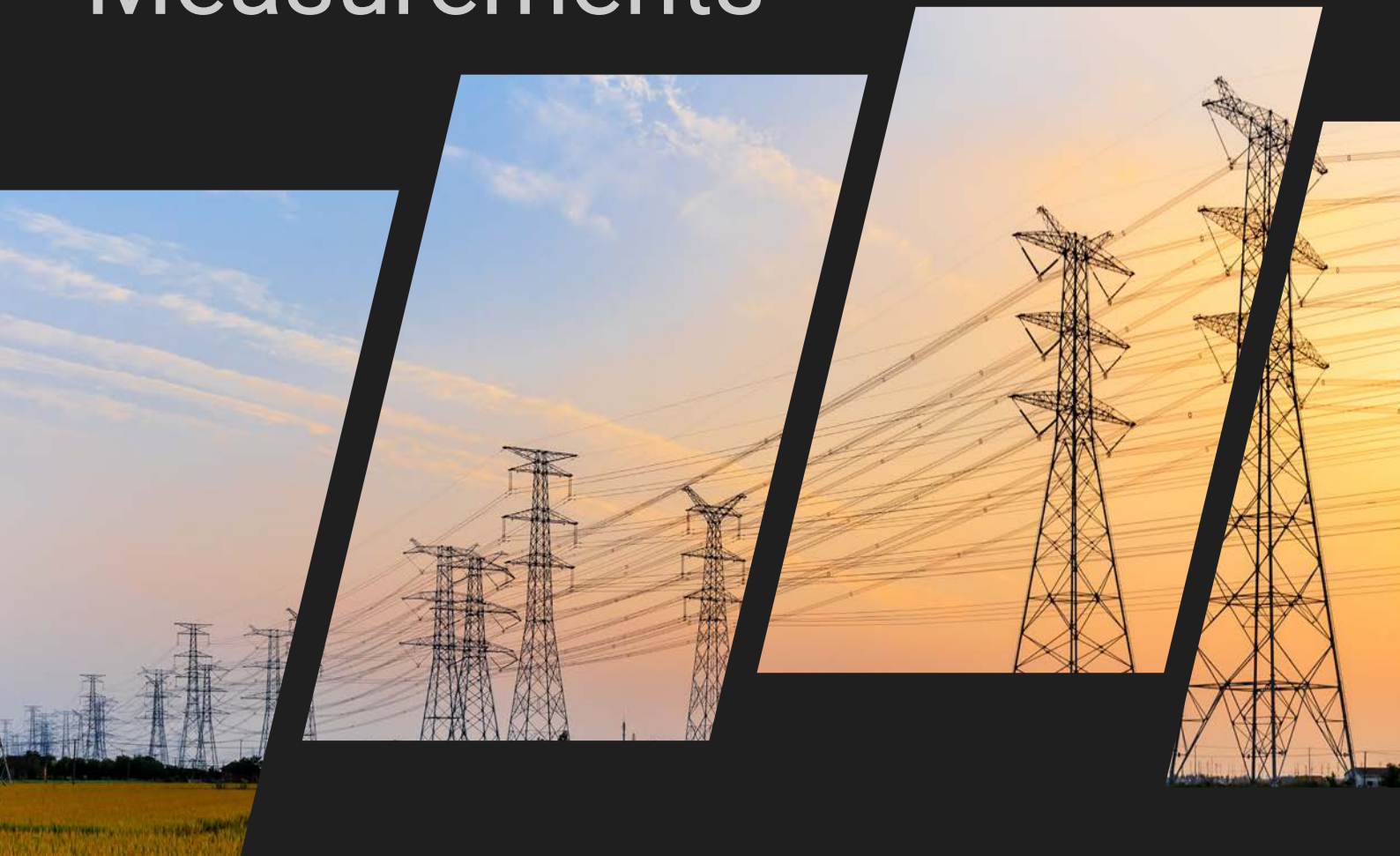


# Power Quality Measurements



**ENERGY SOLUTIONS**



## **MEASURE**

We collect critical power quality data across unique energy distribution environments.



## **ANALYZE**

We identify causes of electrical power problems and pending equipment risks.



## **PROTECT**

We implement tailored power quality solutions to protect against costly network issues.



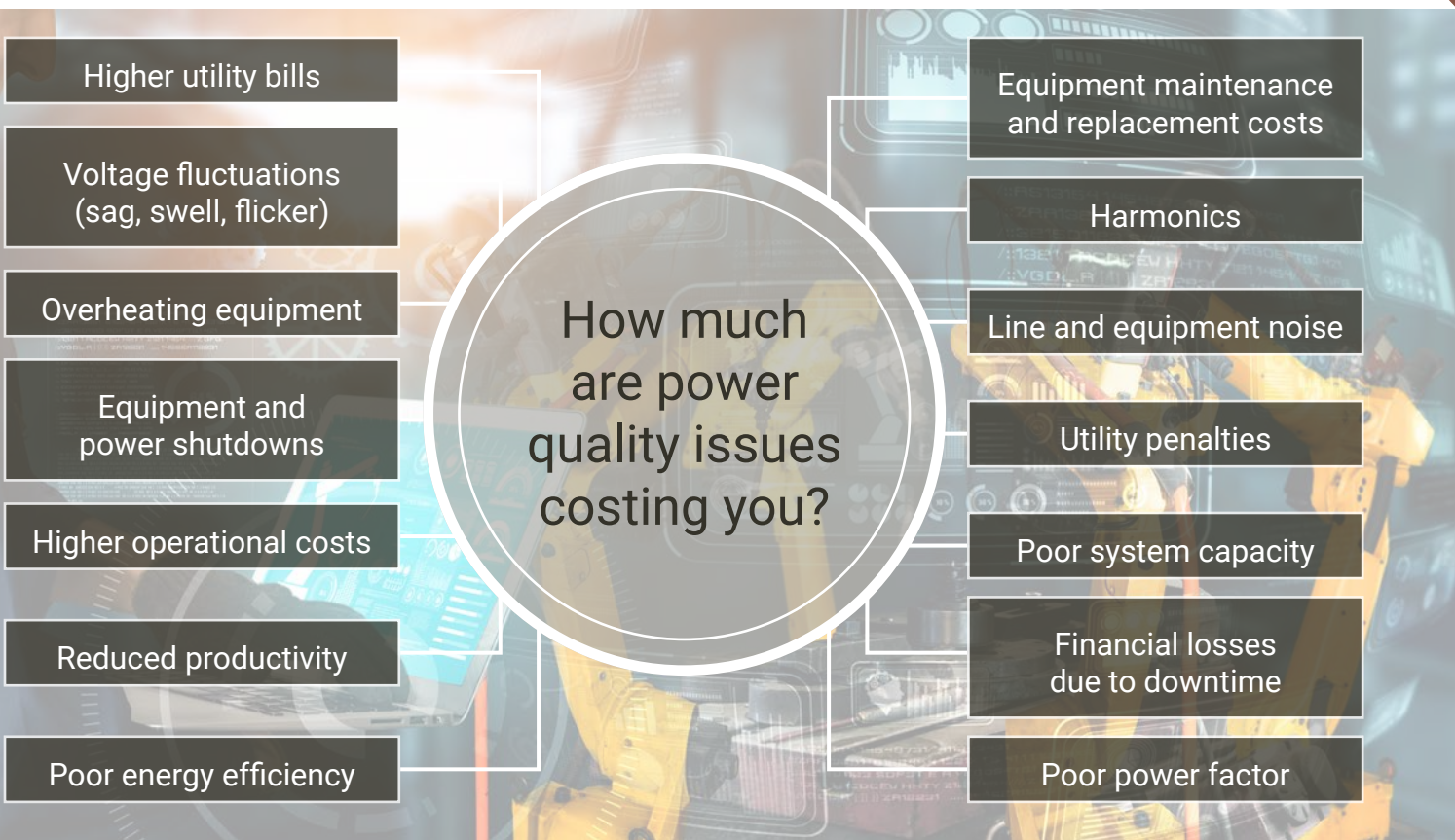
# Power quality

How stable and clean is your power? Even minor disruptive voltage fluctuations can cause major issues from equipment malfunctions, to flickering lights, to complete power shutdowns. The quality is assessed based on a number of parameters (occurrence of disturbances) that you measure across the grid. The most common parameters are voltage swells, voltage increases, harmonics, frequency variations, transients, unbalance, flicker and rapid voltage changes.





## Why should you measure power quality?

You can't change what you can't see. EMES portable Power Quality Analyzers allow you to see and analyze your power quality and reveal hidden problems which can affect multiple aspects of your business. Power quality issues may not always be easy to spot but these hidden problems can affect multiple aspects of your business, with a long list of destructive and costly effects.

Poor power quality may reduce efficiency, cause higher utility and energy costs, and cause expensive downtime. With EMES power quality measurement, you can identify and analyze power quality problems like voltage interruptions, sags, harmonics etc. in order to ensure your electrical systems run smoothly. Gaining power quality intelligence and control will help improve operations, reduce downtime, extend asset life, improve energy efficiency and lower costs.



## Power quality issues

					
Production downtime	Equipment damage	Shortened equipment life	Higher operating costs	Increased energy costs	Safety hazard

30 - 40 %  
The estimated percent of business downtime related to power quality problems.



# Common Power Quality Issues

## Power factor

Power Factor is an expression of energy efficiency. It is usually expressed as a percentage, and the lower the percentage, the less efficient power usage is.

Power factor (PF) is the ratio of working power, measured in kilowatts (kW), to apparent power, measured in kilovolt amperes (kVA). Today, with the heavy proliferation of non-linear loads, low power factor

on a power system is often the result of high distortion reactive power components and not inductive reactive power. Therefore, in this case, one can no longer say that low power factor is normally caused by electric motors and other inductive loads. And, since the best way to improve a poor power factor caused by non-linear loads is to remove the harmonic currents, the traditional means of adding power factor correction capacitors is, quite often, no longer suitable.

**Harmonics** - "Mysterious problems" are often the result of harmonic distortion. Harmonic distortion causes a distortion in the waveform shape of the voltage and current, increases current level and changes power factor supply. This, in turn, can result in a variety of damaging power quality issues.

Harmonic frequencies flow into the electrical system as a result of nonlinear electronic switching devices,

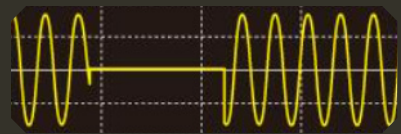
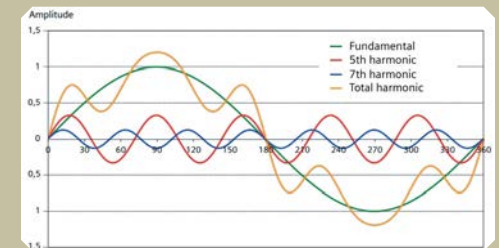
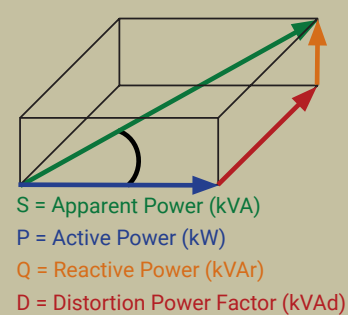
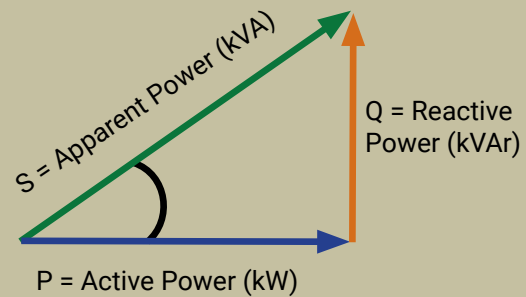
such as variable frequency drives (VFDs), computer power supplies and energy efficient lighting. Different impacts such as source voltage waveform distortion, efficiency losses, increased electrical usage, failures in the compensation system, overheating in motors and transformers, failures in sensitive electronic devices, etc. can occur.

Current distortion causes voltage distortion, which is created by pulling distorted current through an

impedance. The amount of voltage distortion depends on system impedance and the amount of distorted current pulled through the impedance. If either increase, voltage total harmonic distortion (VTHD) will increase.

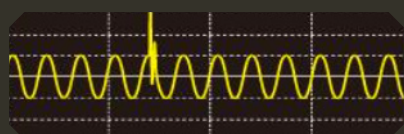
## Without Harmonic Distortion

## With Harmonic Distortion

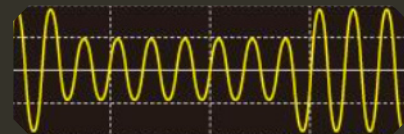


## Interruptions:

A momentary interruption can damage computers and other electronically controlled equipment or disrupt processes. The damage can occur on both the loss and the re-energization of power. Sustained interruptions can last from hours to days.



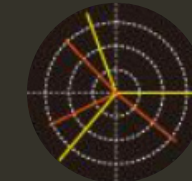
**Transients** are fast, positive or negative voltage peaks which have a duration of less than 20 ms (one period). In other words, transients are a faster voltage change than, for example, voltage dips. Equipment breakdowns, disruption in electronics, control systems, computers, disruption of drives etc. Transients that break through the zero-crossing can cause disturbance to sync devices that trigger on the zero-crossing.



**Dips and sags:** A voltage sag is not a complete interruption of power; it is a temporary drop below 90 percent of the nominal voltage level. Voltage sags are the most significant and costly power quality problem facing industrial and commercial customers today. Many types of electronic equipment are sensitive to voltage sags, including variable speed drive controls, motor starter contactors, robotics, programmable logic controllers, controller power supplies, and control relays.



**Voltage Swell** is defined as an increase in the voltage level to 110% - 180% of nominal, at the power frequency. Swell can cause breakdown of components on the power supplies of the equipment, though the effect may be a gradual, accumulative effect. It can cause control problems and hardware failure in the equipment, due to overheating that could eventually result in shutdown. Also, electronics and other sensitive equipment are prone to damage due to voltage swell.



**Power imbalance:** The current imbalance has two main effects: A higher peak demand in one phase which can lead to heat losses and over dimensioning the feeder. At the same time, a current imbalance creates voltage unbalance when going through the feeder. Voltage imbalance can make e.g. the VSD control system unstable and decrease efficiency of 3-phase motors.



## Frequency variations:

The deviation of the frequency at the point of supply may confuse logic systems and affect the operating speed of machinery.



# EMES Portable Power Analyzer

With this time and labour-saving product, you can configure the instrument, receive reports and download data to your computer without ever leaving your office.



TINY, INTUITIVE, ULTRA-PRECISE,  
MEASURE-EVERYTHING ANALYZER  
4MHz HF Transients • 2kHz–150kHz  
Emissions • Class A Ed3 Power Quality  
8 or 14 Current Channels • Revenue  
Grade Class 0.2 Accuracy • 4-Quadrant  
Energies • Dual 3 phase voltage • AC  
and/or DC  
3G/4G/5G Communication

The most economic and efficient way to monitor power quality– remotely. It has the great attribute of making power studies simple, safe, and successful. Once power is applied the instrument automatically begins recording. Available for sale or lease exclusively from EM Energy Solutions

While other analyzers require you to download and install software, EMES portable Power Analyzers do not. The analyzer has a built-in industrial 4G/Wifi router, allowing your engineers and EMES support personnel to connect to it from anywhere in the world. The Portable PQA makes sophisticated data analysis a simple process, enabling a faster diagnosis and solution to problems.

Regarding today’s Corona-virus situation, a detailed power quality analysis is possible

without traveling across any border. EMES ships the portable PQA to you, and then guides operational personnel through the process of hooking up the meter to the distribution network. We can then access the meter remotely to change necessary settings and create a detailed report. As a specialized company in power quality, EM Energy Solutions gives you unmatched expertise from problem definition to solution identification and implementation, together with our global distribution network.

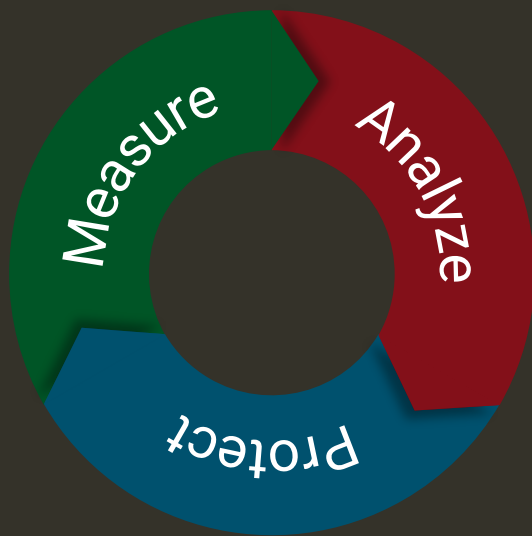
## The Basics of a Comprehensive Power and Energy Management System

### MEASURE

Gather energy and power data throughout your facility. Stand-alone or embedded meters measure, collect, and deliver essential data from key distribution points across your entire electrical network.

### PROTECT

Use actionable information to make intelligent decisions and operational shifts to create change or correct issues.



### ANALYZE

Turn data into actionable information. Power management software brings intelligent analytics and visualization to power and energy data.

# What is the real price of poor power quality?

Globally it is hundreds of billions a year.  
The direct and hidden costs of poor power quality are extremely high.  
The annual cost is estimated to be \$119 – \$188 billion for U.S. companies and 150€ billion for European industry.

## Does your poor power quality cost more than your electricity bill too?

This is a reality in many industries even though it’s not recognized. The cost of power quality problems can be directly related to increased energy consumption but also to hidden costs such as downtime, loss of production, equipment damage, idling personnel, data losses, negative impact on cash flow, customers and marketing value.

Even though we think that the electric network is pretty good in most European countries, poor electric quality is still a significant problem. In industry, automation and machinery are constantly increasing, but they are also more and more sensitive to poor power quality issues they often generate themselves.

€150 Billion	80 %	\$119-188 Billion	4 %
The amount poor quality costs the European economy.	PQ disturbances generated inside the facility.	Losses due to outages and other PQ phenomena in the U.S.	Annual turnover in industry caused by poor PQ.

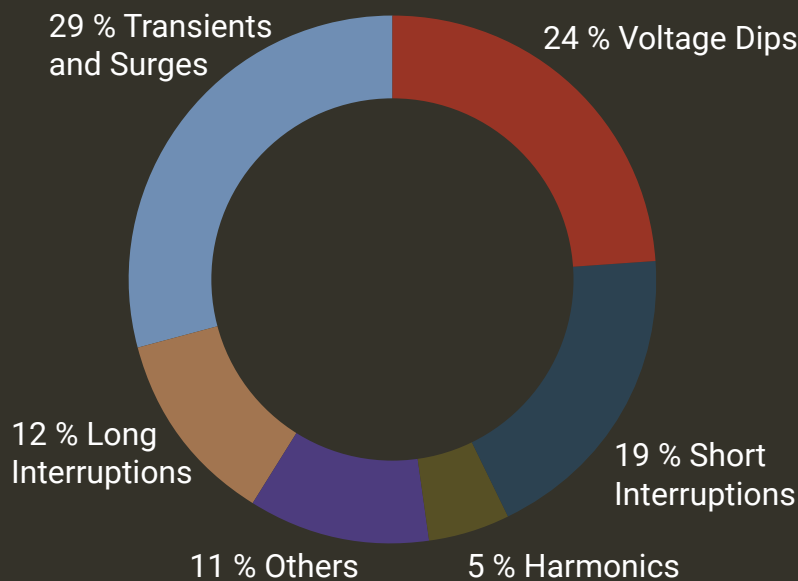
## What is the cost of a single production-stopping voltage event?

Our clients in semiconductor manufacturing report the cost of production stops can be as high as \$40,000 per hour. Total production loss for a single event can exceed \$1,000,000 or more. Pharmaceutical manufacturers, food processors and other power-critical manufacturers report similar staggering costs. In addition, unmitigated voltage sags can cause data loss and equipment damage.

## Cost of Poor Power Quality

According to a European study made by Manson & Roman Targosz, the total cost of bad power quality in Europe alone is 150B euros per year. The expenses are divided according to the diagram shown on this page.

29% Transients and surges  
24% Voltage dips  
19% Short interruptions  
5% Harmonics  
11% Others  
12% Long interruptions



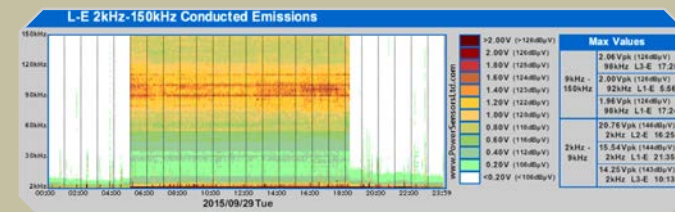




LEDs use 75% less energy and offer a viable energy-efficiency opportunity but can have significant impacts on power quality as they are non-linear loads.  
Power Quality Issues from LED lighting: Harmonics – Low Power Factor – High Inrush Currents.

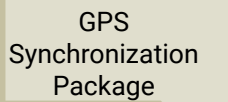


The 2 kHz-150 kHz range voltage conducted emissions, captured at a major laboratory building. The start and end hours of operation of the lab are clearly identifiable, and there is a typical frequency signature around 88 kHz and 100 kHz.



## Dual Voltage Mode


### Flexible Rogowski Coil



## 5G Industrial Router

PSL Ultra-Precise  
CT Series

You have probably experienced power quality symptoms, but didn't know why or what caused it. Typical symptoms could be:

- ▶ Flickering and blinking lights.
  - ▶ Transformer issues, such as noisy, extra hot or premature failure.
  - ▶ Panels, neutral wiring, and other distribution equipment running hot.
  - ▶ Printed circuit board failures in drives, PLCs industrial PC, etc.
  - ▶ Premature motor failure.
  - ▶ Unexpected equipment shutdown.
  - ▶ Breaker trip.
  - ▶ Drive shut down.
  - ▶ Contactors dropping out.
  - ▶ Poor network communications.
- 
- A close-up photograph of an electrical panel. On the left, a yellow triangular warning sign with a black border and a black lightning bolt symbol is mounted on a dark, textured metal surface. To the right, a bundle of electrical wires is visible, with some wires wrapped in red heat-shrink tubing. A bright orange and yellow flame is visible at the base of the wires, indicating a fire or severe overheating. The background shows wooden structural elements.

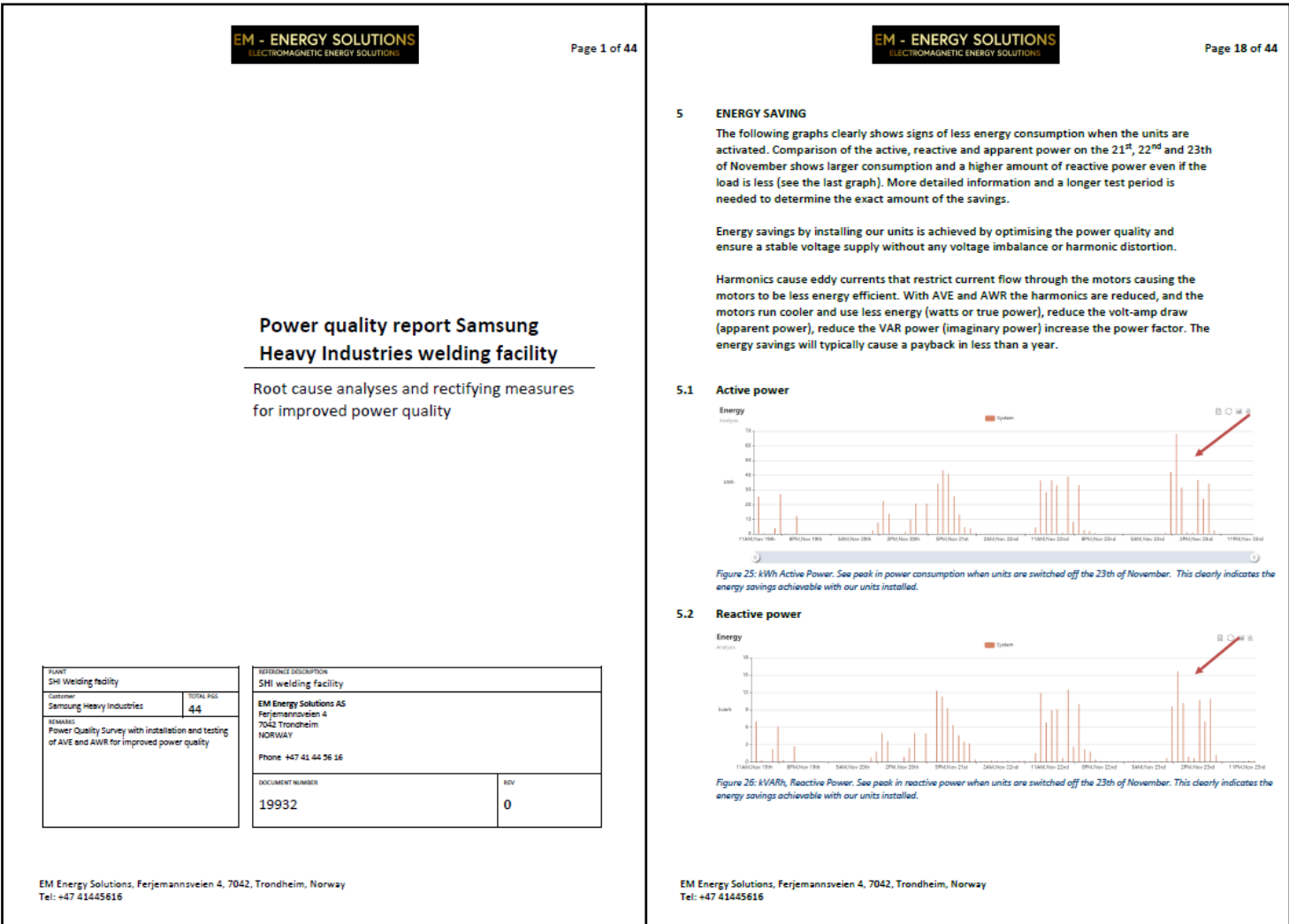




# Reporting

Based on the collected data EMES engineers analyze the data and identify causes of electrical power problems and pending equipment risks. Based on the this we will make a detailed power quality report and come up with an optimized solution for your specific issues.

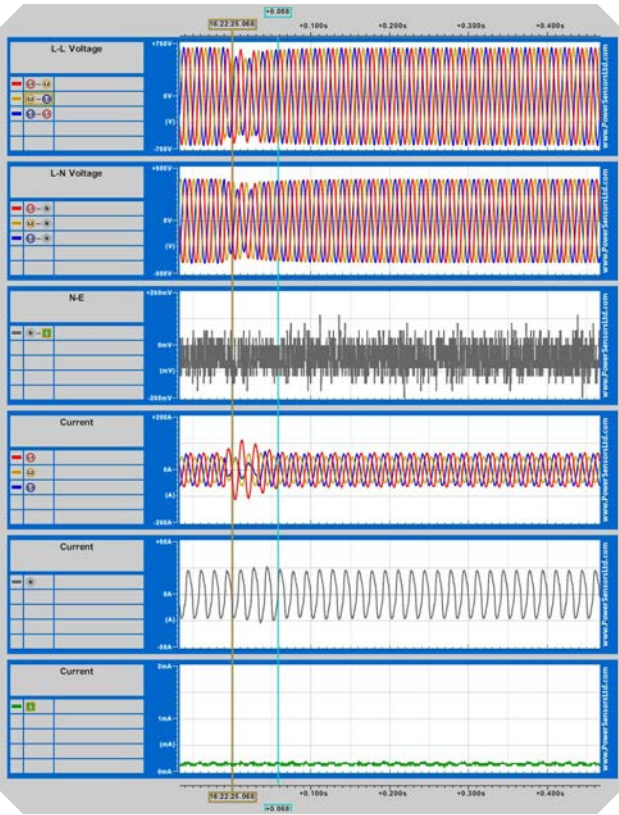
Benchmark against contractual obligations or grid code criteria, power quality recommendations and industrial standards such as: EN50160 – IEEE519 – IEC61000 – G5/4



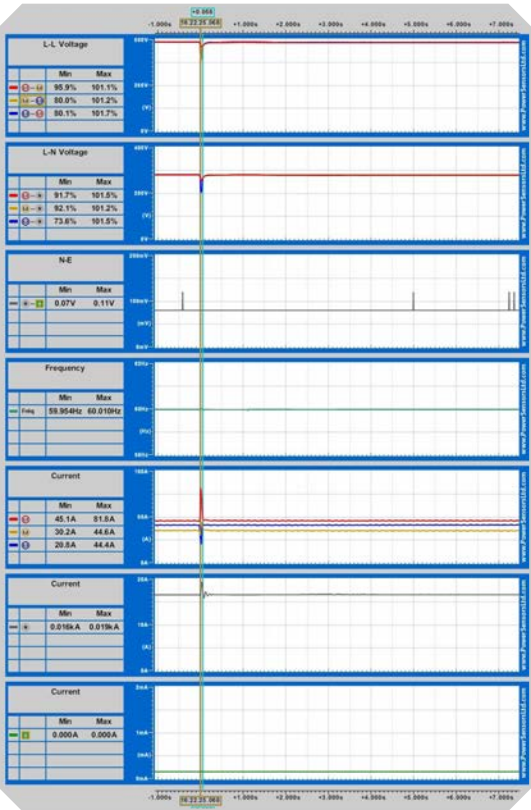


# Power Quality Analyzer Overview

Trends and events can quickly be accessed using your internet browser - no software needed.

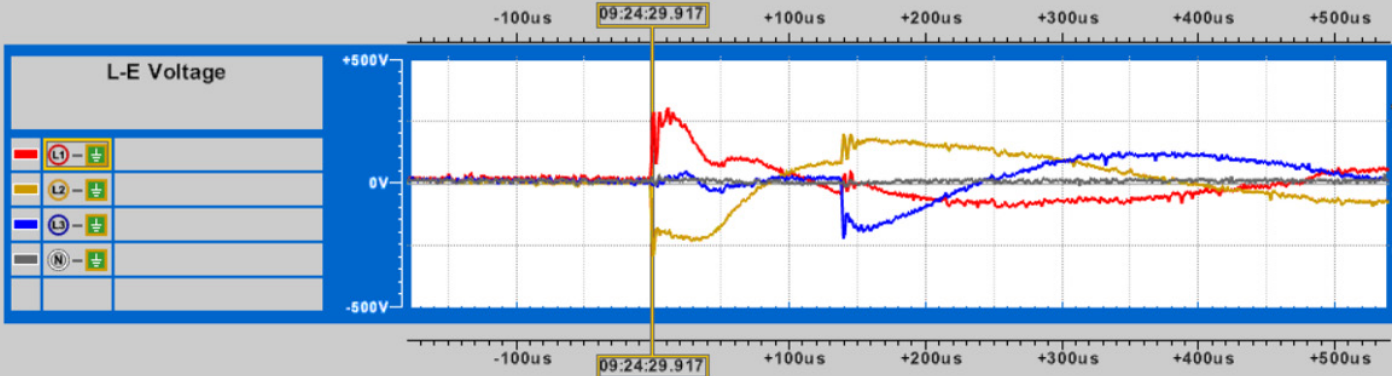


The waveform graphs show you the detailed shapes of the instantaneous voltage and current waveforms. This is useful when you are looking for specific details, at the millisecond level. The Portable analyzer measures all of the waveforms at 512 samples per cycle, but to graph a longer duration, you can choose to record fewer samples per cycle if you prefer (the measurements will not be affected).



The RMS graphs show the cycle-by-cycle true RMS values of the voltage and current, updated every half cycle, and they also show the frequency. This is useful when you are looking at more general characteristics of the event, at roughly the one-second level, especially if you are interested in the available energy.

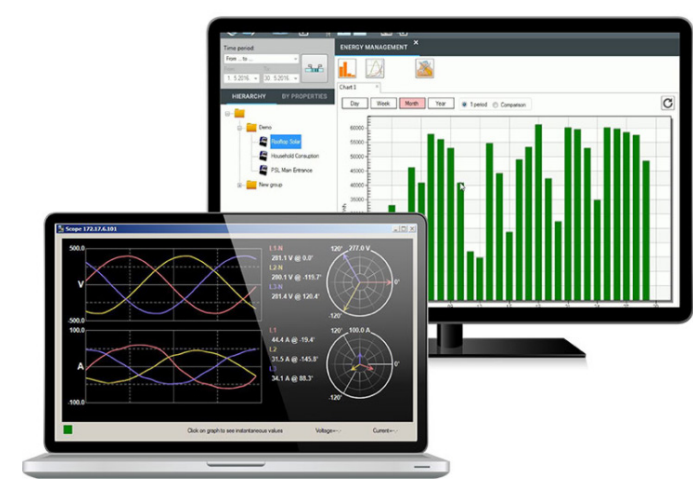
4 MHz Transient Capture capability. Below capture is caused by switching a nearby inductive load. Recorded at one million samples-per-second simultaneously on four channels (four million samples-per-second on one channel is user-selectable, too).



## Cloud Based Monitoring



## Remote meters, scopes, strip charts and logging





# Permanent Power Quality Monitoring System

Gives you the information to identify power quality issues and manage their impact to keep from disrupting operation or damaging critical loads and equipment.



## Snap onto DIN Rail

PQube is simply the best power monitor and real-time sensor you can buy. It records every type of AC power disturbance – including 4 MHz sampling of impulses – and it is an IEC 61000-4-30, edition 3 Class A certified, ultra-precise revenue-grade energy meter. Monitor up to two three-phase loads, or eight single-phase loads with a single instrument.



## IP65 Enclosure

Pre-installed, pre-wired and pre-configured power meters are tested for quality before shipment. The pre-configured panel comes ready to use in a durable and watertight NEMA 4 panel which provides the added convenience and reliability over traditional end-user installations.



## Switchboard and Panelboard

High Performance Power and Energy Meter. Quality engineered energy submeters provide a simple robust solution for power monitoring, power quality analysis, kWh metering, system integration, controlling power distribution systems & other speciality applications.



## Rugged Pole-Mount Installation

The PQube analyzer is perfect for distribution line monitoring. The enclosure is IP44 rated, vented for temperature reduction, made from non-corrosive polycarbonate, and the stainless-steel pole-mount brackets make for a quick and secure installation. The 4G modem is ideal for collecting data where Ethernet connectivity is often unavailable. Power can be taken from the monitored line, or from a separate instrument power line.



## Rugged Wall-Mount Installation

When a rugged indoor or outdoor wall-mount installation is required, this product is perfect. The enclosure is IP44 rated, it's vented for warmer conditions, and you have a hinged window for viewing or accessing the PQube's full color touchscreen display. Quick-connect terminal blocks make wiring simple, and the 4G modem option helps simplify data collection.



## 19-Inch Rack-Mount: Special Single Phase Rack Mounts

The PQube is a great choice for data centers and substations. EMES can supply special single-phase rack mounts with plug-in connectors for pairs of PQube analyzers, or just a single PQube.



## Semi Custom

For those larger, non-standard projects, EMES can supply special enclosures and wiring for your needs. Here's an example: A major shipboard needed multiple PQubes in a single, pre-wired, IP-rated enclosure.

## Grid Analyzer

Ideal solution for micro synchrophasor measurements and ultra-precise Power Quality monitoring. Measure and understand the complex and dynamic power flows in distribution grids and microgrids with the microPMU. The microPMU is like a microscope that has micro-second resolution and ultra-precise accuracy needed for distribution grid applications. The microPMU is ideal for projects that need ultra-precise synchrophasor measurements for investigating stability and impedance questions. The microPMU can also be used for real-time control applications using the IEEE C37.118.2-2011 protocol.

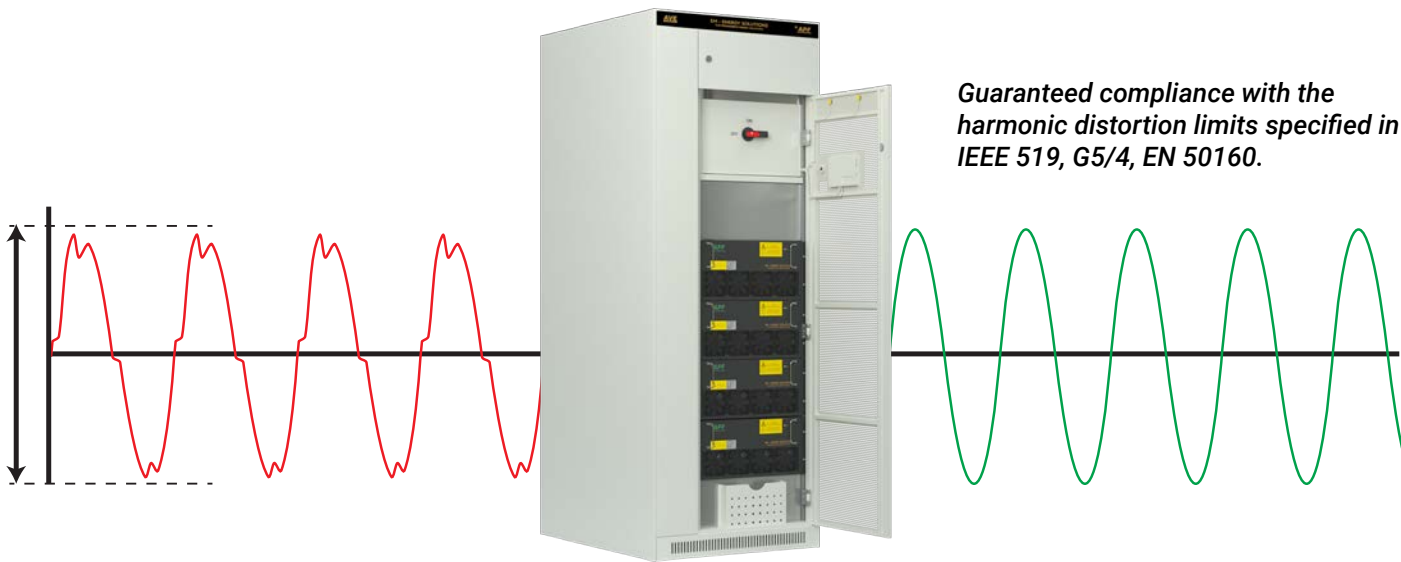


Once a diagnosis has been made, we work with our customers to implement a tailored solution to adequately address their unique power quality needs.

EM Energy Solutions offers a wide variety of leading products to address many common power quality issues:

- ▶ Harmonic Mitigation
- ▶ Voltage Sag Problems
- ▶ Short- & Long-Term Power Interruptions
- ▶ Surge Suppression
- ▶ Transient Mitigation
- ▶ Unbalance Compensation
- ▶ Flicker Correction
- ▶ Dynamic Stepless Power Factor Correction
- ▶ Power Quality Measurement

EMES APF - One device, but many solutions to help you save energy, achieve higher productivity, decrease downtime and extend the lifetime of devices and components.



Power quality solutions can help you increase energy efficiency while extending the life of your facilities and equipment, and reducing maintenance and operating costs.

- ▶ Fast installation, easy operation and low maintenance solutions.
- ▶ Protect critical production equipment from damaging voltage fluctuations and voltage spikes.
- ▶ Improve energy efficiency and reduce utility costs.
- ▶ Improve equipment and facility reliability.
- ▶ Avoid costly downtime and lost productivity.
- ▶ Drastically reduce site maintenance.
- ▶ Reduce dangers of arc flash and ground faults.
- ▶ Increase productivity and lower operating costs.

EM Energy Solutions is your complete power quality partner. We can analyze, plan and implement a tailored power solution for your unique system.



Power Quality Experts



Global Presence



Innovative



Quality Products and Services

AVC – RTS the ultimate solution for protection of equipment and processes against unavoidable voltage anomalies, sags, swells and short interruptions.





# EM ENERGY SOLUTIONS

FUTURING  
SMART  
ENERGY



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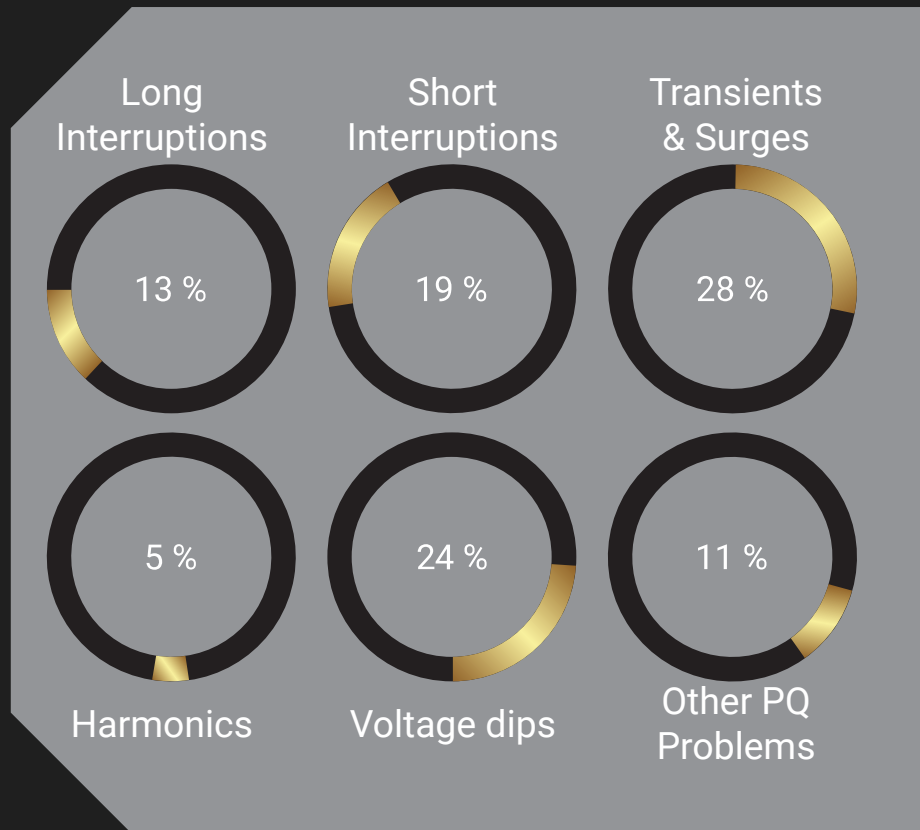
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# Types of Power Quality Issues

- ▶ RMS voltage variations:  
sags, swells, interruptions
- ▶ Voltage transients:  
impulsives, oscillatory
- ▶ Waveform distortion:  
harmonics, interharmonics, sub-harmonics
- ▶ Voltage imbalance
- ▶ Voltage fluctuation
- ▶ Power frequency variation



## The Benefits of Improving Power Quality



- ▶ Improved energy efficiency
- ▶ Reduced utility costs
- ▶ Reduced waste and improved operations
- ▶ Increased productivity
- ▶ Minimized downtime
- ▶ Increased equipment and power reliability
- ▶ Lower operating costs

## The Negative Effects of PQ Issues



- ▶ Energy losses
- ▶ Unplanned downtime
- ▶ Premature aging of equipment
- ▶ Utility penalty costs
- ▶ Decreased productivity
- ▶ Service call costs
- ▶ Decreased reliability

## Ways to Improve Power Quality



- ▶ Power factor correction
- ▶ Voltage stabilization
- ▶ Harmonic filtering
- ▶ Power conditioning
- ▶ Reactive power compensation

