SCEPTRE
INTEGRATED SOLUTIONS

CASE STUDY:
SIS AI-ENABLED SOLAR RELIABILITY & PERFORMANCE SOLUTION

Technology-Enabled Industrial Services Platform

OVERVIEW

Application:	**Utility Scale Solar Operations**
Location:	**Azerbaijan / Utility-Scale Solar Farm**
Industry:	**Renewable Energy / Power Generation**
Solution:	**SIS AI-Enabled Solar Reliability & Performance Solution**
Key Benefits:	**AI-Driven Energy Optimization, Predictive Maintenance, Autonomous Cleaning Robotics, Reduced Downtime, Improved Asset Reliability, Increased Energy Yield**

CASE STUDY: OPTIMIZING SOLAR FARM PERFORMANCE

Utility-scale solar facilities operate in harsh environments where dust, heat, humidity, and equipment degradation can significantly impact energy generation, reliability, and operating costs. Traditional monitoring approaches often fail to provide the real-time visibility and predictive insights required to optimize asset performance.

The client was experiencing reduced energy generation efficiency due to environmental contamination, delayed fault detection, fragmented operational data, and reactive maintenance practices.
Dust accumulation, inverter degradation, panel underperformance, and the absence of centralized AI analytics were contributing to avoidable generation losses and increased operational expenditure.
The client required a fully integrated intelligent platform capable of delivering:

- Real-time operational visibility
- Predictive maintenance capabilities
- Automated fault identification
- Autonomous cleaning optimization
- Improved reliability across critical infrastructure
- Reduced manual inspection requirements

SIS SOLUTION

SIS combines AI-enabled monitoring, predictive analytics, autonomous cleaning technologies, and engineering expertise to improve energy generation, reliability, and operational performance across utility-scale solar facilities.

SIS Solution Outcomes

- **Increased Energy Yield**
- **Reduced OPEX**
- **Improved Reliability**
- **Predictive Maintenance**
- **Autonomous Cleaning**
- **Real-Time Operational Intelligence**

SCEPTRE
INTEGRATED SOLUTIONS

CASE STUDY:
SIS AI-ENABLED SOLAR RELIABILITY & PERFORMANCE SOLUTION

Technology-Enabled Industrial Services Platform

AI-ENABLED SOLAR RELIABILITY & PERFORMANCE MANAGEMENT

CHALLENGES

Utility-scale solar facilities face increasing pressure to maximize energy output, improve equipment reliability, reduce operating costs, and maintain performance in harsh environmental conditions.

- Limited real-time visibility of asset performance
- Delayed identification of inverter and combiner box failures
- Energy losses caused by dust and environmental conditions
- Reactive maintenance increasing downtime and cost
- Lack of centralized integration between SCADA, OEM systems, and maintenance operations
- Fragmented operational data across multiple systems
- Inconsistent maintenance planning and inefficient workforce deployment

In harsh operating environments, environmental factors such as dust, heat, humidity, and panel soiling can materially impact energy generation, equipment reliability, and asset lifecycle performance. For utility-scale solar operators, even marginal efficiency losses can result in significant reductions in annual energy production, increased maintenance costs, and lower return on investment.

SOLUTION

Sceptre Integrated Solutions combines AI-enabled monitoring, predictive analytics, Industrial IoT, autonomous cleaning technologies, and engineering expertise to improve solar asset reliability, operational efficiency, and energy generation performance.

WHY SIS:

Unlike traditional monitoring platforms, SIS combines:

- ✓ **AI & Predictive Analytics**
- ✓ **Engineering Expertise**
- ✓ **Predictive Maintenance**
- ✓ **Asset Integrity Management**
- ✓ **Maintenance Execution**
- ✓ **Operational Optimization**

IMPROVED SCHEDULING

AUTOMATED TRACKING

REDUCED INCIDENTS

INCREASED PRODUCTIVITY

IMPROVED COLLABORATION

SCEPTRE INTEGRATED SOLUTIONS

CASE STUDY: SIS AI-ENABLED SOLAR RELIABILITY & PERFORMANCE SOLUTION

Technology-Enabled Industrial Services Platform

INTELLIGENT ASSET ARCHITECTURE

Solar Panels (PV Modules)
Sensors installed across panel arrays continuously monitored:
- Voltage output
- Current output
- Panel temperature
- String-level performance
- Power generation efficiency

AI analytics compared live panel performance across strings and zones to automatically identify:
- Underperforming panels
- Hotspots
- Cell degradation
- Shading impacts
- Dust contamination

Combiner Boxes
Integrated sensors monitored:
- String imbalance
- Fuse condition
- Voltage inconsistencies
- Connection temperatures

This enabled early-stage identification of electrical faults and cable degradation.

Inverters
Real-time monitoring systems tracked:
- Power output
- Efficiency
- Internal operating temperatures
- Fault alarms
- Cooling system operation
- Harmonic distortion

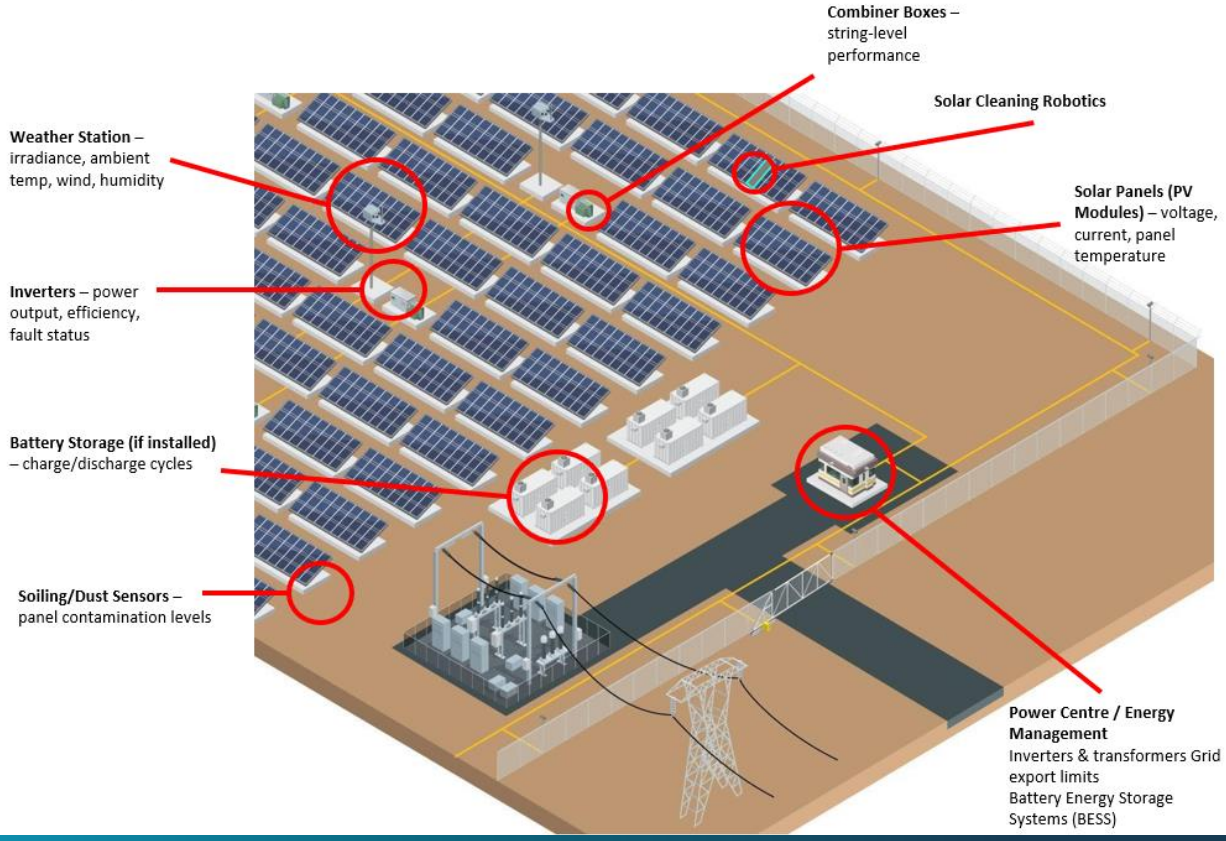
AI algorithms predicted developing faults and identified operational anomalies before critical failures occurred.

Weather Stations
Environmental monitoring stations captured:
- Solar irradiance
- Ambient temperature
- Wind speed
- Humidity
- Dust concentration

AI models correlated environmental conditions against expected power generation to optimize operational efficiency and forecasting accuracy.

Soiling Sensors & AI Cleaning Robotics
Dust contamination sensors installed across representative panel zones continuously monitored panel surface contamination levels.
Based on sensor inputs and AI performance analysis, autonomous robotic cleaning systems were automatically deployed to targeted areas requiring cleaning.
The robotic systems delivered:
- Waterless panel cleaning
- Night-time autonomous operation
- Reduced manual labor requirements
- Optimized cleaning frequency
- Increased panel efficiency
- Improved operational safety

The AI platform continuously calculated the commercial impact of soiling losses and optimized cleaning schedules based on energy recovery potential and environmental conditions.



SCEPTRE
INTEGRATED SOLUTIONS

CASE STUDY:
SIS AI-ENABLED SOLAR RELIABILITY & PERFORMANCE SOLUTION

Technology-Enabled Industrial Services Platform

OPERATIONAL PERFORMANCE IMPROVEMENTS

Improved Energy Output
Potential improvement of **5–15%** through AI-enabled performance optimization and autonomous cleaning technologies.

Reduced Downtime
Earlier fault detection and predictive maintenance can reduce unplanned outages by **20–30%.**

Autonomous Operations
AI-enabled robotics and automation significantly reduced manual inspections and maintenance workload.

Improved Reliability
Enhanced visibility and proactive intervention improve inverter, transformer and panel reliability.

Reduced Operational Costs
Optimized maintenance scheduling and automation reduce inspection and operational costs.

Improved Sustainability
Waterless cleaning technologies reduce water consumption and environmental impact.

SIS Value Delivered

By combining engineering expertise, AI-enabled operational intelligence, autonomous technologies, and maintenance execution, SIS transforms industrial assets from reactive operations to predictive, performance-driven environments.

✓ **Engineering Expertise:**
Reliability engineering, maintenance strategy, asset integrity and operational performance improvement.

✓ **AI & Operational Intelligence**
Predictive analytics, fault detection, performance monitoring and operational optimization.

✓ **Autonomous Technologies**
Waterless robotic cleaning, automated inspections and intelligent maintenance workflows.

✓ **Execution Capability**
Field implementation, maintenance intervention, asset improvement and lifecycle support.

ENGINEERING-LED APPROACH

SIS integrates reliability engineering, predictive analytics, robotic inspection and cleaning technologies, and operational expertise to improve solar plant performance, increase energy yield, reduce lifecycle costs, and enhance long-term asset reliability.