A new approach to improve the power control of wind farms

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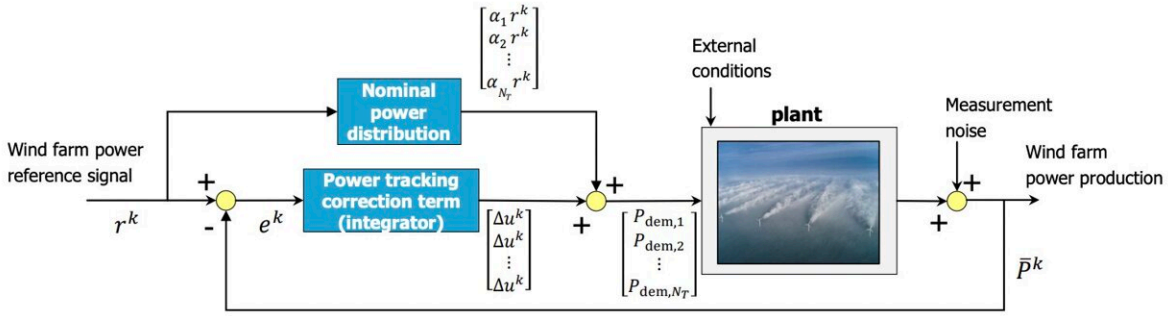

Figure summarizing the controller framework. Credit: Silva et al

To slow down climate change and prevent its adverse consequences, humans will need to transition to more sustainable energy sources. Engineers worldwide have thus been working on a wide range of technologies that can convert natural resources, such as sunlight, wind, and water, into electrical energy.

Wind turbines, devices that can convert the wind's kinetic energy into electricity, are among the promising and widely implemented sustainable energy solutions. Despite their advantageous characteristics, the electrical grid of most existing wind turbines and other alternative energy solutions can be significantly unstable.

Several governments have thus started introducing legislation that forces wind turbine operators to offer ancillary grid services. These are essentially functions that help grid operators to maintain a reliable flow of electricity, addressing discrepancies between energy supply and demand.

Researchers at Delft University of Technology (TU Delft) have recently developed a controller that could help to better manage the energy power of wind farms, through what is known as "active power control." This controller, presented in a paper pre-published on arXiv, could help to enhance the performance of wind farms, thus facilitating their implementation worldwide.

"The proposed design enhances power tracking stability and allows for a simple understanding, where each turbine is considered as a pure time-delay system," Jean Gonzalez Silva, Bart Matthijs Doekemeijer, Riccardo Ferrary, and Jan-Willem van Wingerden wrote in their paper.

To track the power of wind turbines, the researchers' approach employs a closed-loop algorithm. This algorithm has a feedforward and a feedback loop. The first ensures the tracking of power when turbines are not saturated, while the latter tracks power when one, but not all, of the turbines are saturated.

Gonzales Silva and his colleagues evaluated their controller in a series of test ran on SOWFA a high-fidelity wind plant simulator. Remarkably, they found that their approach improved the total active power tracking for the simulated wind farms significantly, increasing power production by up to 15% more than a baseline approach.

"The paper investigated the control performance with different nominal power distributions in a fully waked condition and limited power availability," the researchers explained in their paper. "Results

demonstrate the improvement in power production obtained by closing the control loop, compared to greedy operation."

The improvement in the total active power tracking and power production of wind turbines highlighted by the researchers' simulations suggests that their approach could help to significantly improve the performance of real-world wind farms. However, the team also observed a series of undesirable small spikes and oscillations on the active power of their closed-loop solution. In their next studies, they plan to try to devise a strategy to either eliminate or accommodate these oscillations, to improve their approach's performance and reliability.

"Our future research will elaborate smart time-varying distribution of the nominal active power by predicting available power, as well as consider designed constrained turbines due to faults and failures in the proposed APC solution," the researchers wrote in their paper.

More information: Jean Gonzalez Silva, Bart Matthijs Doekemeijer, Riccardo Ferrari, Jan-Willem van Wingerden, Active power control of wind farms: an instantaneous approach on waked conditions. arXiv:2204.05417v1 [eess.SY], arxiv.org/abs/2204.05417

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