Managing curtailment in hybrid wind-solar plant

The Kabeljauwbeek hybrid project:
an Eneco case study with SynaptiQ

3E

Eneco

Context

At the Dutch–Belgian border, Eneco's Kabeljauwbeek site originally operated as a wind farm. As optimisation of existing infrastructure became more and more important, Eneco decided to add a solar PV installation to the existing wind asset.

By combining wind and solar behind a single grid connection, Eneco aimed to better utilise available capacity, leveraging the complementary production profiles of both technologies.

The company Eneco

Industry

IPP in solar, and onshore & offshore wind

Location

The Netherlands, Belgium, the UK, and Germany

Customers

5 million

Employees

4,000

The Kabeljauwbeek project

Location

The Netherlands

Initial installation

14 MW & 18 MVA wind

New extension

14 MWp & 19 MVA solar

Shared grid connection

16.8 MVA

The challenge: operating a solar plant that is always curtailed

The Kabeljauwbeek project reflects a broader shift in renewable asset management: hybrid plants, grid congestion, and frequent curtailment fundamentally change how performance must be measured.

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Curtailment became continuous

Historically, curtailment occurred occasionally. Eneco simply excluded curtailed periods from PR calculations. However, as curtailment became more frequent, this approach no longer reflected normal operating conditions.

Because wind and solar share a limited grid connection, solar output is continuously adjusted in real time to respect export limits. Curtailment therefore occurs throughout the day depending on solar & wind potential production and grid constraints.

As a result, the PV plant is rarely able to operate at full export capacity. Excluding curtailed periods from analysis was no longer meaningful, as it removed a significant part of normal operating conditions. This made increasingly difficult to accurately assess plant performance using traditional KPI methodologies.

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Loss causes could not be identified

Following their traditional calculations, Performance Ratio (PR) deviations reached nearly -20%. However, Eneco could not determine whether these losses were caused by grid curtailment, weather variability, wind-solar interaction, commercial dispatch decisions or technical issues.

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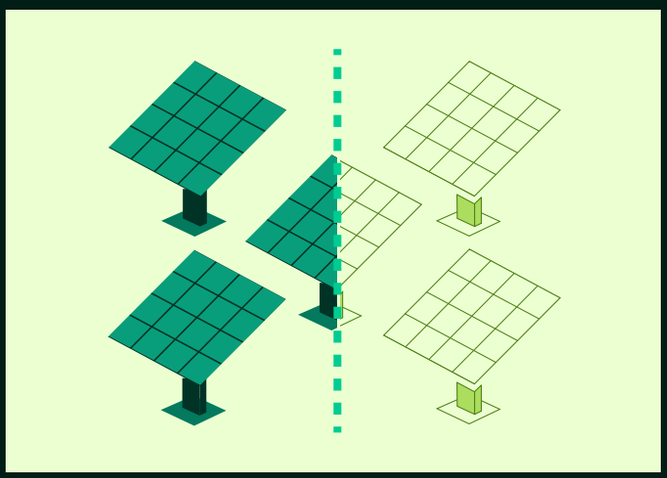
Hybrid operation complicated KPI reporting

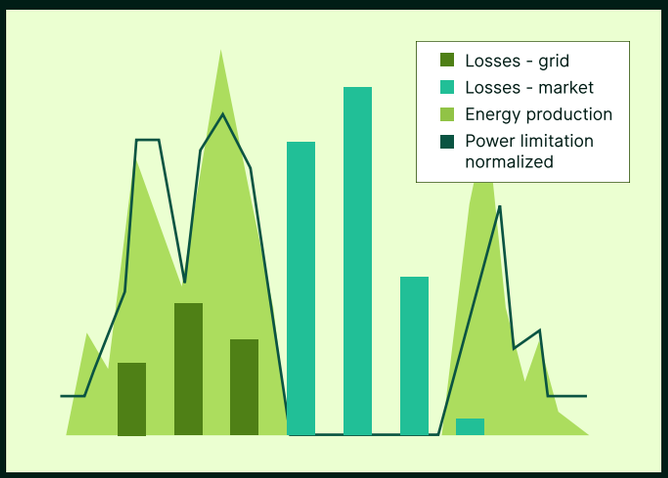
The hybrid configuration introduced a new operational reality:

- Wind and solar share grid capacity.
- Solar is curtailed first due to subsidy structure.
- Curtailment signals are dynamic and continuous.

As traditional PR calculations were no longer suited to this operating model, the key question became how to quantify curtailment losses.

The SynaptiQ solution for quantifying curtailment





Digital twin simulation of expected production

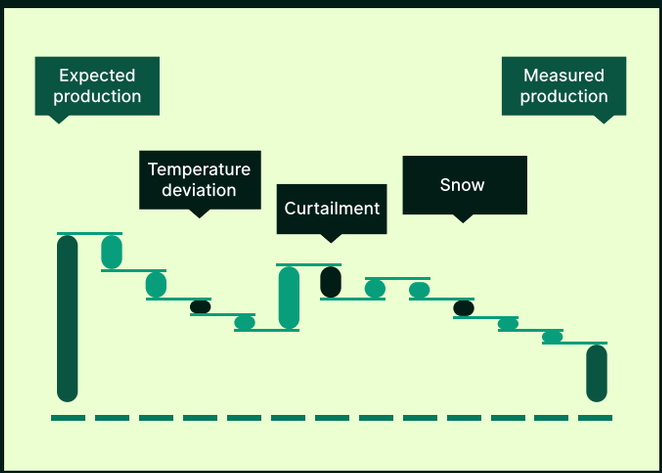
Based on plant configuration, component characteristics and onsite sensor data, Eneco built a digital twin of the Kabeljauwbeek asset in SynaptiQ. This model simulates expected PV production under actual weather conditions, and provides a consistent baseline for performance analysis.

Integration of real-time curtailment signals

Curtailment controller setpoints are fed directly into SynaptiQ and are updated every 4 seconds. This allows Eneco to identify in real time when production is limited by grid constraints rather than by technical issues, including during partial curtailment.

Quantification of curtailment losses

Using the simulation model together with grid setpoints, SynaptiQ calculates how much energy is lost due to curtailment. Instead of removing curtailed hours, Eneco can now reconstruct the unconstrained production of the plant.



Full loss breakdown beyond curtailment

SynaptiQ Solar Analytics gives visibility into the root causes of more than 23 categories of losses: grid curtailment, soiling losses, string faults, RISO faults, snow, etc. It also distinguishes recoverable from non-recoverable losses. This helps Eneco avoid attributing all underperformance to curtailment and enables targeted O&M actions.

Corrected KPI reporting

Thanks to SynaptiQ, Eneco adjusted its internal reporting methodology. Curtailment losses are now added back to measured production, to recalculate PR and availability. Corrected performance is then compared against budget, which results into a performance evaluation more aligned with the actual operating constraints of the hybrid plant.

The results

Using SynaptiQ Solar Analytics, Eneco enhanced both reporting and operational insight.

① More credible performance reporting

Curtailment impact can now be quantified, and differentiated from other causes of energy losses, enabling more transparent and accurate reporting.

② Corrected PR calculation

Once curtailment losses were quantified, Eneco was refine and improve its performance reporting. A monthly PR result initially showing –20% deviation was corrected to +1.91% above budget, demonstrating that the apparent underperformance was largely driven by grid constraints rather than technical issues.

③ Better operational decisions

Eneco's O&M team can now proactively identify additional energy losses, such as soiling, and prioritize actions (e.g., optimize cleaning schedule) based on quantified losses.

④ Future-proof performance management for future hybrid assets

Curtailment steering is now implemented on all new Eneco projects.

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With SynaptiQ we can clearly quantify the impact of curtailment and separate it from other performance losses. This gives us a full loss picture, allowing us to investigate underperformance in detail and take targeted action.

Tom De Waele
Engineering & Realisation Manager, Eneco

About 3E

3E is a market-leading SaaS and advisory company for the renewable energy sector

Our team of over 180 experts works with developers, asset managers, operators, investors, public entities, EPC contractors and IPPs. Our job is to enable them to make informed decisions across the full lifecycle of their projects – whether that's solar, wind, green energy or energy storage.

Based on our 25+ years of global experience, we provide both digital solutions and expert advisory services, which is unique in the sector.

Our SynaptiQ platform offers a comprehensive suite of SaaS solutions that optimises the operations of renewable assets.

In parallel, our advisory team delivers technical, engineering and strategic advice to ensure bankable projects.

Powered by collaborations with universities and industry pioneers, we drive innovation and deliver the industry's most advanced energy intelligence solutions.

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