Cleverly timed current injections will keep wind farms operating despite unexpected voltage swells in power grids

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Researchers from Skoltech, Shandong University, and ORE Catapult have proposed a way to stabilize wind farms under overvoltage

conditions, when imbalances in the power grid causing voltage swells can temporarily knock out wind turbines. The team describes how precisely calibrated reactive current injections may enable continuous clean power generation in spite of brief voltage swells in the system. The study is reported in the *International Journal of Electrical Power & Energy Systems*.

Wind is a clean but inherently variable and intermittent energy source. To ride out wind speed fluctuations and continuously generate electricity, turbines are fitted with what's known as power electronics.

Yet while power electronics are great for dealing with variable wind speeds, they are themselves vulnerable to another kind of imbalance that may arise in the power grid: under- and overvoltage. These could damage sensitive power electronics components, halting power production and the supply of customers.

The study's principal investigator, Skoltech Professor Vladimir Terzija, explains: "Imagine you have many generators simultaneously connected to the grid. They are all supplying energy, which is consumed by customers. It's a complex system that constitutes a critical part of our society's infrastructure. At any given time, at the point where a generator is connected, different conditions may be present: The operating voltage may be nominal, which is desirable, or it may be lower or higher than that due to what's happening elsewhere in the grid."

Voltage swells and dips of this kind are usually transient, but without adequate coping strategies, they still have the potential to incapacitate the turbine by damaging its sensitive power electronics. To avoid this, the generator has to be automatically disconnected when under- or overvoltage is anticipated, but that means no electricity will be generated for some time, and some other power plants will have to make up for that missing energy—perhaps by burning fossil fuels.

This is precisely the problem addressed in the study by Terzija and co-authors. "Engineers have already made sure that generators can withstand undervoltages that persist for some seconds without disconnection, so as it stands, the overvoltage conditions are more of a problem," the researcher commented. "Our solution is to respond to imminent voltage swells by injecting reactive current into the grid, and the paper explains how to implement this approach in a robust and secure manner, making sure that power delivery is not interrupted and the system sustains no damage."

The researchers have thus shown a way to "ride out" overvoltage conditions—as opposed to "sitting them out" by temporarily shutting down the turbine. By maximizing wind generator uptime, this strategy makes renewable power more economical and further reduces our dependence on unsustainable fossil fuels, making sure that wind farms can continue operating even under unfavorable grid conditions and capture every bit of green power available.

More information: Peilin Liu et al, High-voltage ride-through strategy for wind turbine with fully-rated converter based on current operating range, *International Journal of Electrical Power & Energy Systems* (2022). DOI: 10.1016/j.ijepes.2022.108101

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