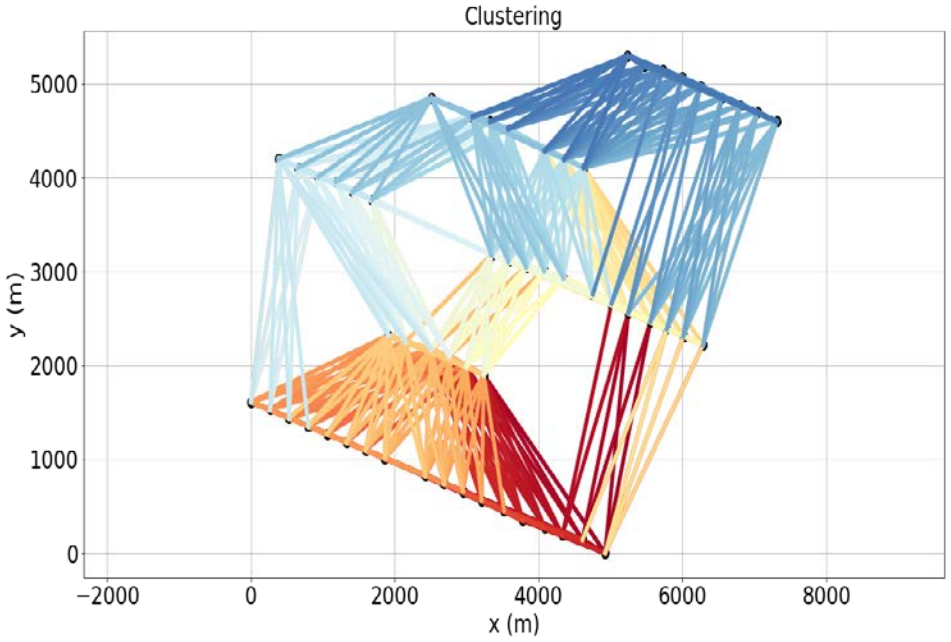
Technical Merit and Relevance

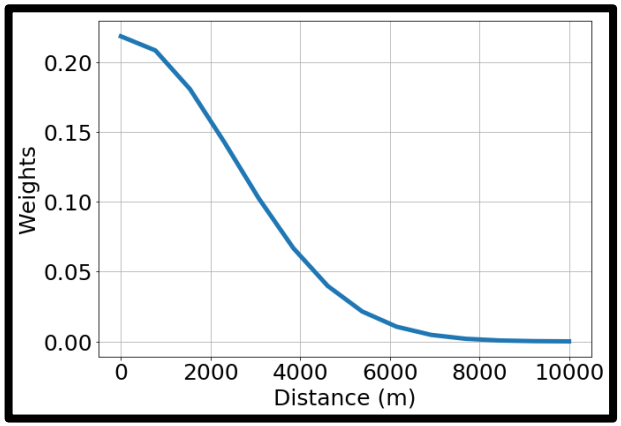


Is there a better way?

Approach and Methodology

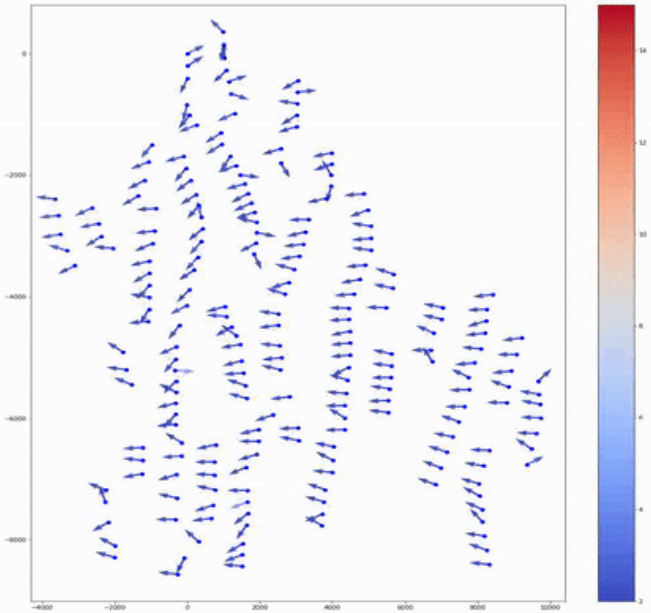
- By coordinating turbines through sharing local information, wind plant performance can be improved.
- For consensus control, clusters of neighboring turbines are defined.
- Measurements of neighboring turbines are weighted by their distance from the cluster's central turbine.



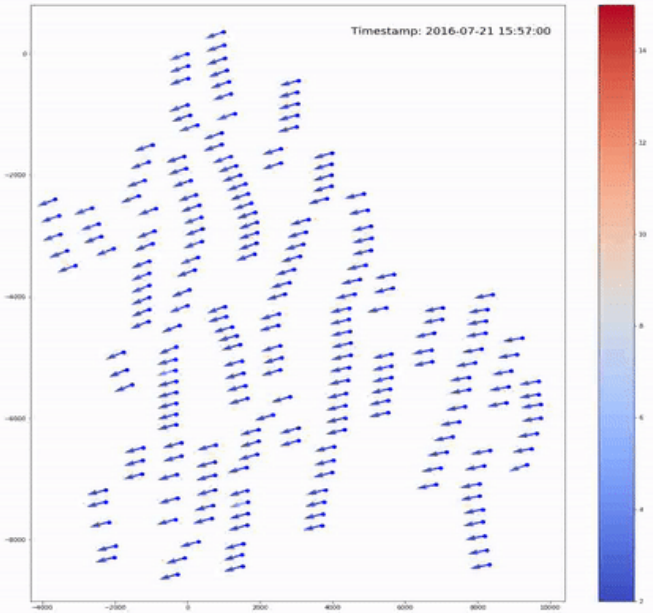


Approach and Methodology

Actual SCADA Data



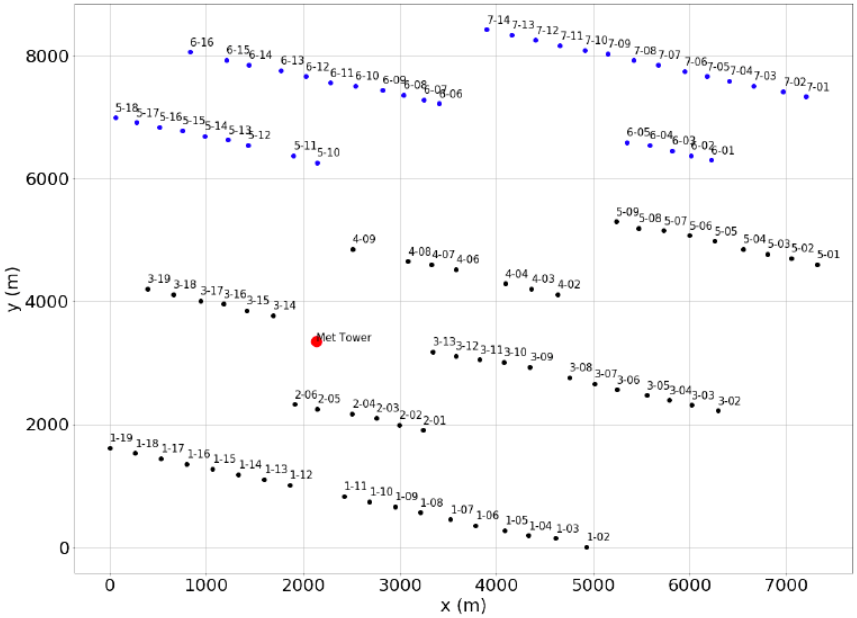
Estimated Wind Direction



Potential for an additional >2% AEP gain

Approach and Methodology

- Wind-direction consensus theory was developed by the NREL Laboratory Directed Research and Development Project
  - "A Framework for Autonomous Wind Farms: Wind Direction Consensus", Annoni et al. 2019
- **Case study** using a data set for 58 turbines provided by WindESCo
  - Evaluate the theoretical potential for **improvement in annual energy production (AEP).**
  - **Reduction in yawing** if the approach was implemented at the wind farm.

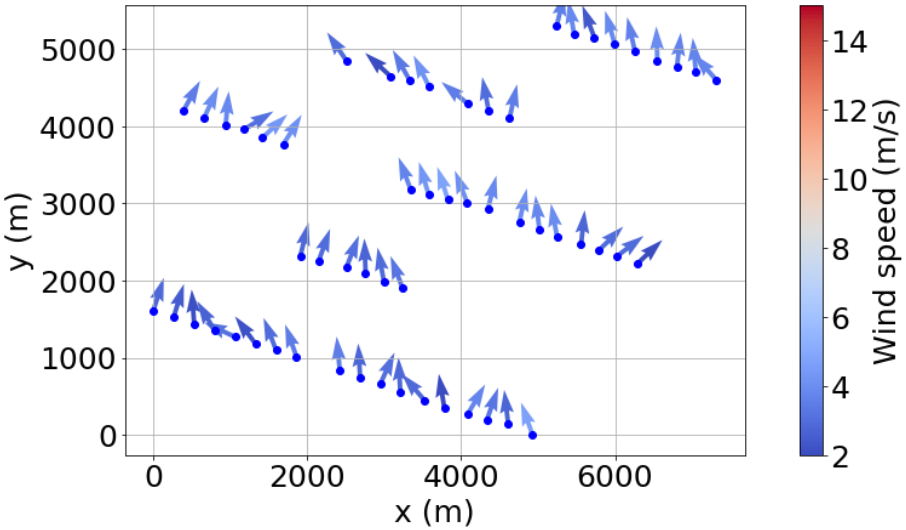


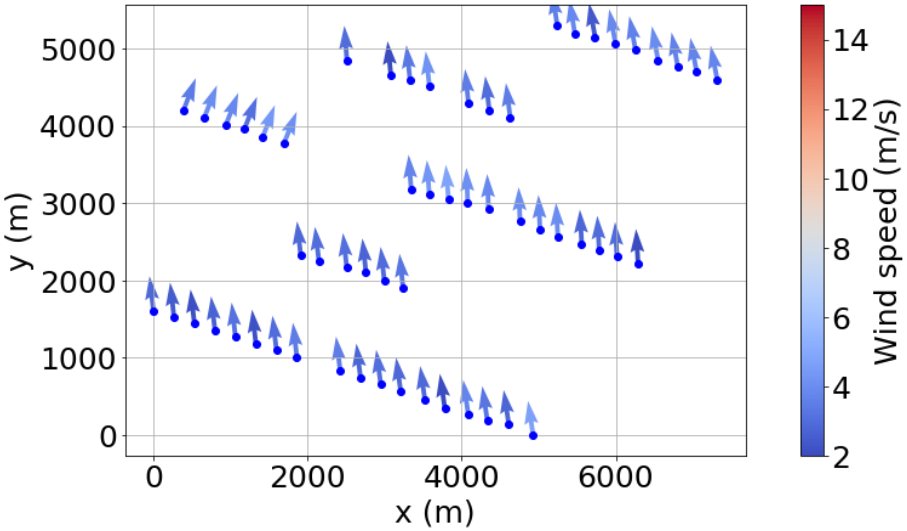
Collaboration effort funded by the U.S. Department of Energy Small Business Voucher Program

Accomplishments and Progress

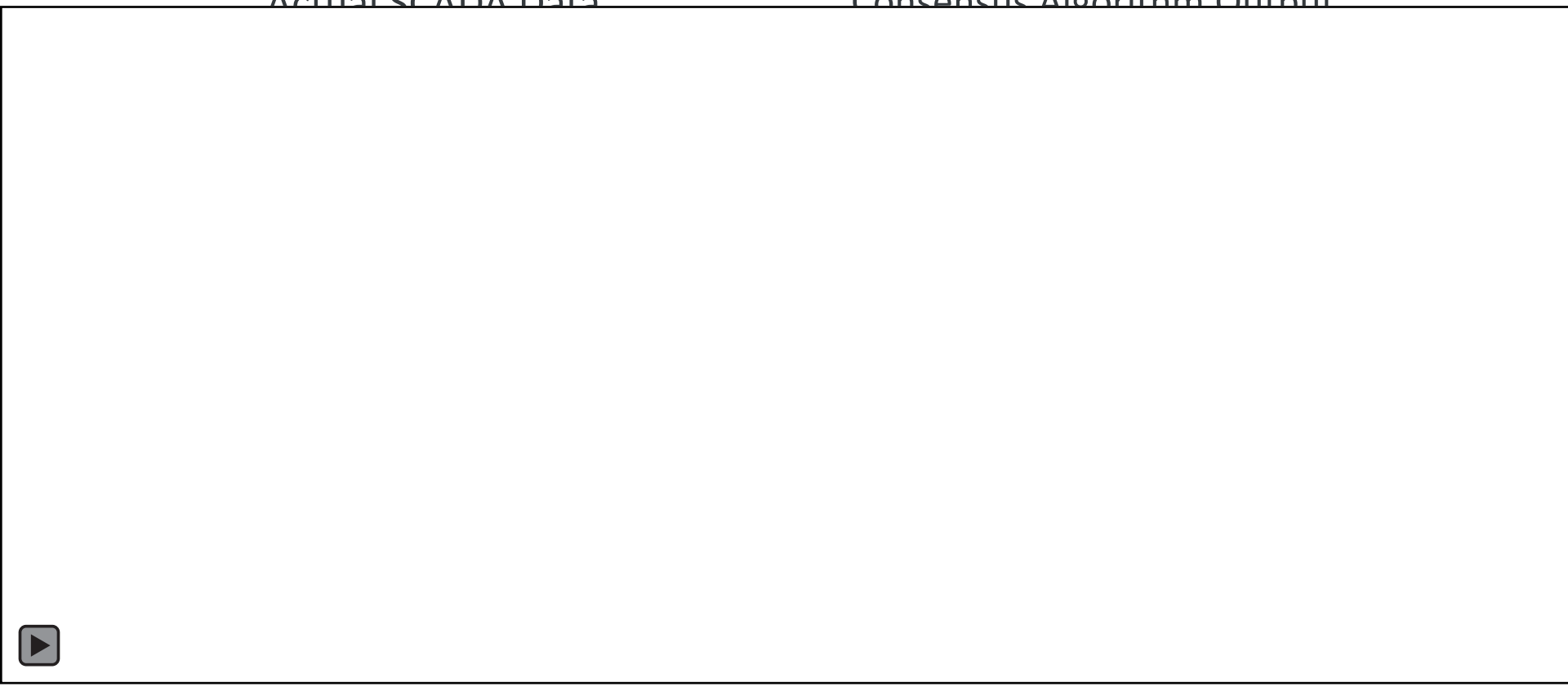
- **All milestones accomplished, final milestone delivers report on hybrid study using real data from wind farm.**

Actual SCADA Data → Estimated Wind Direction



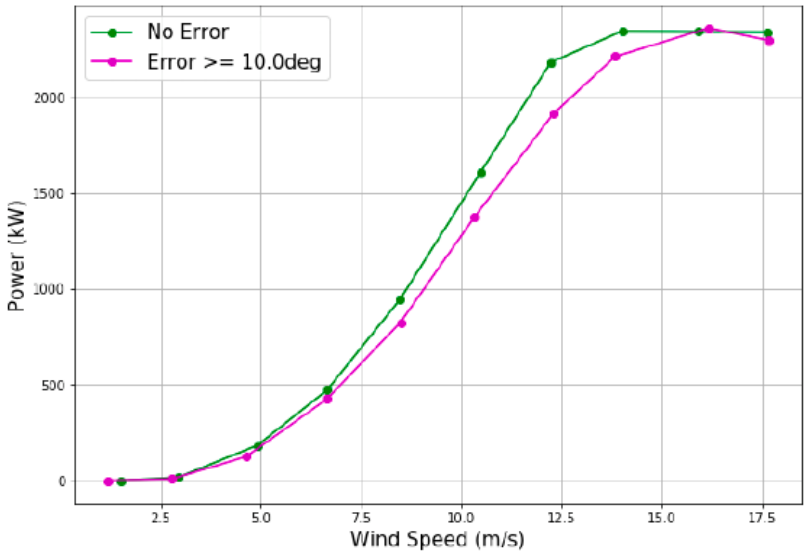


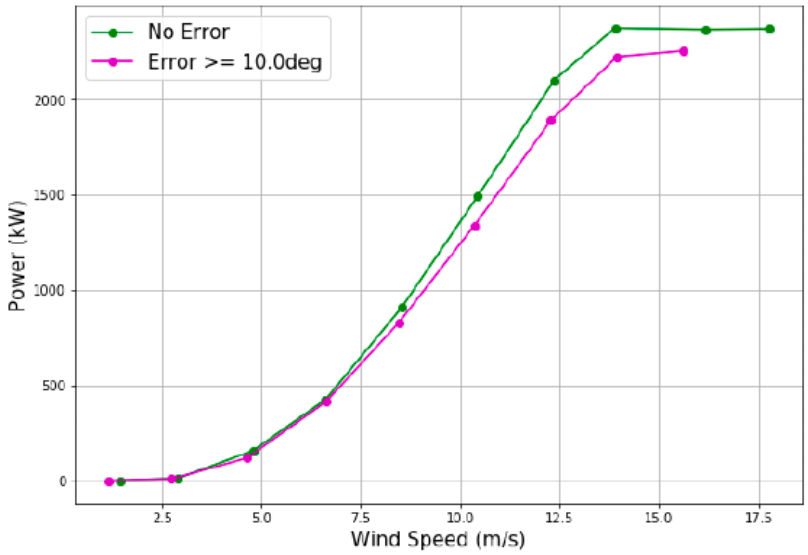
Accomplishments and Progress



Accomplishments and Progress

Comparison of power curves of turbines showing that agreement with consensus is associated with high power production.





Accomplishments and Progress

- Validation analysis of the consensus control method was performed using SCADA data from a large wind farm.
- Significant AEP lost because of yaw misalignment resulting from local wind direction measurement errors at each turbine.
- Simulated analysis indicates **AEP increase >2% is possible.**
  - Need field tests to verify.
- Yaw analysis indicates that there would be a **31% reduction** in yaw travel for the simulated controller.

Communication, Coordination, and Commercialization

- Reports generated and shared within project.
- Public slide deck is available.
- WindESCo is currently looking for a commercial wind farm partner to implement consensus controller using their hardware. Once they have identified a partner, they plan to license the controller from NREL and apply it using their hardware.