

## Case Study

# Power Quality Optimization for BESS & Hybrid Energy System in South Africa



A high-visibility digital media billboard in South Africa was designed to operate using a hybrid energy system comprising the grid, solar power, an inverter with battery storage (BESS), and a generator backup. The goal was to minimize grid energy usage and ensure uninterrupted operation. However, since commissioning, the system experienced frequent voltage dips and inverter overloads, threatening operational reliability.

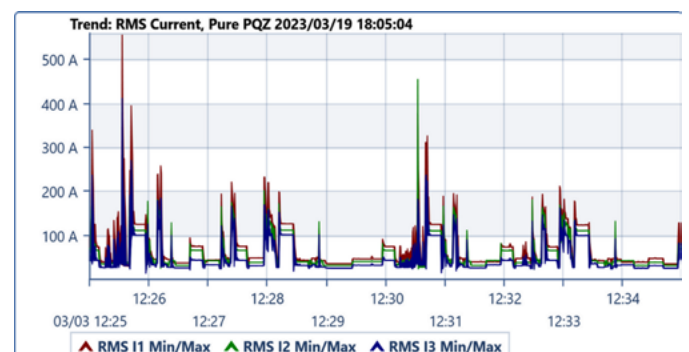
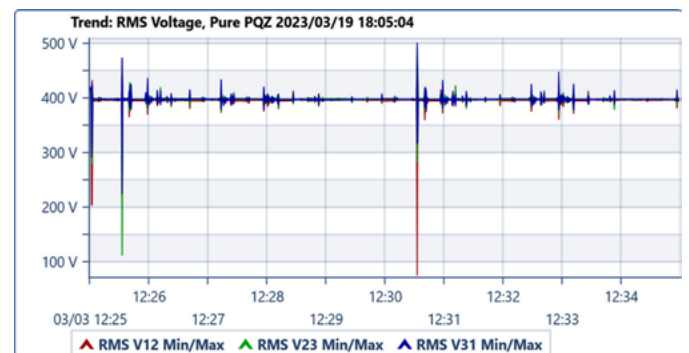
## Investigation & Findings

[Rubicon](#), Elspec's agent working in collaboration with [PQFlow Solutions](#) in South Africa, conducted a detailed power quality analysis using Elspec's PureBB [Power Quality Analyzer](#).

The investigation uncovered several critical issues:

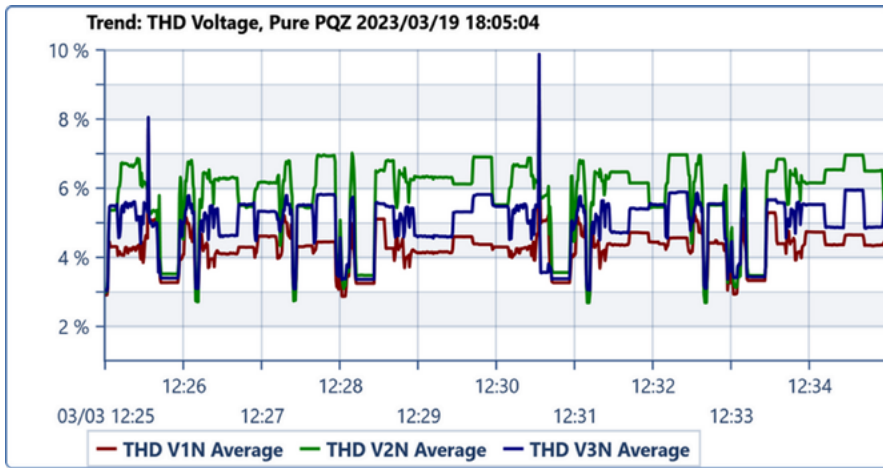
### Inverter Overload:

The inverter, rated at 217A, experienced load surges up to 558A, leading to instability. The initial energy meter used during setup failed to detect these extreme surges.



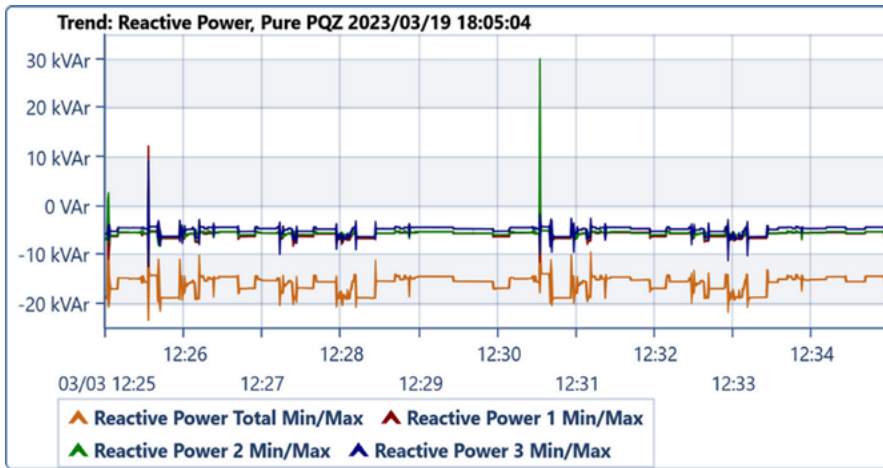
### Harmonics Distortion:

Total Harmonic Distortion (THDv) exceeded 8%, further strained the inverter and generator.



### Reactive Power Challenges:

A leading reactive power of 20kVAr placed additional strain on the inverter and generator.



Unbalanced loads further contributed to system inefficiencies.

Notably, the initial energy meter used during setup failed to detect these power anomalies, highlighting the need for advanced power quality monitoring.

## How PureBB Provided a Superior Analysis?

Unlike conventional analyzers and meters that use event-based recording, PureBB continuously records all waveforms without relying on predefined thresholds. This ensures that short-duration transients and surges are captured in full detail. In this case, the meter used during setup failed to detect the extreme load surges (from 217A to 558A), likely because it used threshold-based recording and averaged out short-term fluctuations.

### No Triggers or Thresholds – Captures Data Before, During, and After Events

Many meters only record power disturbances once a threshold is exceeded, missing crucial pre-event and post-event data. In this case, the PureBB recorded not just the extreme leading reactive power of 20kVAr but also how it developed over time and its impact on system stability. This level of insight allowed Rubicon to diagnose the root cause of instability.

### High-Resolution Harmonic Analysis (Up to the 127th Harmonic)

Most power quality analyzers measure harmonics only up to the 50th or 60th harmonic in compliance with IEC 61000-4-7. However, Elspec’s PureBB Analyzer measures harmonics up to the 127th harmonic, providing a much deeper analysis of harmonic distortion. In this case, THDv exceeded 8%, this included the higher-order harmonics. With its extended range, PureBB identified specific problematic harmonics, allowing targeted mitigation strategies. Higher-order harmonics, often generated by inverters, LED lighting, and variable frequency drives (VFDs), can severely impact power quality. The PureBB enabled Rubicon to pinpoint which harmonics were causing the most distortion.

## Accurate DC & Low-Frequency Disturbance Detection

Many meters struggle with accurate DC current and voltage measurements, especially in hybrid systems. The PureBB accurately detected power imbalances and phase unbalances, which were contributing to system instability. Conventional meters often overlook these nuances in AC-DC hybrid setups.

## Immediate Remote Access via PQSCADA App

PureBB data is instantly available through Elspec's PQSCADA software, allowing real-time visualization and deep analysis without the need for on-site data extraction. This allowed Rubicon to quickly analyze all waveform data remotely and diagnose the problem efficiently.



## Challenges Identified

1. Inverter Undersizing: The existing inverter capacity was insufficient for peak loads.
2. High Harmonics Distortion: Excessive THDv led to voltage distortion, impacting system components.
3. Unbalanced Phases & Reactive Power Issues: These factors contributed to instability and inefficiency.

## Solutions Considered

### Option 1: Install a Parallel Inverter

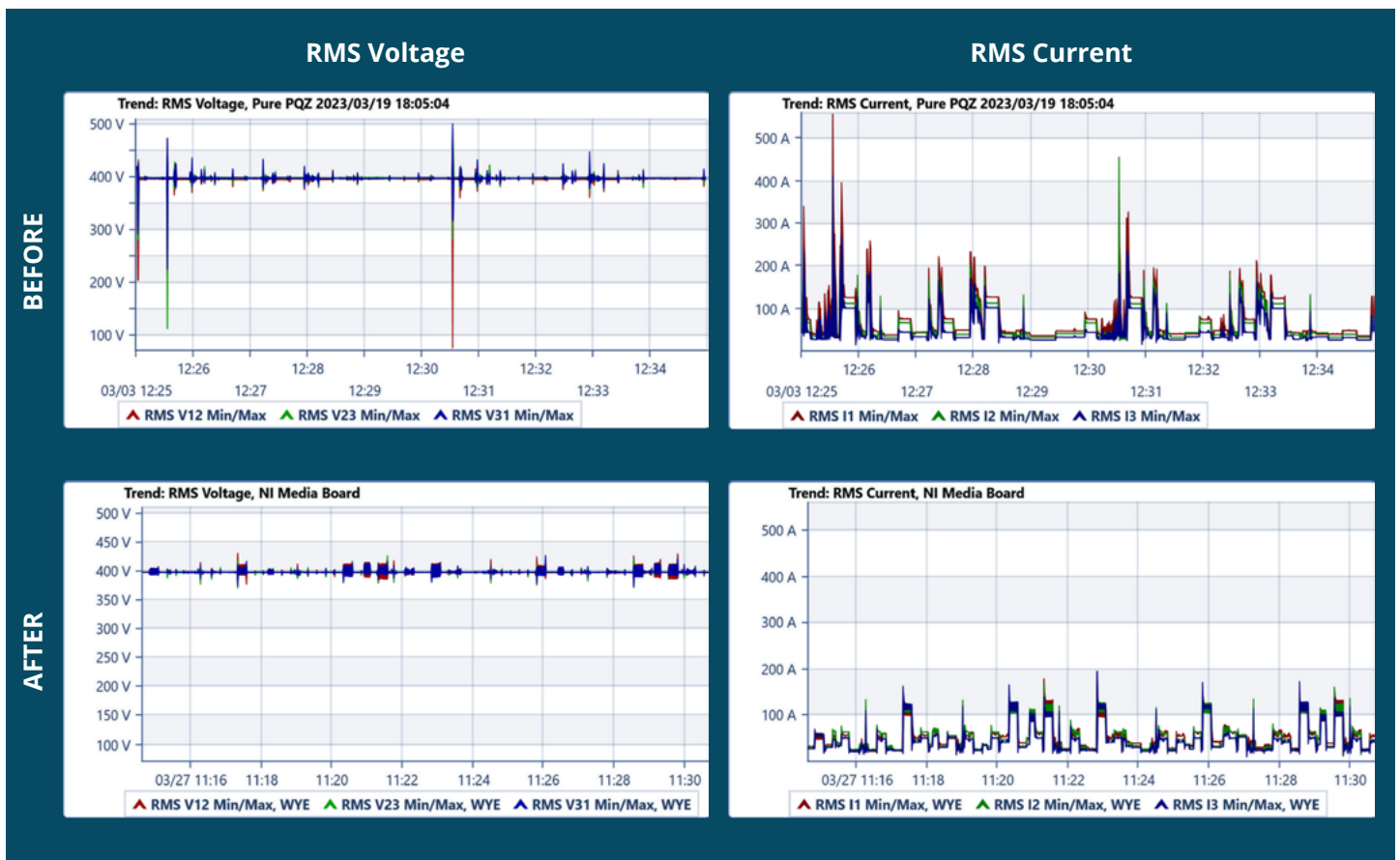
- Pros: Increased load capacity.
- Cons: High cost, continued leading power factor issues with the generator.
- Estimated Cost: 5x the price of a power quality solution.

### Option 2: Power Quality Intervention

- Solution Implemented: Installation of an Active Power Filter (APF).
- Reduced reactive power to lagging levels.
- Lowered THDv by 2–3%, improving voltage quality.
- Balanced phases, enhancing system stability.
- Eliminated inverter overloads, restoring operational

## Results

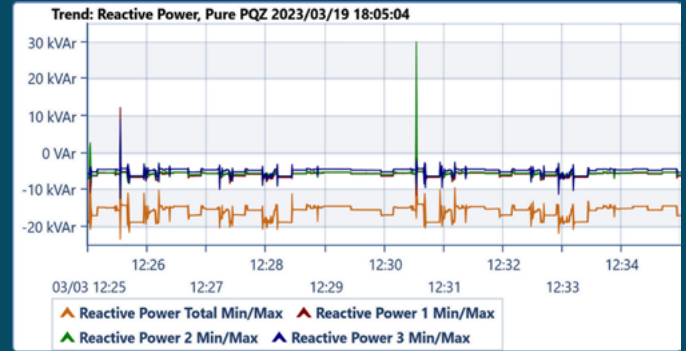
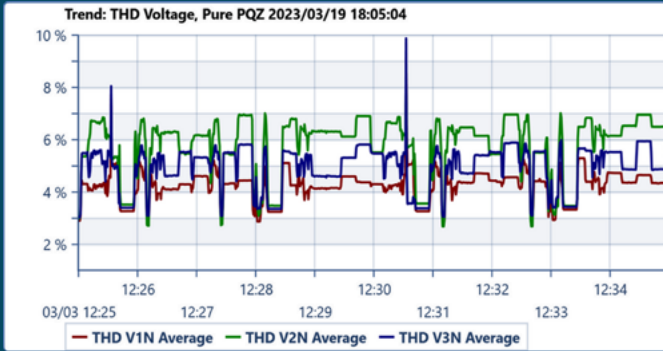
The chosen option was option 2. Intervention Results based on option 2: Before (Top row) graphs and After Compensation (bottom row):



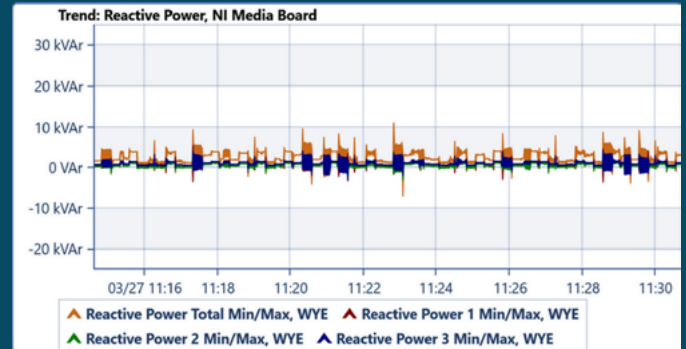
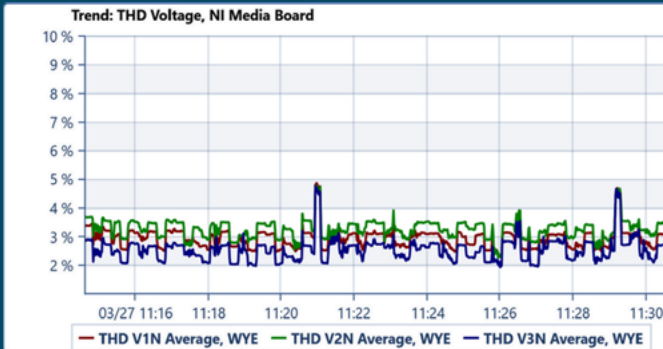
## Total Harmonic Distortion

## Voltage & Reactive Power

BEFORE



AFTER



- **System Stability Restored:** No more inverter overloads.
- **Power Quality Improved:** Voltage regulation and harmonics reduction ensured smoother operation.
- **Cost Savings:** 76% savings compared to installing a parallel inverter.
- **Long-Term Reliability:** The PQ intervention ensured efficiency and durability of the energy system.

## Conclusions

This case study highlights the critical role of advanced [power quality monitoring](#) in hybrid energy system including BESS. With Elspec's Analyzer, Rubicon identified and addressed power anomalies that conventional meters missed. The implemented power quality intervention provided a cost-effective and sustainable solution, ensuring uninterrupted operation and long-term efficiency for the media billboard.



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