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National Physical Laboratory

Statkraft could save millions thanks to more accurate performance metrics

Statkraft operates solar farms which sell electricity to the grid. As part of its client agreements, it sets contractual key performance indicators (KPIs) for how much energy it will deliver. The most important KPI is performance ratio (PR), a guarantee that the amount of energy delivered will not fall below a percentage of the system's theoretical maximum output under ideal conditions.

Statkraft must pay heavy penalties for every percentage point if it falls below the agreed performance level – which can amount to £millions on larger sites. "We want to eliminate any inaccuracies that put us at financial risk," says Elena Koumpli, who heads up the Performance Analysis Team at Statkraft.

The PR for any given site is affected by various factors such as shading, temperature, terrain, soiling, module mismatch losses, wiring losses and inverter losses. The PR guarantee is based on simulations using Typical Meteorological Year (TMY) data. One challenging factor is clipping - which occurs when the power generated by PV panels exceeds the inverter's maximum capacity, causing the system to cap or "clip" the energy output. When there are many more sunny days than the TMY predicts, this leads to a mismatch with the PR model.

While clipping is a design choice to optimise for average conditions, excessive clipping during unusually sunny periods can cause PR metrics to misrepresent actual performance. An ideal PR metric must compensate for this effect.

Challenge

Statkraft wanted to develop a reliable and accurate way to remove the effect of clipping. Initial approaches involved calculating the energy lost from clipping and using that to adjust the KPI calculation. "But this turned out to be quite complex to implement and control its quality and could risk masking data that might provide important information, such as inverter derating - the intentional reduction of an inverter's capacity during higher operating temperatures to enhance its efficiency and longevity," says Elena Koumpli.

Aiming to find a clipping formula that was both reliable and simple for customers, Statkraft turned to NPL.

Solution

NPL developed a model of a typical solar farm based on Statkraft's portfolio and used synthetic weather data to simulate the system under many different realistic weather conditions and climates.

It then applied statistical analysis to the resulting data to establish the level of sunlight that caused the system to cross the clipping threshold.

That was used to create a simple new equation for defining PR - simple enough to be put in contracts and easily calculated and evaluated.

The standard PR equation is: Energy output / expected energy output (under perfect conditions). Under the new system, on days when the levels of sunshine crosses a certain predefined threshold, a new calculation kicks in, which caps the expected energy output to align more closely with the operational limits of the inverters.

"Essentially, we're capping clipping based on a threshold for sunlight, rather than a threshold on the system output," says James Blakesley of NPL. "This gave us a PR metric that more accurately compensates for clipping than using output data, has no unintended consequences, and works consistently for any system, anywhere in the world".

Impact

By adjusting the PR calculation, Statkraft has a fairer way to assess performance, which will help it avoid being hit with unfair penalties when the actual weather dataset comprises many sunny days, especially during PR testing.

The PR guarantee of a site essentially reflects its project value. "Missing the guarantee by just 0.5% could lead to a penalty of £100,000 for a project valued at £50 million," says Elena Koumpli. "For a portfolio of over 1GW that could mean penalties of several million. That is pushed even higher where actual weather datasets have much higher solar radiation values than TMYs, and we do see differences as high as 8%, depending on location and year. For plants, where sizing (DC to AC) ratios are as high as 1.6 the risk of missing the guaranteed target increases even further."

The calculation also helps with future project design. A recent solar deployment had its test phase during a particularly sunny week. The clipping calculation was essential in providing accurate data, without which it would have failed to meet its PR KPI, despite performing well.

“The fewer risks of falling below the PR due to non-predictable factors the better for our business and reputation” says Elena Koumpli. “And the fewer penalties we have to pay, the more money we have to invest in new projects, speeding up the rate at which we can deploy the renewable energy that is critical for transitioning the world away from fossil fuels”.

NPL and Statkraft are collaborating to incorporate this clipping correction into future industry standards for solar PR, providing all solar operators and customers with fairer, more reliable performance metrics. More reliable KPIs provide greater confidence in the operation of solar farms, reducing risks and encouraging further investment.

“NPL helped us define a more accurate Performance Ratio metric which will help us - and the rest of the Solar industry - avoid expensive penalties where calculation inaccuracies could incorrectly imply we have missed targets. Having NPL behind the new metric ensures that we are doing right by our customers, and gives our customers confidence that the resulting equation is a better way to get a reliable picture of solar PV performance” concludes Elena.

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