
EKO

Why data quality is the missing link in solar forecasting performance

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As solar markets grapple with volatility, curtailment and negative pricing, the accuracy of short-term forecasting has become critical to PV performance. But while forecasting models continue to advance, their effectiveness still depends on one often-overlooked factor: the quality and integrity of the irradiance data behind them.

Across global solar markets, and particularly in Europe, the rapid expansion of renewable energy capacity is fundamentally changing how photovoltaic (PV) systems are operated. The increasing frequency of negative electricity prices and curtailment events reflects a structural imbalance between generation and grid flexibility.

As more solar capacity is deployed, the challenge is no longer limited to maximising annual energy yield, but increasingly focused on managing variability and responding to real-time grid constraints.

In this context, short-term forecasting has become a critical operational tool. Accurate irradiance forecasts on timescales from seconds to minutes allow operators to anticipate rapid changes in generation, prepare battery energy storage systems (BESS), and manage ramp rates to comply with grid requirements.

The difference between reactive and proactive control strategies can directly affect revenue streams, exposure to penalties and the overall efficiency of plant operation.

However, while forecasting techniques continue to evolve, incorporating satellite data, sky imaging and machine learning models, their performance remains fundamentally dependent on the quality of the underlying measurement data.

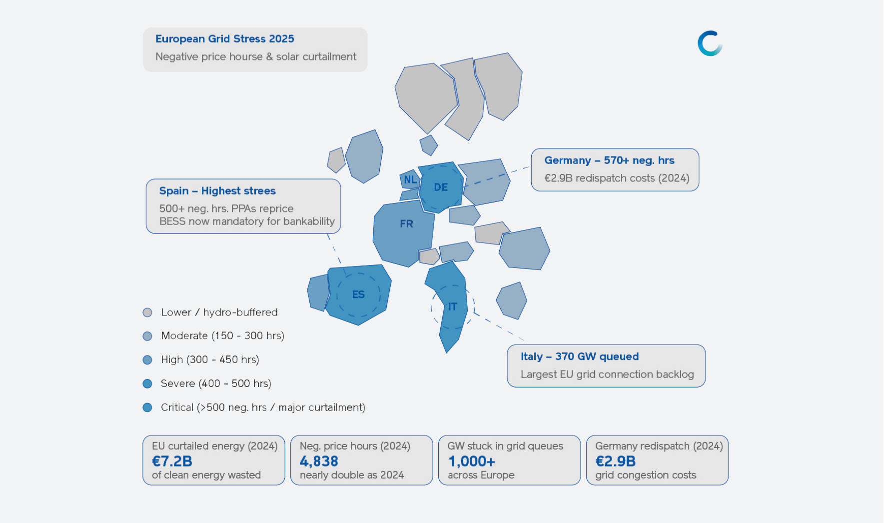
Forecasting systems cannot exceed the accuracy of the data they are trained on and validated against. This raises a critical question: how reliable is the irradiance data that underpins these systems?

Data and insights in this infographic are based on publicly available information and research from Aurora Energy Research, Ember European Electricity Review, Next Kraftwerke, Fortune, and Financial Times (FT).

Capturing fast irradiance dynamics: the role of sensor response time

One of the defining characteristics of solar irradiance is its variability. Under dynamic cloud conditions, irradiance can change rapidly, with fluctuations occurring on timescales of seconds or even sub-seconds.

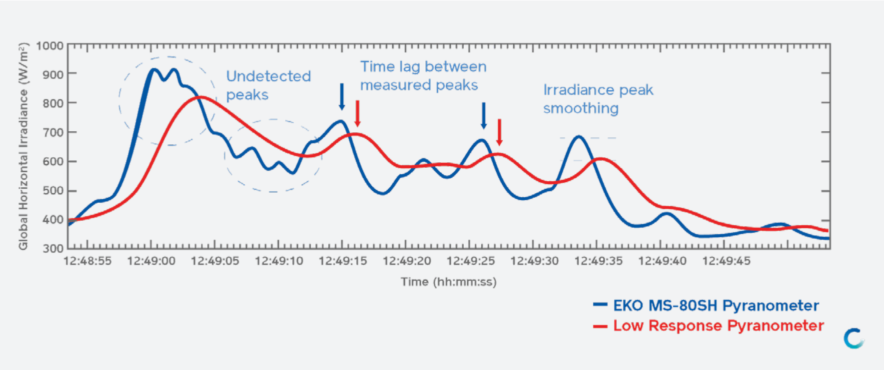
These rapid transients are particularly relevant for operational decision making, as they influence inverter loading, battery dispatch, and compliance with grid requirements such as ramp-rate limits.



Data quality is revenue protection

Poor data quality doesn't just distort forecasts; it converts operational uncertainty into guaranteed financial penalties.

In an environment where regulators charge for imbalance and inefficiency, clean, reliable data is not a back-office concern; it is a frontline revenue protection strategy.



Traditional pyranometers, based on thermopile technology, have historically been limited by relatively slow response times, often on the order of several seconds. While sufficient for long-term resource assessment, such response times are not adequate to capture fast irradiance ramps or short-lived cloud enhancement events. As a result, critical information is effectively smoothed out, reducing the ability of control systems to react in time.

Recent developments in sensor design have addressed this limitation. Fast response thermopile pyranometers, such as the MS-80SH, achieve sub-second response times, enabling the detection of rapid irradiance variations with significantly improved temporal resolution. This allows PV systems to 'see' irradiance changes as they happen, rather than after they have already impacted system performance.

In practical terms, this improved responsiveness supports earlier detection of irradiance spikes and drops, enabling more effective BESS control, improved ramp-rate compliance, and better management of inverter clipping events.

However, while fast response measurement improves the temporal fidelity of irradiance data, it does not, by itself, guarantee long-term data reliability. Sensors remain subject to environmental and operational influences that can introduce bias or degradation over time.

The hidden impact of data degradation

Even with high-quality instrumentation, irradiance data is vulnerable to a range of degradation mechanisms. Sensor soiling, for example, gradually reduces measured irradiance levels, often without immediate visibility. Calibration drift can introduce systematic bias, while installation issues such as tilt misalignment or partial shading can directionally distort measurements. In addition, errors in data acquisition systems, including incorrect time settings, averaging intervals or unit conversions, can further compromise data integrity.

A key challenge is that these issues rarely manifest as obvious failures. Instead, they develop gradually and persist over long periods, creating datasets that appear consistent but contain hidden inaccuracies.

When such data is used as input for forecasting models, these inaccuracies become embedded in the predictive system. Machine learning models, in particular, will learn and reproduce any bias present in the training data, leading to systematic errors in forecast outputs.

The consequences extend beyond forecasting. Irradiance measurements serve as the reference for evaluating PV system performance, including metrics such as performance ratio and specific yield. When the reference data is unreliable, it becomes difficult to distinguish between true system underperformance and measurement artefacts. This can lead to delayed fault detection, inefficient maintenance strategies and challenges in substantiating contractual or warranty claims.

In this sense, data degradation represents a hidden but significant source of operational and financial risk.

Why irradiance data validation still lacks standardisation

A notable gap in the current solar measurement framework is the absence of standardisation for irradiance data quality assessment. While hardware standards such as ISO 9060 define how sensors are specified, tested and certified under controlled conditions, no equivalent standards exist for validating the data these instruments produce in real-world environments.

This is primarily because data quality is inherently context-dependent: it is influenced not only by the sensor itself, but by installation practices, environmental conditions, maintenance routines, and data acquisition settings, all of which vary significantly from site to site.

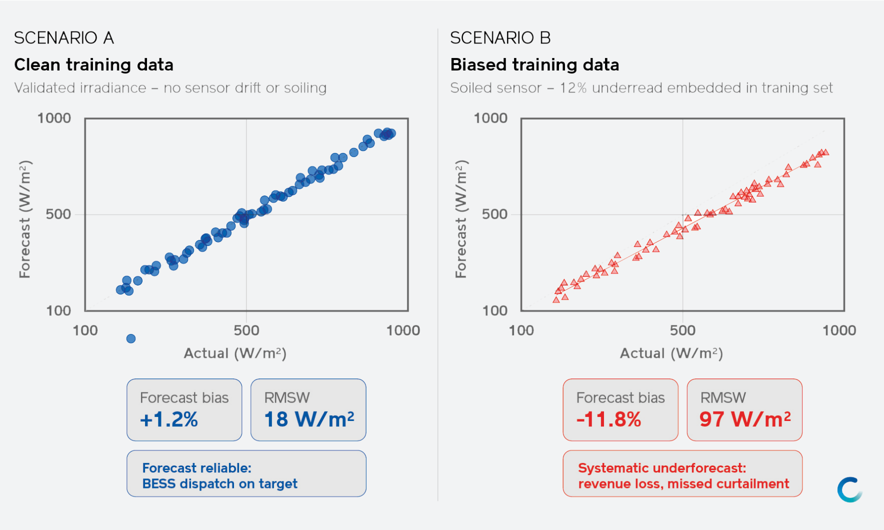
Unlike sensor performance, which can be reproduced and standardised in a laboratory, field data reflects dynamic and non-repeatable conditions that are difficult to formalise into a universal standard. In addition, the rapid evolution of PV system design, forecasting methods, and digital tools has outpaced the development of agreed validation frameworks, leaving data assessment methodologies fragmented and often organisation-specific.

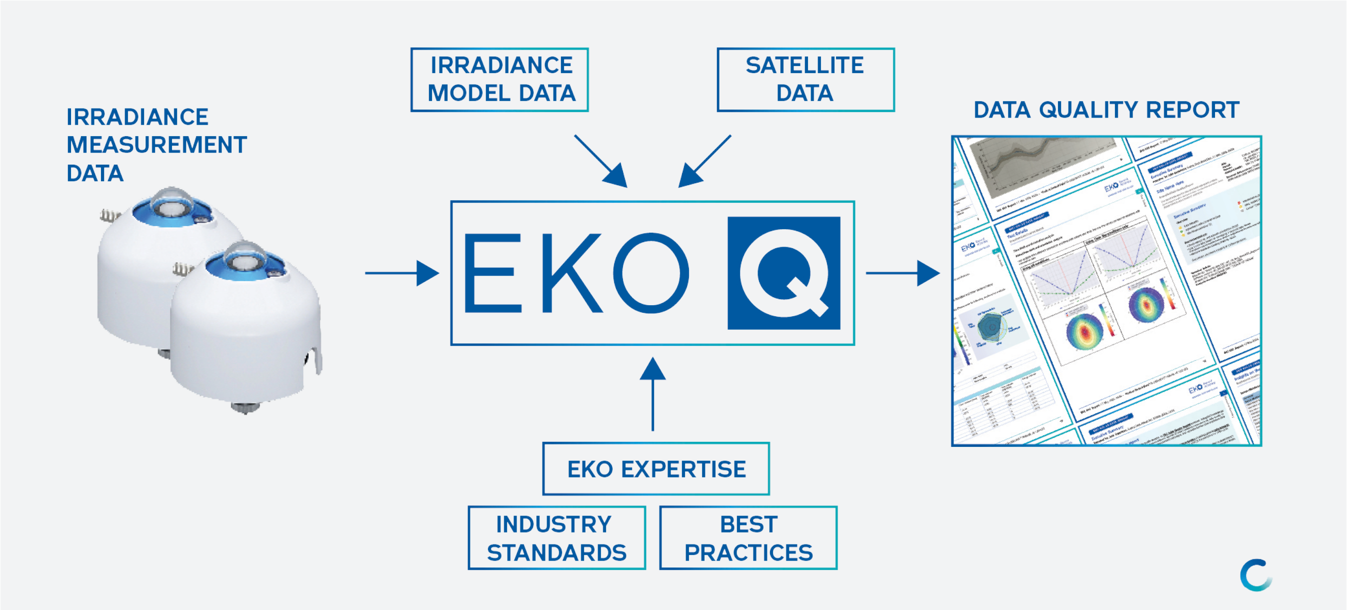
A further challenge is that meaningful data validation requires not only statistical analysis but also an understanding of sensor performance characteristics, including response time, directional sensitivity and environmental behaviour.

Incorporating this domain-specific knowledge is essential to correctly interpret measurement data and distinguish between true system effects and sensor-related artefacts. As a result, irradiance data validation remains an interpretative process rather than a standardised one. In response, structured approaches are emerging, where platforms such as EKO Q enable irradiance data to be analysed clearly and systematically, supporting more consistent and transparent validation across different applications.

Towards systematic data quality verification

Recognising these challenges, there is a growing need for structured and automated





approaches to irradiance data quality assessment. Rather than relying solely on periodic manual checks, these approaches aim to provide continuous and consistent evaluation of measurement integrity.

Typical methodologies involve multiple layers of analysis, including checks against physical limits, statistical analysis of data distributions, comparison between co-located sensors and benchmarking against independent data sources such as satellite-derived irradiance models. By combining these techniques, it becomes possible to detect both obvious anomalies and subtle long-term biases that would otherwise remain unnoticed.

In recent years, software platforms have been developed to support this type of analysis at scale. These tools automate the evaluation process and present results in a structured format that can be interpreted by both technical and non-technical stakeholders.

The latest platforms, such as EKO Q, provide one example of how this concept is being implemented in practice, offering automated quality checks and diagnostic insights based on established measurement principles.

While different solutions may adopt varying methodologies, the underlying objective is consistent: to transform irradiance data from an assumed input into a verified and transparent foundation for decision-making.

Enabling scalable and reliable PV operations

As solar portfolios expand across regions and continents, the need for consistent and scalable data quality management becomes increasingly important. Large operators must manage data from multiple sites, each with different environmental conditions, system configurations, and operational practices. In such contexts, manual validation is not only inefficient but also prone to inconsistency.

Automated data quality platforms support standardisation by applying consistent evaluation criteria across all datasets, regardless of location. With global coverage spanning Europe, Africa, the Middle East, the Americas, and Asia, solutions such as EKO Q are designed to support geographically diverse PV assets and provide comparable insights across portfolios. This capability is particularly relevant for asset managers and operators seeking to maintain consistent performance and reporting standards.

Beyond operational benefits, data quality also plays a role in shaping the overall value proposition of PV systems. Reliable, validated irradiance data enhances confidence in forecasting models, supports transparent performance evaluation, and strengthens the basis for financial and contractual decisions. For technology providers and system integrators, the ability to deliver not only high-quality measurement hardware but also verified data can represent a meaningful differentiation in an increasingly competitive market.

Conclusion: data quality as the foundation of modern solar operations

The evolution of solar energy systems from simple generation assets to complex, data-driven infrastructure has elevated the importance of irradiance measurement and analysis. ISO 9060 Class A fast-response sensors such as the MS-80SH provide the temporal resolution needed to capture rapid irradiance dynamics, enabling more responsive and efficient plant control. Automated data quality platforms also ensure that the data generated by these sensors remains accurate, consistent and reliable over time.

Together, these developments reflect a broader shift in the industry: from focusing solely on measurement accuracy to recognising the importance of data integrity throughout the entire operational lifecycle. As forecasting, control, and performance evaluation become increasingly interconnected, the reliability of irradiance data emerges as a critical enabler of system performance.

About the company

EKO Instruments is recognised for advancing innovation beyond the hardware of its sensors.

Through a deep understanding of solar irradiance measurement and photovoltaic system applications, the company has consistently contributed to raising industry expectations around accuracy, reliability and data integrity.

Its approach integrates sensor design with practical field performance, acknowledging that measurement quality extends beyond specifications to real-world conditions.

By linking measurement technology with data validation and application insight, EKO has helped shape evolving standards in both instrumentation and data quality, supporting more reliable performance assessment, forecasting and decision making across modern PV systems.

In this context, data quality is not an isolated technical consideration, but a foundational element that underpins the effectiveness of modern PV operations. Ensuring that this foundation is robust will be essential for operators seeking to navigate an increasingly complex and dynamic energy landscape.

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