EPFL

31st January 2024

PitchMe

We provide smart blade pitch-control solutions to enhance vertical-axis wind turbine performance and lifetime.

In a nutshell

Vertical-axis wind turbines are excellent alternatives for the production of ultra-low carbon electricity, but they often suffer from low efficiency and premature failure.

The industry has implemented elementary control solutions that rely on wind measurements occurring far from the wind turbine to mitigate performance shortcomings. While these solutions may improve turbine performance on average, they fail to ensure safe turbine operation in the broad range of wind conditions encountered throughout a turbine’s lifetime.

We've pioneered an innovative control software for vertical-axis wind turbines, optimising the blade's orientation in real-time based on sensors embedded on the turbine blade. We use a novel physics-informed, data-driven algorithm that is interpretable, versatile, and robust. On our small-scale lab prototype, we've demonstrated a 3-fold power coefficient enhancement and project a 5-fold extension of turbine lifespan.

Why is our technology important?

The Swiss Confederation's strategy for achieving net-zero carbon emissions by 2050 necessitates the installation of approximately 1000 wind turbines in the next two decades. Currently, Switzerland operates 37 wind turbines. Concerns raised by the Swiss population regarding exploitable land surface and noise emissions from traditional wind turbines highlight the need for increased versatility in wind turbine technology.

Vertical-axis wind turbines offer several advantages, with an estimated potential of around 300 GW of installed capacity in Europe (market size: EUR 450 billion). These benefits include low noise emissions, fauna friendliness, and three times lower land requirements compared to traditional turbines. However, their industrial deployment is currently constrained by inefficiency at low wind speeds and a lack of structural resilience at high wind speeds.

Our control strategy utilizes recent advances in sensing technology and data-driven methods to assist wind turbine manufacturers in maturing and deploying the technology within the next three to five years. We have received letters of interest for our control framework from Agile Wind Power and SeaTwirl, two major players disrupting the wind energy landscape using vertical-axis wind turbines.

Benefits of the cluster-based control we are developing

- **Computationally efficient**. Once the model is trained from data, the control framework mostly relies on simple calculations.
- **Interpretable**. As opposed to black-box control strategies obtained from reinforcement learning or model predictive control, cluster-based control offers a interpretable control framework. This attribute emerges for the simplicity of the method once the control framework is built and optimised.
- **Robust and versatile**. Cluster-based control relies on the creation of a reduced-order space that we carefully designed to best capture the flow physics using advanced aerodynamic metrics. The metrics were selected based on deep knowledge of the governing flow physics to ensure the control framework is robust to quickly changing and extreme weather conditions.
- **Generalisable**. Cluster-based control can easily be adapted and tune to different applications. Whether it is a new turbine geometry or even a different system. Other potential fields of application are traditional wind turbines, micro-aired vehicles, drones and the aerospace industries.

Keywords

Wind energy, flow control, cluster-based control, data-driven, physics-informed, cyber-physical system, power enhancement, life-extension.

Founding Team

Sébastien Le Fouest & Daniel Fernex

École polytechnique fédérale de Lausanne

startup launchpad

Get in touch
We’d love to speak to you more about our project.
You can book some time with us here: sebastien.lefouest@epfl.ch