Excellence in Solar Farm Operations

Company Profile

The client is a prominent solar farm owner and operator with a significant presence in the renewable energy sector. The company owns and operates a **200 MW** ground mounted solar farm which is spread over an area of 1,000 acres, strategically situated in Rajasthan, a region renowned for its ideal solar conditions. The solar farm plays a vital role in contributing to the renewable energy landscape of Rajasthan.

Case Summary

- In response to the increasing complexity of managing solar energy assets, the client sought to implement a comprehensive system aimed at enhancing operational stability, improving performance, and reducing O&M costs. A key requirement was a system capable of providing real-time monitoring and predictive analytics for critical equipment performance such as Inverter, SCB/SMB & IDT. This would empower the site O&M teams with actionable insights and recommendations, aimed at preventing catastrophic failures and optimizing O&M costs.
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- The client also needed a system for tracking production deviations, deviations in conversion efficiency , Monitoring of soiling depositions over the modules, conducting yield analysis, and gaining insights into lost production, alongside a centralized data repository for benchmarking performance across multiple sites.

- To address these needs, a digital platform was developed that integrates AI/ML analytics, SCADA, and digital twin technology, enabling efficient management of solar energy assets and ensuring optimal performance.

Business Challanges

Prior to the implementation of the system, the plant faced operational inefficiencies that significantly impacted performance, cost-effectiveness, and overall operational stability.

To address these challenges, the client required an integrated solution that would streamline operations, reduce O&M costs, improve asset health management, and enhance overall performance efficiency. The goal was to ensure quicker resolution of issues, minimize downtime, and optimize energy yield, ultimately driving improved operational outcomes.

Our Solution

To address the client's operational challenges, we implemented our Central Control Room for Renewable Assets (CCRA)—a scalable, AI-driven platform for centralized monitoring and management of renewable energy assets. This solution was integrated with 65 solar sites (3100 MW) and 21 wind sites (1050 MW), providing a comprehensive and secure system using open SCADA protocols (OPC UA & MQTT) for reliable data acquisition.

The system offers real-time performance monitoring, predictive analytics, and remote diagnostics, enabling proactive asset management. Key features include:

- Monitoring deviations in conversion efficiency, performance ratios, and power output.
- Tracking critical alarms, tripping, and breakdown events.
- Identifying underperforming assets and providing insights into potential issues.

The key challenges identified were as follows:

Decentralized Monitoring & Data Management

- Lack of a unified platform to manage all critical solar farm asset such as Inverter, SCB/SMB &IDT.
- Consolidating data from various sources proved to be a complex and time-consuming task, leading to delays in decision-making.

Operational Inefficiencies and Performance Loss

- Delays in identifying underperforming assets.
- Lack of real-time insights of deviations in current levels with respect to solar radiation.

Asset Health and Maintenance Challanges

- No predictive analytics for asset health monitoring.
- Monitoring of soiling depositions over the module.
- Increased downtime due to unanticipated failures.

Reporting Constraints

- Lack of a central data repository created significant challenges generating consolidated reports.

Our Solution

Key Features Include

- Generating custom reports and conducting historical performance benchmarking.
- Analyzing yield loss and production deviations at various asset levels.
- Monitor SCB/SMB performance by tracking deviations in current generation relative to solar radiation.
- ·Virtual string monitoring identifies underperforming strings and offers immediate recommendations for rectification.
- Monitoring of soiling depositions over the modules.

With this extensive monitoring assisted client with following insights:

Redistribution of DC loading of Inverter:

Through continuous monitoring & performing analysis and benchmarking of Critical Inverter parameters, it is come to notice that there was uneven load distribution between invertors as multiple inverters/Units are affecting with the Clipping in the peak hours, due to this the max load of inverter is not reached. Load shifting/balancing with nearby inverter. Overall inverter peak power is getting as per the connected DC/AC Ratio.

Clipping **loss reduced by ~5%**. Results in yield maximization **by ~2 MUs.**

Virtual String Monitoring:

By adopting virtual string monitoring mechanism, Reduced manual intervention for string monitoring. Real time remote monitoring of strings offers Timely identification & rectification of strings.

As a result, these improvements led to a **~16 MUs** increase in energy yield.

Success Recap

The implementation of the Central Control Room for Renewable Assets (CCRA) solution has significantly improved the management of the client's wind farm, setting a new standard for operational efficiency in renewable energy. By leveraging AI-driven analytics, real-time monitoring, and predictive maintenance, the solution optimized asset performance, increased energy yield, and reduced operational costs.

This digital transformation has enhanced energy production and ensured long-term reliability. The project highlights the transformative impact of digital solutions in renewable energy management.

Key Business Impact

Real Time monitoring of critical asset

Real time remote monitoring of strings offers timely identification & rectification of strings. As a result, these improvement led to **~ 16 MUs** increase in energy yield. Resulting in revenue gain of **~ $7,41,081 USD per annum.**

Early Detection of Underperforming Assets

Behavioral analysis identified uneven load distribution between invertors, with timely identification & rectification leads to reduction in Clipping **loss by ~5%** thereby enhanced energy yield by **~2 MUs.**

Yield Analysis

Enabled identification of production deviations and lost opportunities, optimizing energy output.

Predictive Maintenance & Alerts

Reduced breakdowns and improved operational reliability through predictive maintenance and quick alert systems.

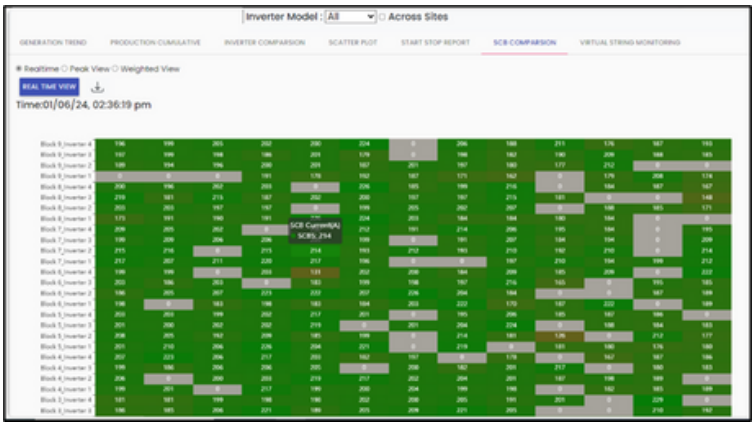
Benchmarking & Data Access

Facilitated continuous performance improvement through historical data and benchmarking.

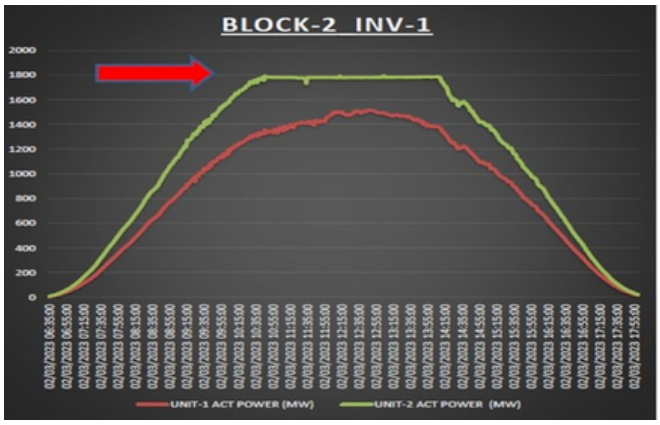
AI & ML Analytics

Improved real-time decision-making, enhancing asset management efficiency.

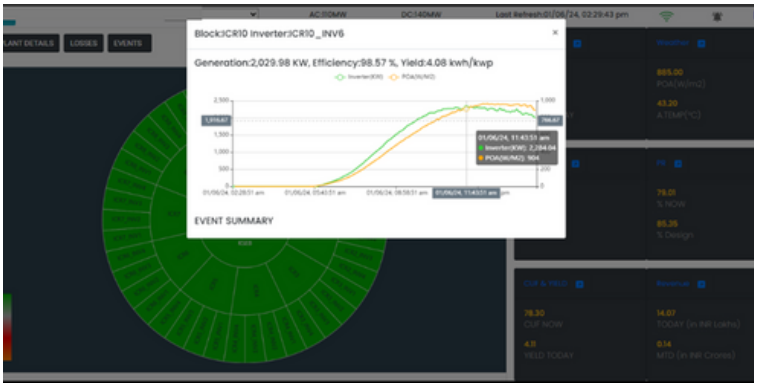
Heatmap for SCB



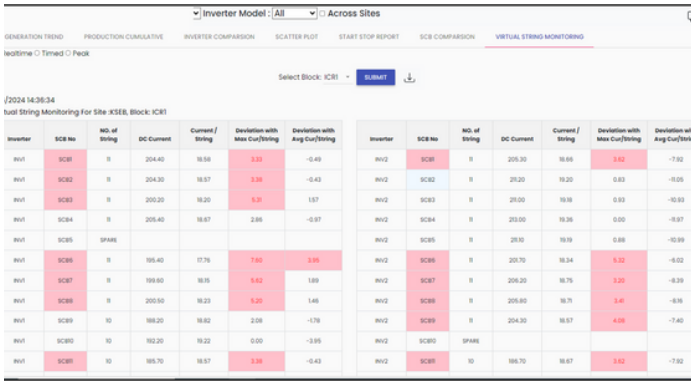
Redistribution of DC loading of Inverter



Comparative trend chart of Power and Solar radiation



Virtual String Monitoring



Real-Time Monitoring of Solar Site