

Case Study

Improving Energy Efficiency in a Copper Pit Mine: Mitigating Voltage Fluctuations Across Excavators in the Pit Grid

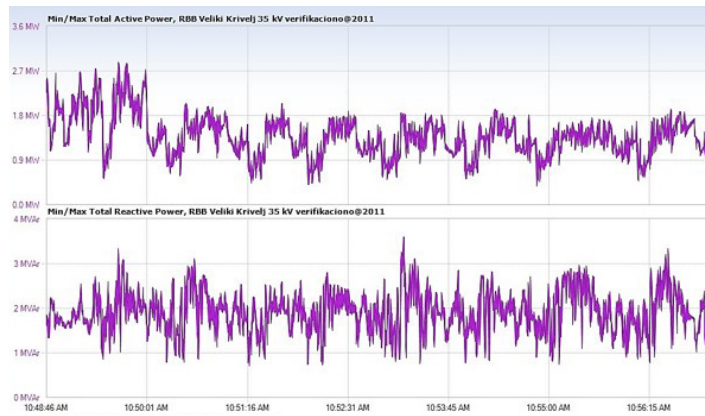


Espec's dynamic reactive power compensation system improved production and energy efficiency in an open copper pit mine by improving power factor levels, as well as reducing reactive power and voltage fluctuations.

The mining industry plays a pivotal role in global resource extraction, supplying vital materials across various sectors. Yet, conventional mining operations are known for their energy-intensive nature, leading to significant environmental impact and high operational costs. In response to these challenges, the spotlight has shifted toward energy efficiency solutions as a central concern within the mining sector.

Customer Situation

A Copper open pit mine in Serbia experienced operational problems and penalties from the local utility due to poor power factor. Within the pit's operational framework, four 6kV lines emanate from a shared 2x4MVA 35/6kV substation to power the excavators. The dynamic movements of the mining shovels creates load fluctuations, as shown in the graph below.



Active and Reactive power profile of pit excavators

As seen in the graph above, the load is very dynamic, active power spanning from 0.5 to 2.6 MW, alongside reactive power variations spanning 0.9 to 3.2MVA. This dynamic behavior resulted in an average power factor of 0.64. Due to the considerable length of the transmission lines and the impedance of the transformers, the resultant current fluctuations increased to pronounced voltage fluctuations. These fluctuations had a direct impact on the efficiency of regular digging operations, leading to a reduction in torque on the motor shaft and a frequent occurrence of under-voltage tripping.

The power factor of 0.64, induced high reactive power penalty from the local power utility. To avoid penalties, the customer targeted the average power factor to 0.99. Given the rapid rate of reactive power changes, a conventional MV Power Factor Correction approach would fall short of achieving the desired power factor.

To address these multifaceted challenges and to optimize energy efficiency, a different solution was indispensable.

Solution

Elspec's 3MVAR [dynamic reactive power compensation system](#).

Elspec's agent in Serbia, Avalon Partners, conducted an in-depth power quality investigation and recommended a 3MVAR dynamic reactive power compensation system by Elspec. This system uses ultra-high power thyristor switching technology, providing transient free smooth switching by connecting capacitors at zero-crossing. The system's full acquisition time is less than one cycle. Avalon Partners delivered and commissioned the complete solution.



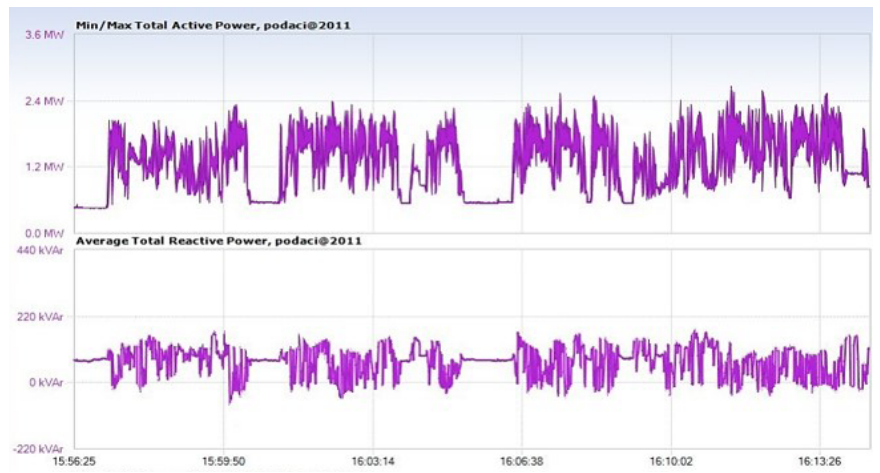
Elspec's 3MVAR Equalizer system



35/0.69kV step-up transformer

Results

The figure below shows the active and reactive power of the mine after the Equalizer installation. The excavators' operating mode remained unaltered, with active power levels ranging from 0.6 to 2.3MW during the verification measurement. The reactive power was effectively stabilized and reduced, transitioning from its initial range of 1MVar to 3.2MVar to a much narrower span of -50kVar to 210kVar. As a result of the project, Power Factor improved from an average of 0.64IND to 0.99IND, as requested. Transformer current also decreased significantly by 36%.



Open pit mine Active and Reactive power with Elspec's Equalizer in operation

	P [kW]	Q [kW]	Cos fi	RMS reduction
Before	500-2600	900-3200	0,64	-
After	600-2300	-50-170	0,99	36%

Conclusions

The implementation of the Elspec's [Equalizer system](#) significantly improved the equipment uptime and excavation capacity. This solution enabled the customer to achieve substantial reductions in their utility bills and eliminated penalties. Moreover, it led to a substantial decrease in losses within cables and power transformers. This newfound efficiency not only contributed to cost savings but also freed up capacity, enabling the seamless integration of new loads within the mine.

This case study highlights the potential for cost savings, reduced environmental impact, and enhanced operational efficiency by adopting energy-efficient technologies and practices.



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