MSc. Thesis Proposal

Title: Optimization of small-scale hybrid energy farm and short-term power generation prediction

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Introduction

Motivation

Many large-scale wind turbines are deployed in Portugal to contribute to the energy independence and decarbonization of the country. However, those turbines have many constraints regarding their deployment and operations: they occupy a large space, they can receive negative opinion due to their noise, they only work with strong steady winds, they must be grid connected, and they represent a large investment. Therefore, large-scale wind turbines do not offer a viable solution for local urban energy consumption, where the available ground space is limited, and the wind flow is variable. Instead, two common solutions are proposed in urban areas: solar energy and small-scale wind turbines. Identifying which technology produces the best energy yield at their deployment location and for the best price is a critical challenge that should be answered before investing in renewable energies solutions.

Existing work

blueOASIS deployed sensors since September 2022 at their headquarters in Ericeira to measure, among others, the irradiance, wind speed, and temperature with a time step of 10min. This gathered dataset allows us to calculate the potential energy production from various commercial solar panels and small-scale wind turbines. blueOASIS also built a dashboard for the real-time analysis of the energy resources and potential energy production and cost savings.

Figure 1: Left - Sensors at Ericeira Business Factory; Right - Snapshot of the existing dashboard.

Objectives

The work will be divided into three tasks:

- Build up a database of commercially available small-scale wind turbines, both horizontal (HAWT) and vertical axis (VAWT) and solar panels with costs and power curves for each energy device. This step is crucial for the relevance of the following tasks.

- Develop a procedure to optimize the number and type of solar panels and wind turbines to best match the energy output with a predefined expected consumption for various time frames. The work will start with a simple objective function that will be progressively refined to include the acquisition costs of the energy devices, the possibility of energy storage with batteries and the possibility to remotely update the operational setting of the energy device.
- Develop a prediction algorithm to plan the production of energy in the next days based on the past 14 days (or more of data) and the farm setup as optimized in the previous task.

Machine learning and modern data analysis tools, such as transformers, genetic algorithms, Bayesian approach, etc., are expected to be used, tested, and compared to select the most performing method. Special attention should be given to the computational power needed for the analysis to allow for the visualization of the results in near real-time. A strong interaction is planned with the development team of the dashboard.

Requisites

Applicants must have:

- Good python skills.
- Experience with optimization procedure.
- Experience with AI development.
- Dedication to sustainability and decarbonization.

Good to have:

- Git experience.
- Linux experience.

Location

The student must be present at Ericeira office at least 3 days per week. This is mandatory to pursue a thesis with blueOASIS.

Companies Involved

blueOASIS (www.blueoasis.pt) is a young team with more than 60 years of combined knowledge and experience in Aerospace, Mechanical, Naval and Maritime engineering. The multicultural and multidisciplinary team is committed to making our oceans safer and greener, using state of the art numerical and data science tools. BlueOASIS focuses on renewable energies, ocean cleaning including underwater acoustics, decarbonization, sustainable offshore structures and green ships optimization.