

# The Valencia algorithm: Calculating costs of energy loss due to poor power quality

## Technical Note

Thanks to a breakthrough at Polytechnic University in Valencia, Spain, power quality analyzers are now able to calculate the cost of energy loss due to inefficient electrical systems.

### Just what is power quality?

Power quality is generally defined as the voltage that will enable continuous, safe operation of equipment connected to a power source. It's usually expressed as a tolerance around the normal operating voltage level. Voltage can dip or sag below the normal level or, conversely, it can also swell, spike or surge. The former can cause equipment to reset or momentarily power down; the latter can damage equipment, blow fuses or cause breakers to trip.

Generator. Junction box. Transmission lines. There are a number of places problems may occur in an electrical circuit. However, 80% of all power quality issues originate within a user's own facility. Problems may be due to power quality issues such as unbalance or harmonics,

poor electrical installation, deteriorating wiring or improper grounding. Starting large loads in a facility can disrupt adjacent equipment as the high current drawn causes supply voltage to slip.

Symptoms include equipment resets or spurious circuit breaker tripping. Programmable logic controls (PLCs) and variable speed drives may be affected as control signals are interrupted. Motors and transformers can run hot or noisy. Computers may lock up causing data loss.

Whether a dip or swell, flicker or transient, power disturbances can increase operating costs—including those for energy—and bring about premature equipment failures.

### In search of the perfect measurement

Since the 1940s, formulas for measuring power quality were based on non-distorted voltages and balanced systems of motors, lighting and other linear loads of the day. With the advent of power electronic equipment such as computers and variable speed motor drives, loads became non-linear and harmonic-producing, often resulting in distorted voltages and currents that affected the characteristics of the power delivered and the system capacity required to supply it.

Over the years attempts were made to arrive at a universally accepted measurement of power quality that took into account modern power equipment. In 2000, the Institute of Electrical and Electronics Engineers (IEEE) established Standard 1459. This blueprint of definitions and formulas allowed meter and other monitoring equipment manufacturers to implement accurate power measurements in environments with significant distortion.

However, while 1459 provided definitions of power measurement, the formulas expressed power quality in values that were more comparative than tangible. Put another way, the values were more academic than practical.



### **“Nothing like it on the market”**

Since Standard 1459, academics and engineers sought a formula that expressed power quality in terms that were more useful to engineers and technicians. Professors Vicente Leòn-Martinez and Joaquín Montañana-Romeu of Valencia University in Valencia, Spain, had the inspired notion to incorporate energy loss into the equation.

“We formed the research team in 1996 to try to explain the functioning of electrical systems in order to make them as efficient as possible,” explains Leòn. Adds Montañana, “If we know the energy lost we can predict what the savings will be. There’s nothing like this on the market.”

### **The Valencia Algorithm: Energy lost is money lost.**

Since opening its doors in 1968 the Polytechnic University of Valencia has built its reputation as a teaching and research facility, undertaking applied research projects jointly with national and international bodies and companies. Such projects have brought 52 million Euros of research and development activity—and more than 200 patents—to the school.

Professors Leòn and Montañana were awarded one such patent for their breakthrough work eventually resulting in the development of an energy analyzer. As instructors in the school’s Department of Electrical Engineering they pioneered the development of a mathematical algorithm that analyzes electrical systems in terms of energy efficiency.

Through a series of theoretical and practical experiments with automobile companies, electrical utilities and others, the pair was able to test and verify their formula, analyzing energy loss and calculating the corresponding costs to the respective organizations.

### **Power quality analyzers: Taking the uncertainty out of the power quality equation**

Since the introduction of power quality analyzers, users have been able to validate incoming power quality at the service entrance, verify electrical system capacity before adding loads, detect and prevent power quality issues before they cause downtime, and help uncover hard-to-find intermittent issues. Troubleshooting analyzers with display screens show three-phase measurements for harmonics, power, sags and swells, transients, voltage and current waveforms.

And thanks to the Unified Power Measurement Method developed by the University of Valencia, the monetization of energy loss due to poor power quality can now be a viable part of your measurements.

### **In practical terms**

To understand what this means in industrial applications, let’s briefly consider two examples. Large drive systems—such as electric motors—inject increased harmonics into the power system, which distorts the voltage signal. Conductors overheat, cables burn, connections fail.

With three-phase systems, loads can build if the current is not balanced. Motors fail to spin concentrically. Shafts vibrate causing misalignment. The inefficient system requires more energy and eventually fails over time.

In both cases, proper power quality analysis could detect problems. Energy calculations could determine how much energy is being wasted and the corresponding cost. Companies can then develop a cost/benefit plan for repair or replacement.

### **Power quality analyzers just became more powerful**

Valencia University and Fluke, Inc. have teamed up to benefit end users. So not only will test and measurement tools be able to analyze power quality, they’ll also be able to calculate energy lost due to poor power quality, apply a monetary figure to it, and help find appropriate solutions to eliminate the problems. In short, facilities will become more efficient. And companies will save money.

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