Inside the evolution of hybrid energy systems: lessons from a landmark project

Casper Johansen, Senior Project Engineer at TGS | Prediktor, shares insight into Scatec's groundbreaking Kenhardt hybrid solar and battery project in South Africa. From real-time control to high-fidelity forecasting, he explores how data infrastructure and integrated operations are setting new benchmarks for the future of hybrid systems.

PES: Welcome to PES Solar, Casper. Thank you for being here. Let's start with Scatec ASA's Kenhardt project, a landmark hybrid solar and battery site in South Africa where Prediktor PowerView™ played a key role in the data infrastructure. What, for you, makes this project so significant in the evolution of hybrid systems?

Casper Johansen: Thank you, it's a pleasure to be here. Scatec's Kenhardt is a huge project. What makes it so significant is its massive scale, operational complexity and its strategic role in showing how hybrid systems can provide grid stability.

From a technical standpoint, integrating large scale solar PV with battery storage at this level requires precise engineering, close coordination with plant operations and the engineering team and high-performance, high-availability systems. It also demands efficient data flows and reliable engineering tools to support smooth operation and integration with other systems.

At TGS | Prediktor, we worked closely with Scatec to deliver the real-time monitoring and data infrastructure using Prediktor PowerView™, which plays a key role in ensuring reliable system performance and centralized control across the site. The success of this deployment underscores the importance of robust data flows and trusted operational insights in integrating hybrid assets at scale.

PES: At Kenhardt, hybridization wasn't just about colocating solar and storage; it was about integrating them operationally. Why is that distinction important?

CJ: Colocating solar and storage at this scale simply means they share the same site but may still operate as separate systems. Hybridization means the solar and battery systems are fully integrated and operate together as one coordinated, flexible energy asset.

This integration enables real-time coordination between solar generation and battery charging and discharging. It allows the system to respond dynamically to grid demands and changing weather conditions, guided by accurate forecasting, to deliver reliable, dispatchable power.

PES: We often think of solar and storage as complementary, but Kenhardt shows they need to be comanaged in real-time. What does that require from a data and control perspective?

CJ: On the data side, full visibility into all key assets is essential, including trackers, inverters, strings and BESS equipment such as PCS inverters and battery units.

Critical metrics include hybrid system data such as production and forecasts; PV metrics including availability, performance, production and forecasts; BESS metrics covering availability, state of charge (SoC), and charged or discharged energy; and equipment, specific metrics such as statuses, production figures and both direct alarms and data-driven alarms.

To enable this, we used Prediktor PowerView™ to aggregate and structure these data streams in real-time, ensuring accurate hybrid tracking, smart alarming and clear visualization for operators.

Accurately tracking the combined hybrid output is vital, especially when delivering dispatchable energy or meeting grid obligations.

On the control side, a tightly integrated SCADA and Energy Management System (EMS) must operate in real-time. For example, if PV generation drops due to cloud cover, the EMS must immediately compensate with battery discharge, all while staying within SoC limits, ramp, rate constraints and grid compliance requirements. Control also extends to support systems like tracker positioning, which may need adjustment for cleaning or maintenance.

This level of coordination demands high-speed data acquisition from a wide range of equipment, rapid detection and response to deviations or faults and the integration of forecasts to enable proactive adjustments and ensure compliance with obligations.

Prediktor PowerView™ supports all these elements through its native integration and real-time analytics engine.

PES: The project involved detailed SCADA integration across inverters, BMS, PCS units and more. What does it take to turn that volume of raw data into a coherent operational picture?

CJ: Turning raw data from inverters, BMS, PCS and other subsystems into a usable operational picture takes more than just connectivity; it requires a high-performance, well designed SCADA system, especially at this scale. In this project, Prediktor PowerView™ was used to handle high frequency logging, KPI calculations and intelligent alarming.

Raw signals from inverters, BMS, PCS and weather systems are modeled, validated and transformed into clear dashboards that align with operator workflows. With Prediktor PowerView™, we ensured consistency in naming standards and data templates, critical at this scale.

Most importantly, Prediktor PowerView™'s architecture supports integration with higher level portfolio systems, minimizing latency and delivering the trusted, contextualized insights needed to operate efficiently.

Strong data modeling, naming standards and reusable templates are essential to ensure consistency, scalability and efficient analysis across multiple assets.

Ultimately, it's about transforming data into clarity, enabling fast decisions, long-term optimization and reliable performance at a complex hybrid site like Kenhardt.

PES: The use of OPC UA and Modbus to collect and model data was key. Why is robust data modeling foundational to hybrid system performance?

CJ: Robust data modeling is essential to the performance of a large scale hybrid system like Kenhardt.

We pulled data from multiple sources: meters, inverters, PCS, BESS EMS, weather stations and more, using OPC UA and Modbus.

Given the site's complexity, it was critical to ensure data was well-structured, time-stamped and consistent across all systems.

High quality data underpins everything: real-time monitoring, alarms, reporting, forecasting and performance optimization. Without it, you can't reliably track performance and availability, respond to issues in real-time, generate compliant and accurate reports or analyze long-term trends, equipment efficiency and degradation.

A standardized data model ensures that all components of the system are easily

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identifiable in the different tools available in the SCADA system.

Over time, that data supports lifecycle decisions, warranty claims, predictive maintenance and smarter forecasting.

PES: You delivered real-time dashboards and reporting across the plant, BESS, PCS and ancillary services. How does visibility at that level change how a hybrid site is operated?

CJ: Delivering real-time dashboards and reporting across the plant, including the PV system, BESS, PCS, and ancillary services, fundamentally changes how a hybrid site like Kenhardt is operated.

First and foremost, it enables fast, informed decision making. When you have real-time visibility into both PV and BESS performance from the same dashboards, you can immediately detect deviations in equipment, identify critical issues and take corrective action before they impact delivery or compliance.

For example, if the system shows that you're unable to meet a forecasted dispatch due to equipment limitations or changing conditions, operators can quickly adjust the plan or reconfigure the dispatch strategy or give notice that they will not be able to deliver, reducing or avoiding penalties. A centralized platform like Prediktor PowerView™ ensures these insights are delivered with clarity and speed.

Additionally, real, time data feeds into performance analytics and dashboards across the fleet of assets, allowing operators to compare KPIs between different Hybrid, PV and BESS sites, track degradation rates over time, evaluate system response to grid events or ancillary service participation and make data, driven decisions on upgrades or system tuning.

In short, Prediktor PowerView™ helps teams move from reactive to proactive, giving operators not just control but strategic insight into how to maximize availability, compliance and long-term value from the hybrid system.

PES: One of the project's strengths was its ability to unify solar and storage data into Scatec's Portfolio HMI. Why is portfolio-level visibility critical as more hybrid systems come online?

CJ: Scatec manages a large and growing fleet of assets across multiple geographies and technologies. Without a unified view, it becomes nearly impossible to operate efficiently or identify which issues require immediate attention. The strength of the different Portfolio HMIs, supported by tools like Prediktor PowerView™, is that they bring assets like solar and storage together into one centralized interface, giving operators and engineers a clear, real-time overview of all full assets together in a unified platform.

This enables several important capabilities: prioritization, by allowing quick identification of which sites or systems require attention based on alarm severity, underperformance or compliance risks, and enabling action based on criticality; standardization, as consistent data structures make it easier to compare performance across assets, identify systemic issues and apply best practices effectively; and efficiency at scale, where a unified platform reduces complexity and operational overhead, eliminating the need to manage each PV, Wind or BESS site in isolation.

In short, portfolio-level visibility transforms hybrid operations from being site-specific to being fleet-optimized, which is essential for global scaling, maintaining control and supporting strategic decision making across Scatec's global operations.

PES: Forecasting was also part of the Kenhardt setup, both for weather and battery performance. How does forecasting move from being a nice to have to a strategic tool in hybrid operations?

CJ: At a site like Kenhardt, forecasting isn't just a support function; it's actively used to make sure one can meet grid obligations.

In hybrid operations, particularly when you're delivering dispatchable power, accurate forecasting of both solar production and battery SoC is essential. It directly impacts your ability to commit to and deliver energy as scheduled, which in turn affects financial outcomes.

If you miss your forecasted or fail to predict what the system can realistically deliver, whether due to weather variability, state of charge limitations, or inverter constraints, it can lead to penalties, lost revenue or failure to meet contractual obligations.

What makes forecasting even more critical in a hybrid setup is the interdependence between PV and BESS. You're not just predicting how much the sun will shine; you're forecasting how much energy can be stored, when it can be dispatched and how the system should respond to grid signals in real-time.

This turns forecasting into a strategic planning tool. It enables proactive energy management, optimizes charging/discharging windows, and supports smart decision, making under uncertainty.

To be effective, it requires high-resolution weather and irradiance models, accurate system modeling for both PV and BESS, continuous performance validation against forecasts and real-time adjustments based on operational conditions.

PES: Hybrid KPIs went beyond basic metrics. What new performance indicators matter most when you're managing an integrated system like this?

CJ: Forecast accuracy becomes a key metric, along with state of charge (SoC) alignment versus forecasted, BESS and PV availability, round-trip efficiency and overall hybrid output compared to forecasted.

These indicators must be viewed in context, as part of a coordinated system. Success depends on predictability, responsiveness and tight PV, BESS integration, all driven by high quality data and unified monitoring.

PES: You also reported on mismatched data between assets. Why is data quality reporting often underestimated in hybrid system performance and compliance?

CJ: Data quality issues can undermine everything, from forecasting to compliance. In Kenhardt, Prediktor PowerView™'s validation layer and exception reporting helped surface inconsistencies between sources, like SoC mismatches or gaps in PCS data.

Without this, you risk acting on inaccurate inputs, triggering unnecessary maintenance, or breaching dispatch commitments. Prediktor PowerView™ constantly monitors for anomalies and provides confidence in both historical and real-time insights, enabling fast correction and preserving trust in the system.

PES: Kenhardt generated both trend and downtime analysis reports. How does historical insight drive better hybrid system reliability and optimization over time?

CJ: Historical trend and downtime analysis are key to improving reliability and optimising performance over time. It helps us spot recurring issues, understand root causes and make data-driven decisions. For a complex hybrid system like Kenhardt, this insight is essential to ensure long-term efficiency, availability and value.

PES: Were there any surprises in how the solar and BESS assets interacted in practice, vs. what was expected during planning?

CJ: Yes, one key surprise was just how critical accurate forecasting became for reliable system operation. We also realized the need for new KPIs, especially around system

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deviations and forecasted performance. Finally, the project highlighted the value of data-driven, contextual alarming to manage complexity and improve operator response.

PES: We talk a lot about dispatchability in hybrid systems. How did the project shift your thinking around how flexibility should be measured, delivered, and monetised?

CJ: Flexibility should be measured by the system's real-time ability to respond to grid demands, forecasts, and operational constraints.

Achieving this level of flexibility requires tight coordination between PV and BESS, accurate forecasting, and fast, reliable control systems.

PES: As hybrid systems like this mature, are you seeing a change in how asset owners and operators define value, both in terms of performance and risk?

CJ: Yes, there's a clear shift. Value is no longer just about energy output; it's about reliability, flexibility, and meeting commitments. Owners now focus more on forecasted accuracy, availability and responsiveness, because these can directly impact revenue and compliance.

Operationally, risk management, from equipment degradation to data quality, is also becoming central. In short, performance is now measured holistically and long-term value depends on how resilient and predictable the system is.

PES: Finally, based on everything learned here, what is the single biggest lesson you think the industry needs to understand if hybrid systems are to become the default model going forward, and what does this mean for TGS?

CJ: The biggest lesson is that data is no longer just a support feature; it is fundamental. If hybrid systems are to become the standard, we must move beyond viewing solar and storage as separate entities. We need to treat them as part of an integrated, responsive energy ecosystem. That requires intelligent infrastructure capable of real-time response, forecasting accuracy, and seamless scalability. This is not possible with siloed systems or inflexible software. Instead, we need adaptable platforms that unify operations, data, and insights across multiple technologies and geographies.

At TGS, this reinforces why we have invested in flexible, high-integrity platforms like Prediktor PowerView™, purpose-built to meet the operational, compliance, and optimisation demands of modern hybrid energy systems.

Hybrid systems are no longer an emerging trend; they are fast becoming the industry's new normal. The real opportunity lies in accelerating their rollout with tools that offer insight, agility and long-term reliability. That is where we believe we can lead the energy transition, and we are ready for what comes next.

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