Learning Factory Industry Project-Deliverables Agreement

Date 9/1/2022

Project Title BP Simulated wind turbine and wind farm generation
Sponsor Company BP
Company Contact Glenn Gesoff **Phone** 713-594-4760 **Email** glenn.gesoff@bp.com
Faculty Coach Al Verbanec **Email** **acv@psu.edu**
Team Name BP Wind Sim
Student Team (primary contact) Marissa Stecko **Email** mzs1219@psu.edu

Problem Statement (this should be 300+ words)

A push to switch from fossil fuels to renewable energy sources is sweeping the energy industry. Wind energy is a source of renewable energy that BP is working on incorporating into their business model. The wind energy industry is monopolized by a few companies that use proprietary processes for designing, optimizing, installing, monitoring, and maintaining their wind turbine and wind farms. BP would like to develop a simulation application that uses several wind turbine and wind farm models that adequately matches their wind farm operations. This simulation will allow perturbation of several inputs as happens in the real world and allow visualization and data collection for the simulation inputs and on a variety of important outputs.

Wind turbines are most efficient when angled directly into the oncoming wind. Blades on a wind turbine act as air foils to create a pressure difference along the blades, driving motion. As the turbine spins, it generates a wake of turbulent air behind the turbine. This wake of air of the leading turbine can pose mechanical risks to turbines in the wake, as well as deplete the efficiency of their functioning. Operating wind turbines at a different angle of attack with respect to the oncoming wind will modify the wake impact of the leading turbine, potentially allowing for more optimal efficiency and energy output of the downwind turbines and as a result the overall wind farm.

The goal of the simulation would be to use models available from BP, open source and in industry to adequately simulate the operation of a wind turbine and by extension a wind farm. Then use actual site layout and operational data from BP to validate the outputs from the different models where possible, it is expected the outputs from some models will be more detailed or give different parameters when compared to others. The simulation should reflect the closed-loop controllers which are implemented by the wind turbine vendor's controller. This will allow any optimization that is explored later to be compared to the energy generated by the OEM's controller. This simulation needs to model and display the critical moments and forces on a wind turbine, allow for the adjusting of angle of attack, as well as wind conditions such as speed, direction, and density. The simulation will model and give a visual interface for the wake generated by each turbine as we change the angle of attack offset from the oncoming wind, as well as the resulting forces on the body of the turbine when operating it with different settings. The initial simulation will be for a wind farm with the stretch goal to use multiple wind farm layouts and data from conditions as well as energy generated over a period of operations to test, validate, and evaluate the many models to see which models execute faster and better represent the actual operations.

This will be a steppingstone that BP can use to as a training tool to make engineers more familiar with design and operations of wind turbines, wind farms. Eventually this model will be extended to perform monitoring where the models can be run in parallel with actual operations to detect abnormalities where significant deviations between the model and actual operations occur. It is expected this simulation can then be scaled up to develop a cloud based online optimizer which can be used for closed loop control to minimize the wake impact at a wind farm and generate increased energy from BP on shore and planned offshore wind farms.

Deliverables:	Delivery Date
1. Review of models available - Selection of models for simulation	**9/16/22**
2. Review of software available from BP and what the team is familiar with - Software selection	**9/16/22**
3. Review of data available from BP - Set Inputs and Outputs of Simulation	**10/7/22**
4. Draft GUI for a single turbine and a wind farm and Single Turbine Simulation	**10/21/22**
5. Wind Farm Simulation	**11/4/22**
6. Combing the simulation tool (4) and GUI interface demo (5) and agree for use within project	**11/18/22**
7. Final Report (copies to sponsor, instructor, and Learning Factory)	**12/11/22**
8. Weekly update memos (status reports); delivered via email. BP stakeholder presentation to be presented last Friday of each month.	**Monthly Last Friday**
9. Statement of Work (Project Proposal)	**9/18/22**
10. Detailed Design Specification Report	**9/25/22**
11. Poster (32 x 40") for Showcase	**12/4/22**
12. One-Page Project Recap (submit to instructor)	**12/11/22**

Check below if this project involves:

☑ Non-Disclosure Agreement (attach copy of agreement to this form)

☐ Loan of equipment, materials, documents (see next page)

Signatures: We agree to the deliverables listed above:

Project Sponsor date

Faculty Coach: date

Team Members:

Scott Carroll 9/1/22

Bert Yan 9/1/22

Marissa Stecko 9/1/22

David Rohrbaugh 9/1/22

Seyilayo Olagbami 9/1/22

Shuaipeng Dong 9/1/22

Nelloe Anonyuo 9/1/22

Deliverables Agreement

Sponsor Supplied Items

In support of this project, we (project sponsor) agree to provide the following equipment, materials, or apparatus by the date listed.

The student team is responsible for returning all loaned items. The instructor reserves the right to withhold a final grade if loaned items are not returned, or if a copy of the final report is not delivered to the sponsor.

Item	Delivery Date	Check one	If Loan, Return Instructions
		☐ donation ☐ loan	
		☐ donation ☐ loan	
		☐ donation ☐ loan	
		☐ donation ☐ loan	