Hybrid solar and wind system

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Increasingly weather-dependent electricity production makes grid operation more complex. A plant in Hjuleberg, Sweden, is using a solution based on new smart technology, combining wind power and batteries to bring optimum stability to the grid.

Wind and solar power are the fastest-growing energy sources in the world today, thanks to their low climate impact and high cost-efficiency. But as electricity production from weather-dependent energy increases, it also makes it harder for the supply system to maintain balance and stability.

In so-called hybrid power farms, different types of energy are combined and controlled in a way that brings out the best from each type. This way, a hybrid power farm based on wind power and batteries provides capacity for sustained production, split-second adjustment and energy delivery even in still weather. This makes it a very valuable addition when it comes to important system services. There is strong evidence to suggest that the hybrid farm technology could become the standard for new wind farms and also for large solar farms in the future.

In Hjuleberg in southern Sweden, Vattenfall and the pension company Skandia have built Sweden"s first commercial hybrid energy farm. The farm, which is one of the most advanced of its kind in Europe, combines twelve wind turbines (combined output 36 MW) with a large battery (30 MW capacity), all controlled using advanced algorithms.

An electrical system needs to be in balance and the mains frequency must be stable – in Europe this means 50 Hz. This is normally achieved by throttling or slowing down the power plants in the system as electricity use varies over the day.

A normal wind farm is already very flexible and can quickly adjust its output if needed – faster than many other types of energy preoduction. If we also combine wind power with extensive battery storage and smart control, the possibilities and capabilities grow enormously, because the farm can then not only step its production down, but also boost it when needed. And this is where Hjuleberg comes into its own.

“We have built hybrid power farms in other places too, in both the Netherlands and the UK, but Hjuleberg differs in that the two resources, wind and batteries, work as a single unit. This allows us to use the renewable capacity in the most efficient way. For example, if we need to reduce wind power production for a time, we can charge the battery instead and use the energy later. We can also maximise the utilisation of the grid connection,” says Johan Kronman, Project Manager at Vattenfall Business Area Wind.

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The hybrid power farm in Hjuleberg went into operation in the summer of 2024 and can deliver a wide range of different support services to Sweden"s electricity system, ranging from split-second tweaks up and down to compensating for major changes, such as outages or loss of production elsewhere in the system. The fact is that the hybrid power power farm has a unique ability to deliver all the support services that Sweden"s TSO, Svenska Kraftnät, needs.

“With our solution, bids are placed on all available services and markets, after which our algorithms make an estimate of the best combination based on the needs of the market and the status of the hybrid power farm. Our sale decision is then translated into control signals to the farm, which then executes the request, taking account of technical and network constraints.”

The uniqueness of the Hjuleberg solution lies in the smart control system developed by Vattenfall, which calculates in real time what combination of wind energy generation and battery power that gives the best results for the grid.

“In other hybrid farms that we have developed, the battery is controlled separately and so is the wind/solar production, but in this solution, energy storage and wind turbines work as an integrated unit. Every moment, a new calculation is made to determine the optimum split between production and storage. So when the wind varies, we can back up with the battery, and vice versa,” says Ozan Sahin, Development Engineer at Vattenfall R& D who is part of the team behind the technical solution. The team is led by Alin Raducu from Digital Engineering within BA Wind.