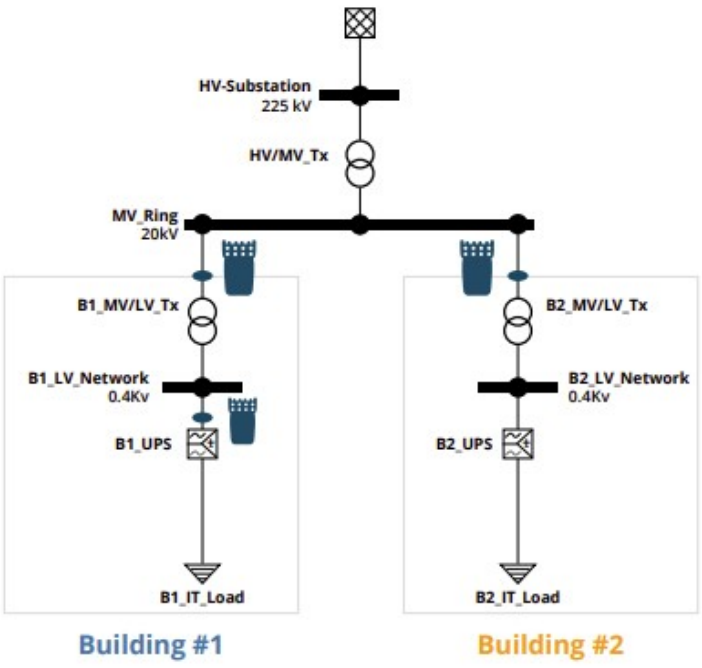
Ensuring Reliable Data Centre Commissioning

The Importance of Continuous Waveform Recording in Power Quality Monitoring

A newly built hyperscale data centre in France required detailed power quality monitoring during its medium and low voltage testing and commissioning phase. The facility comprised several buildings, all supplied through an internal high-voltage substation network. Each building featured an N+1 MV/LV transformer topology with large capacity UPS systems ensuring redundancy and uninterrupted operation. The customer approached ANALYSEO, Elspec's agent in France to perform some power quality measurement on the MV and LV levels. ANALYSEO deployed Elspec's analysers to perform power quality measurements on both MV and LV levels, validating system behaviour during commissioning and energization.



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Challenge

During energization of Building #2 MV transformer, ANALYSEO's engineers observed unexpected UPS behaviour on Building #1: • UPS systems in Building #1 switched to battery mode, despite no loss of utility power. • Multiple BMS alarms were triggered on Building #1, suggesting voltage or waveform disturbances originating from the MV substation. Given the complexity of the power architecture, identifying the root cause required high-resolution, time synchronized waveform data across the MV/LV network.

Power Quality Investigation

To isolate the issue, we approached the Analysers installed at the key points on both buildings #1 and building #2:

- Upstream of the MV transformers
- Upstream of the UPS systems in the LV side

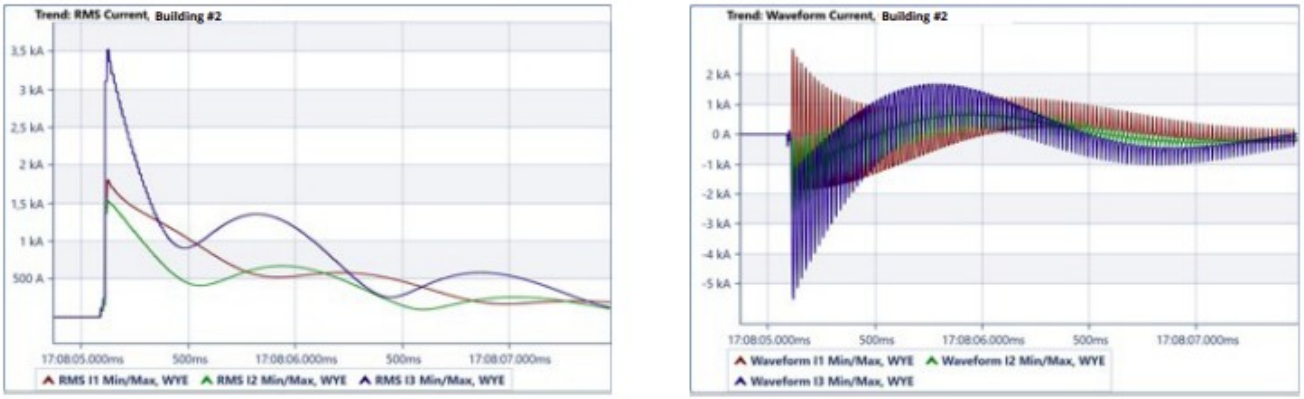
Power Quality Analyzer installed in medium voltage side (upstream B2_MV/LV_Tx)

Power Quality Analyzer installed in low voltage side (upstream B1_UPS)

Using Elspec's continuous waveform recording technology, the engineering team re-performed the MV transformers energization and analysed the complete event data across multiple locations.

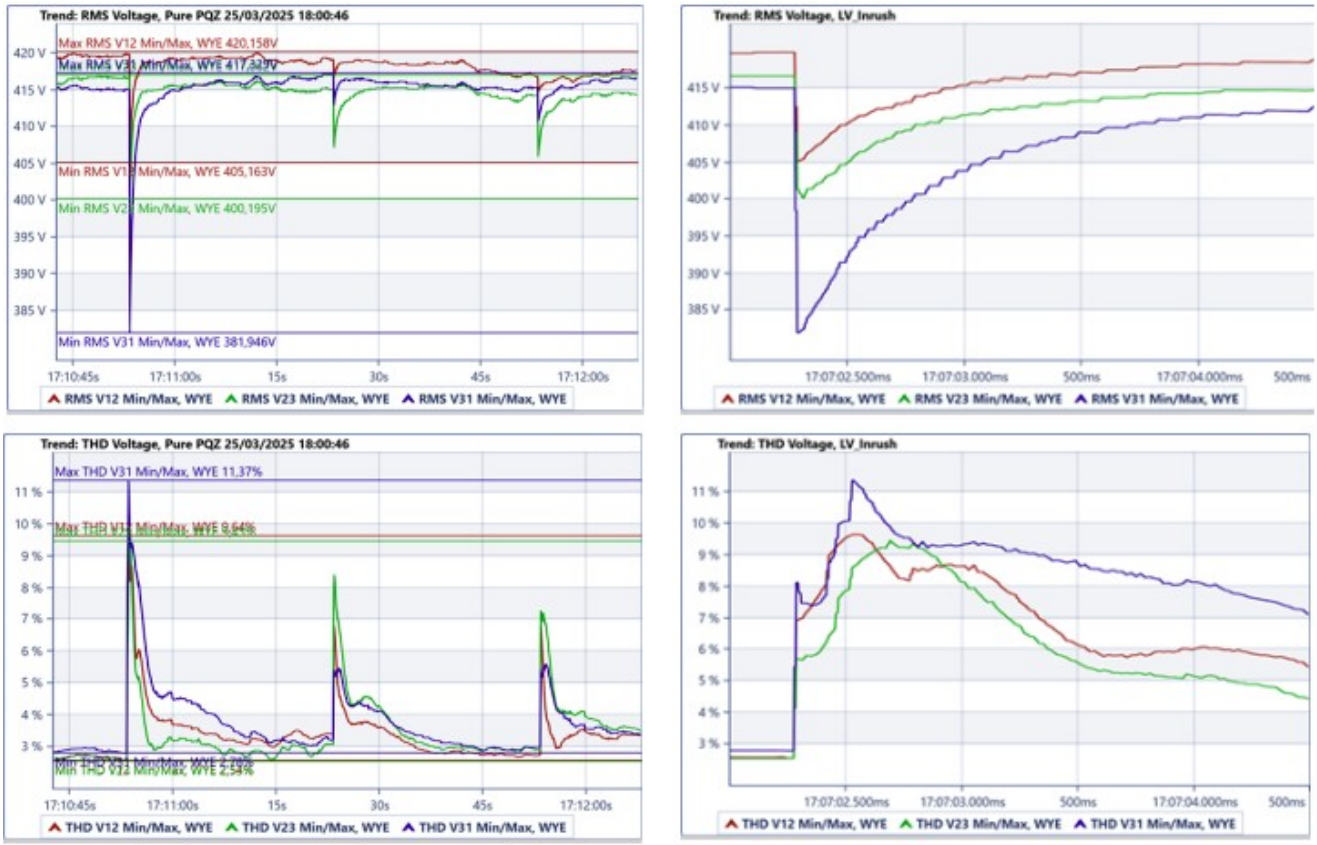
Root Cause Analysis & Findings

The building #2 MV transformer energization generated a non-linear inrush current reach in even-order harmonics.



MV side Power Quality recordings – Building #2 MV transformer inrush

This non-linear current generated during the magnetization of Building #2 transformer caused distortion in the voltage waveform, resulting in instantaneous peaks in the Total Harmonic Distortion of voltage (THDv%) observed in the building #1 Low voltage installation.



LV side Power Quality recordings – Building #1 UPS upstream

Reviewing the data from the analysers on the building #1 at the same time as the main inrush current spike (17:07:02), revealed voltage drops and THDv spikes. The maximum THDv% value recorded on Building #1 low voltage installation was out of tolerance rang of the UPS systems which were been operating under an "Eco/high-efficiency mode" which is more efficient but more sensitive to volage distortions. From this data it appears that the disturbances on Building #2 propagated through the shared HV substation to Building #1, where UPS systems tolerate THDv up to 5%, by generating voltage sags and temporary THDv% spikes due to current non-linearity. Once this limit was exceeded, the UPSs automatically switched to battery mode, interpreting the event as a power anomaly.

Continuous PQ recording provided full visibility into the true transient behaviour of the electrical system - capturing and recording every waveform, every cycle and every disturbance in real time and enables access to historical data.

This allowed engineers to:

- Observe instantaneous inrush current profiles and their asymmetric waveforms
- Track the voltage sag and harmonic distortion (THDv%) evolution over milliseconds
- Detect how disturbances propagated through the MV ring to the other building
- Correlate UPS operational transitions with exact waveform distortions This level of visibility exposed subtle interactions between transformers, UPS systems and the HV network, insights that standard PQ meters or transient recorders could not provide due to their limited recording duration, sampling rate or trigger dependency.

Solution

Based on the power quality findings, the engineering team evaluated several technical options to mitigate transformer energization effects and prevent UPS disturbances. This comprehensive analysis enabled the team to propose effective solutions balancing reliability, efficiency, and cost, ensuring stable operation during future load transfers.

Results

Power quality measurement was key to diagnosing complex energization interactions in the data centre's MV/LV network. Continuous waveform recording provided complete visibility into the real electrical behaviour - beyond what event-based tools could show. The analysis demonstrated that energy efficiency (PUE) must be balanced with operational reliability, especially in hyperscale environments. PQ insights enabled data-driven engineering decisions, ensuring stable operation and alignment with design and uptime targets.

Conclusion

This case highlights the essential role of power quality measurement during commissioning. Power quality measurement was key to diagnosing complex energization interactions in the data centre's MV/LV network. Continuous waveform recording provided complete visibility into the real electrical behaviour - beyond what event-based tools could show. PQ insights enabled data-driven engineering decisions, ensuring stable operation and alignment with design and uptime targets. Through detailed PQ investigation, the engineering team gained a clear understanding of MV substation dynamics and implemented corrective measures that secured reliable, disturbance-free operation for this data centre.