Case Study

Eliminate Grid Penalties in Commercial Buildings with Varying Load Demand - Elspec's Hybrid Compensation SVG Approach

A major commercial bank in Colombia, experienced significant power quality issues and high expenses on grid penalties due to its highly variable load demand throughout the day. The challenge stemmed from low grid import during nighttime hours and sudden load surges in the early morning when operations resumed.

The Challenge

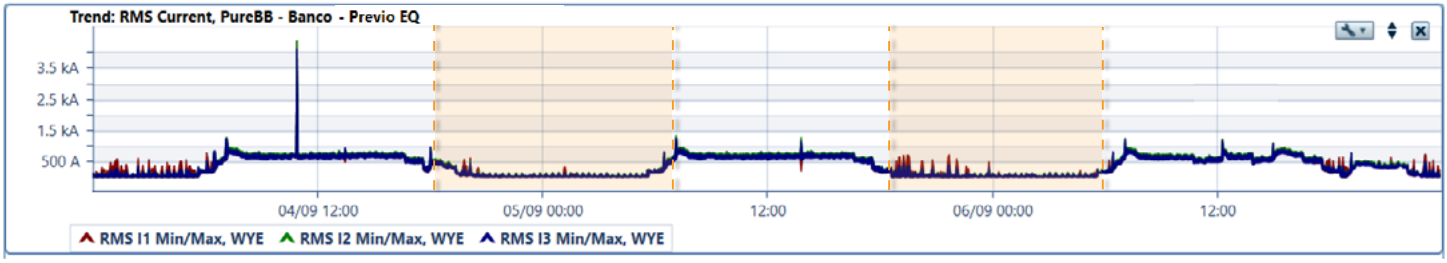
During low-load nighttime hours, the shift in consumption pattern resulted in a sharp decline in power factor, dropping below 0.9 inductive, primarily due to minimal current drawn from the grid.

This condition requires highly accurate reactive power compensation at low power levels to match the light and variable load. In the early morning, sharp load increases required high-capacity compensation to avoid voltage instability and penalty triggers.

The facility faced recurring fines totaling $3.1 million COP per month, with a penalty factor (M) of 12 due to continuous non-compliance.

Low Grid Import and High Grid Penalties: Why This Happens in Banks and Other Commercial Buildings

This type of power quality challenge is common in banks and similar commercial buildings. These facilities typically have low nighttime demand (running only essential systems) and rapid load increases during business hours. Devices like elevators, ATMs, UPS systems, and air conditioning units introduce non-linear and unbalanced loads, making precise compensation crucial. Banks also operate in tightly regulated urban areas, where utilities closely monitor and penalize poor Power Factor or excess reactive energy. This creates a strong need for dynamic, real-time Power Factor correction - especially in facilities with oversized transformers or fluctuating loads.



Common Approach & Limits

Most commercial facilities use step-based capacitor banks for reactive power compensation. While cost-effective for stable loads, they struggle in environments with rapid or low-load fluctuations - like banks. The fixed steps are often too large for low demand, causing overcompensation, instability, and poor power factor during off-peak hours.

A Cost-Effective Solution for Varying Load Demand

Elspec's PQ-Hybrid system solved the challenge by combining a 300kVAr Equalizer dynamic reactive power compensation with an ~80kVAr Static Var Generator (SVG) for stepless reactive power compensation, integrated into a single compact cabinet. What sets the PQ-Hybrid apart is its combination of thyristor-based step switching, real-time compensation, and SVG technology. Both the Equalizer and the SVG respond in less than one electrical cycle, enabling ultra-fast reactive power correction under varying load conditions.

While the Equalizer technology delivers high-capacity compensation during peak load periods, the SVG stepless technology "fills the gaps" and ensures seamless correction especially during low-load hours, ensuring stable power factor and full grid compliance at all times.

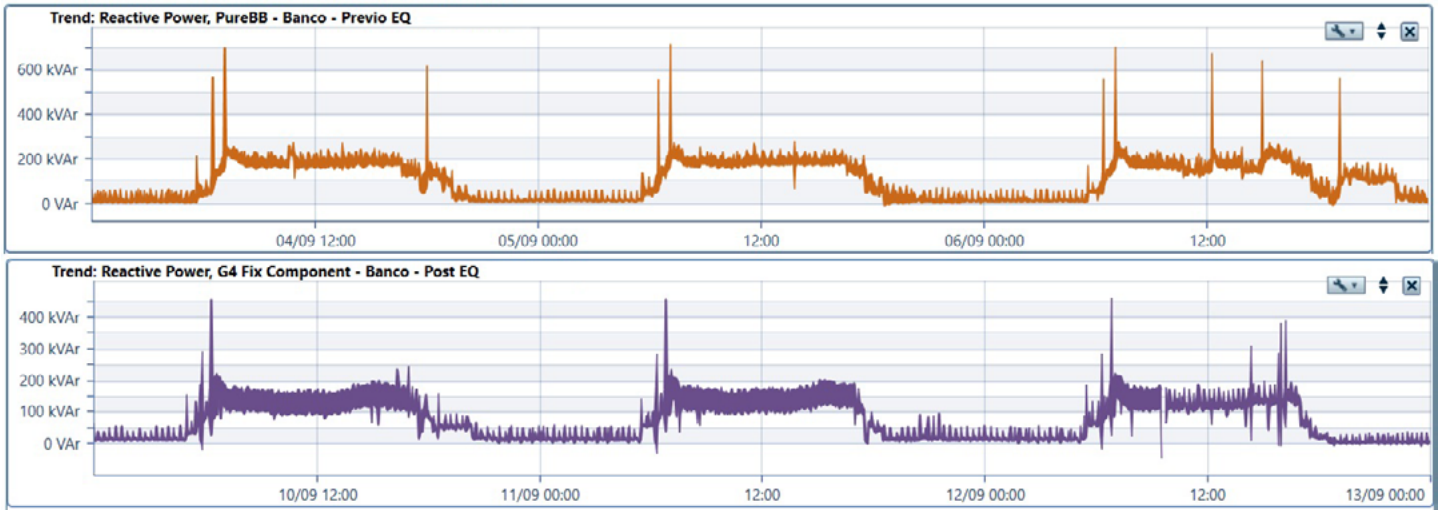
Measurement & Verification Approach

The project followed the IPMVP protocol to validate energy savings. A baseline simulation was performed in September 2023, followed by a complete post-installation verification in September 2024. Power quality was monitored with Elspec's Class A PureBB analyzer, recording continuous waveform data in high resolution. Analysis was done using PQSCADA Sapphire software, with additional high-resolution data from the Elspec G4420 Analyzer built into the Equalizer system, with sampling rate of up to 512 samples/cycle.

Key Results

Meeting Grid Requirements: Reactive Power Controlled, Grid Penalties Eliminated

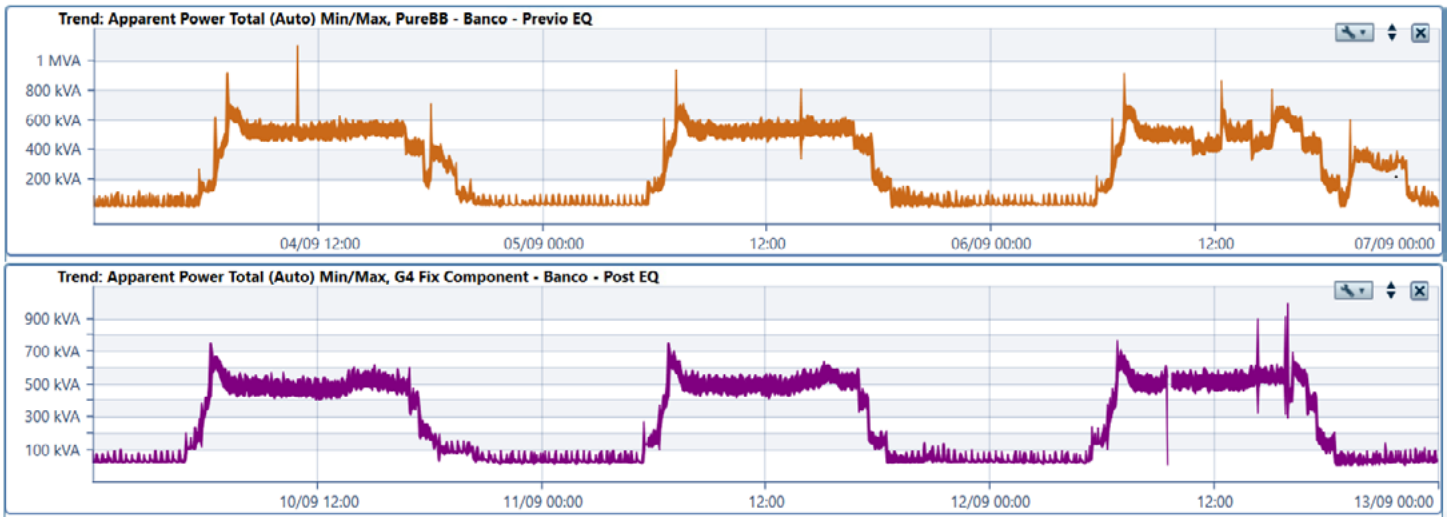
Reactive power reduced by 34.4%, from 101.98kVAR to 66.84Kvar. No hourly periods exceeded the 50% reactive-to-active energy threshold and Grid compliance was fully restored.



According to Colombian regulation CREG 015 of 2018, the ratio of reactive to active energy per hour must not exceed 50%. Prior to the installation, the bank frequently violated this limit, especially during nighttime low-demand periods, resulting in significant penalties. After implementing the PQ-Hybrid system, reactive energy was kept below this threshold in every hourly measurement, which restored grid compliance and eliminated all related charges.

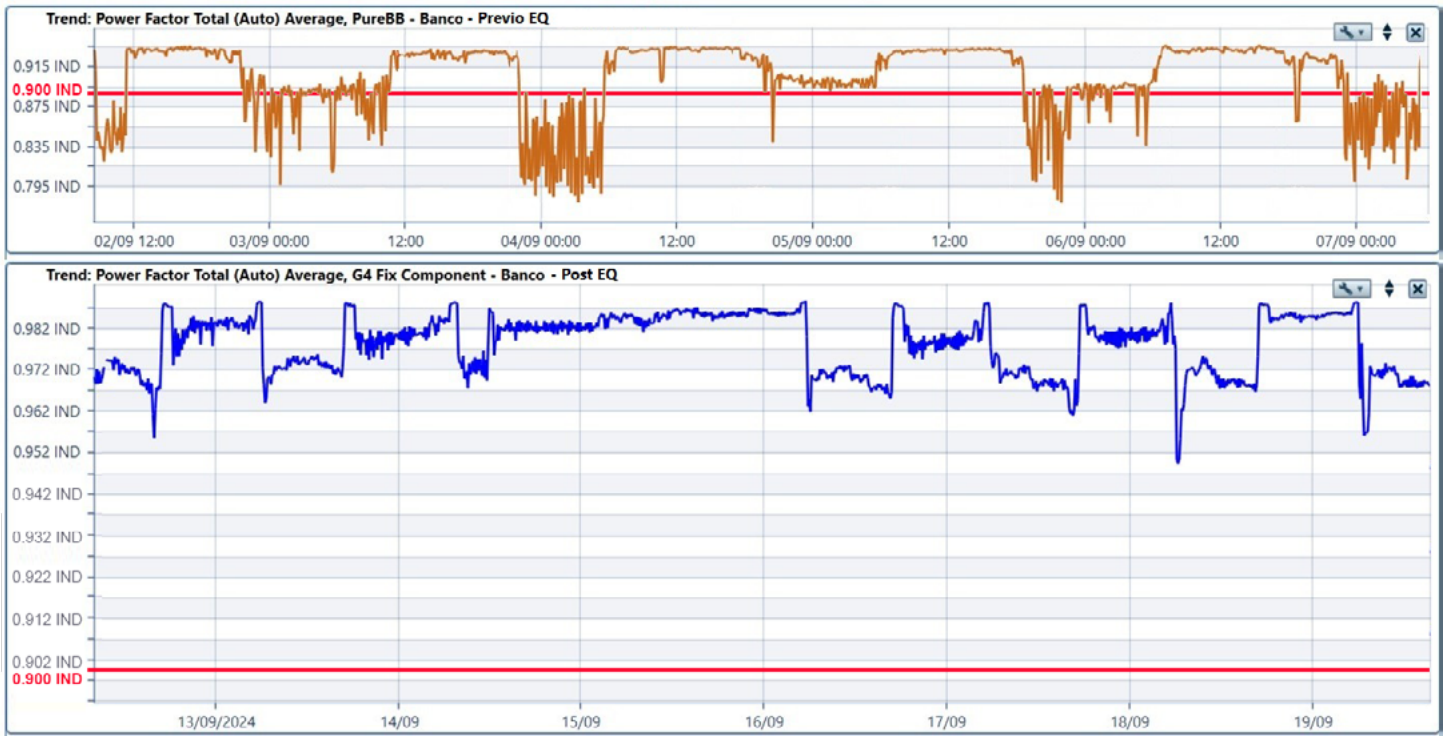
Optimized Transformer Performance

Prior to the installation, the transformer utilization factor stood at approximately 88%. After implementing the Elspec PQ-Hybrid solution, this figure dropped to about 80%, reflecting a reduction of approximately 9%. It is recommended to keep the transformer utilization below 85% of its capacity. This improvement reduces the apparent power stress on the transformer, which helps to minimize power losses and energy dissipation in the form of heat. As a result, it contributes to improved efficiency, extended equipment lifespan, and reduced operating costs.



Continuous Power Factor Compliance

According to local regulations, when the inductive reactive energy (kVArh) exceeds 50% of active energy (kWh), and the power factor is below 0.9, the utility applies an additional charge, multiplied by a penalty factor (M) that in this case reached the maximum value of 12.

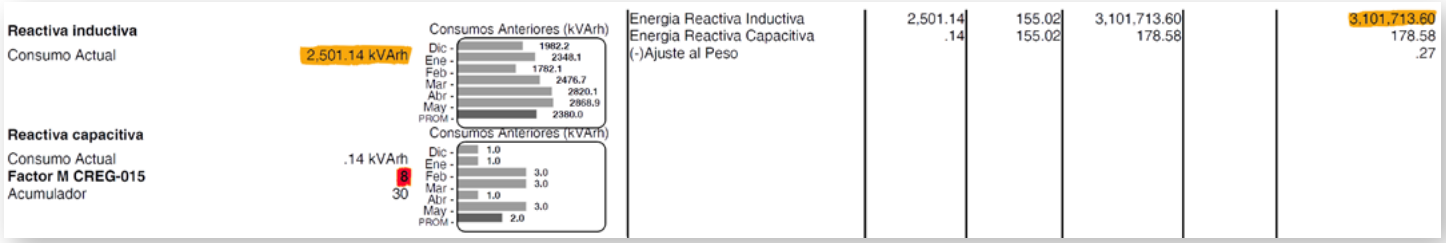


After implementation, power factor values stabilized around 0.975IND, with no recorded instances of non-compliance. This progression reflects an effective correction of the power factor, resulting in efficient system behavior and full alignment with the required technical standards.
Stepless compensation ensured a stable power factor of 0.975IND, maintaining compliance even under low-load conditions.

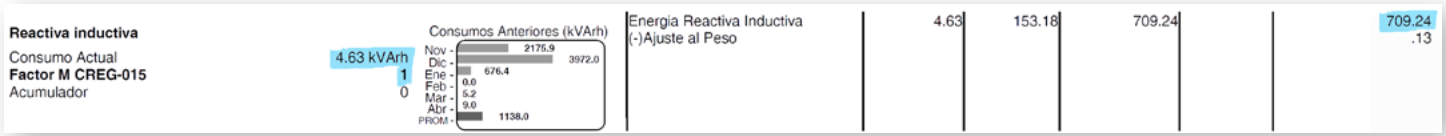
Billing & Regulatory Impact

Based on official billing reports from the utility operator, the bank's monthly energy charges showed a dramatic improvement after installing the Elspec PQ-Hybrid solution:

Before installation



After installation



Monthly fines dropped from $3.1 million COP to just $709 COP (>99% reduction)
Reactive energy charges decreased by 99.81%
Capacitive energy overcompensation eliminated
Penalty Factor M dropped from 12 to 1, and penalty history was cleared.

Conclusions

While Static Var Generators (SVG) provide precise, stepless reactive power compensation, deploying them alone for the bank's full reactive power needs was not economically viable. The high costs of sizing SVGs to cover both peak and low-load periods would have significantly increased CAPEX. Additionally, SVGs tend to generate constant heat losses, especially when oversized for occasional peak use.

Elspec's PQ-Hybrid solution successfully addressed the bank's complex load profile by ensuring stable power factor and penalty-free operation under all conditions. The embedded SVG played a key role by delivering stepless, real-time reactive power compensation, maintaining power factor continuity during low-demand periods. This made the system an ideal cost-effective solution for facilities requiring varying load demand, low-load correction and robust daytime support.