SENSIA
Rockwell Automation + SLB

+ CASE STUDY

Elevating ESP efficiency with AI-driven real-time analytics

Avalon + AiRP integration & power analyzer 2.0 across 11 wells

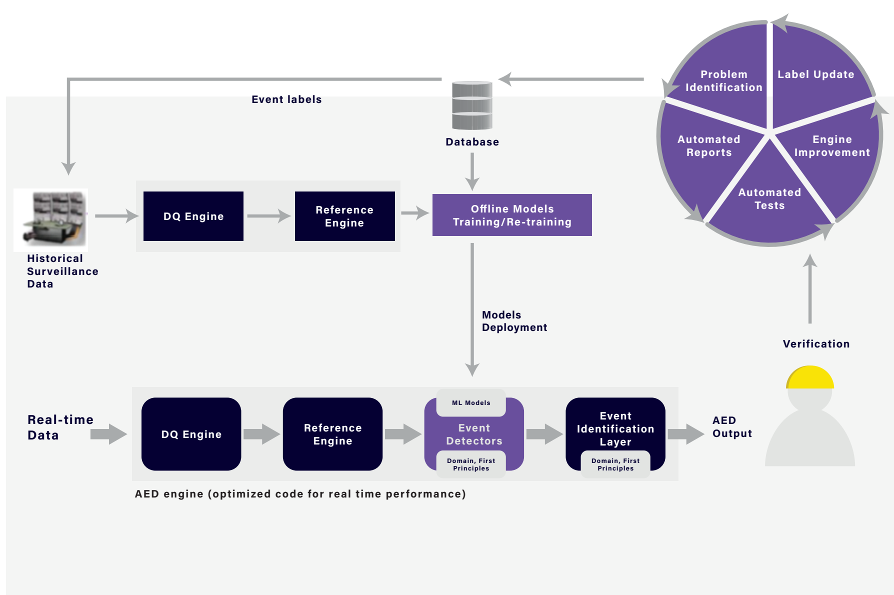
Challenges

- **Data limitations:** Sporadic, incomplete, or fragmented downhole measurements across systems.
- **VSD design constraints:** Primarily built for real-time control, not diagnostics or predictive analysis.
- **Dynamic well operations:** Frequent transitions between artificial lift methods; 36% start with ESPs but face response time inefficiencies due to delays.
- **Surveillance challenges:** Alarm fatigue from excessive notifications, delaying responses and increasing downtime.
- **System complexity:** Integration hurdles from safety valves, inflow controls, bypass systems, and sensor/SCADA architecture.
- **Infrastructure limitations:** Sensor telemetry and communication networks (wireless, satellite, cellular) hinder real-time monitoring.

Electric Submersible Pump (ESP) monitoring faced challenges due to fragmented data, complex systems, and energy inefficiencies. To address this, an AI-powered analytics solution combined real time power analysis, machine learning, and sensor networks to detect voltage irregularities, energy leaks, and equipment stress. This enabled predictive maintenance, reduced false alarms, and improved operational clarity. Tested across 11 wells, the solution minimized downtime, extended equipment life, lowered energy costs, and provided actionable insights - bridging the gap between technical and operational teams for more reliable and efficient performance.

Solutions

The Automated Event Detection (AED) system integrates four core components—Data Quality (DQ) engine, reference engine, ML-based event detectors, and an event identification layer—to monitor equipment like Electric Submersible Pumps (ESPs) in real time. The DQ engine validates streaming data, while the reference engine establishes baseline operating conditions and extracts features (e.g., noise levels, pump status). Event detectors use these features with machine learning to identify patterns linked to ESP anomalies, flagged to users via the identification layer. The system leverages high-resolution electrical measurements (voltage/current) for frequency domain analysis, distinguishing degradation-related signals from noise, and assesses drive performance through steady/transient state diagnostics. Operating non-intrusively, the AED combines AI analytics with IIoT connectivity to prioritize wells, reduce false alarms, and shift maintenance from reactive to preventive—extending equipment life, minimizing downtime, and optimizing energy use. Compatible with diverse VFDs, controllers, and connectivity options (Ethernet, Cellular), it offers cross-platform versatility for onshore/offshore applications, delivering cost savings through real-time anomaly detection and actionable insights.



Key Highlights

- Harmonics exceed 5% (indicating significant distortion in the electrical system).
- Potential presence of solids or gas in the system (causing operational disruptions or inefficiencies).
- High power consumption (inefficient energy use or system overload).
- Absence of permanently installed power quality monitoring devices (limiting real-time diagnostics and issue detection).
- Lack of correlation between process data from multiple wells and power quality metrics (hindering holistic system analysis and optimization)

Results

The system provides immediate visualization of power quality, detecting distortions in current/voltage waveforms and enabling real-time identification of harmonic filtering issues that risk motor winding and insulation degradation, thereby increasing the Risk of Failure (RoF). It identifies electrical stress during start-up events to refine operational practices, reducing excessive strain on motors and electrical systems to extend Remaining Useful Life (RUL). By pinpointing energy leaks, earth asymmetry, phase imbalances, and grounding faults, it mitigates RoF escalation. Operational-electrical correlations, such as synchronous frequency adjustments versus Total Harmonic Distortion (THD) and Power Factor (PF), are analyzed to optimize well-specific settings, enhancing RUL. The system detects mechanical or electrical stress from fluid composition changes or solids presence, while rapid assessment of voltage/current balance and shaft rotation direction safeguards motor integrity. Engineering analysis improves power efficiency and reduces motor slip in induction motors (IM), further boosting RUL. Integrated with Dismantle, Inspection, and Failure Analysis (DIFA), it offers insights into pump/motor damage, identifying Key Performance Offenders (KPOs) for precise failure magnitude estimation. When combined with AiRP, the platform enables Prognostic Health Management (PHM) solutions to accurately determine RoF and RUL for broader failure classes, driving proactive maintenance strategies.