

# Voltage Control – Choosing the Best Energy Efficiency to Save

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*A solution that provides immediate energy savings while eliminating wasted electricity in commercial facilities, and contributing to a greener environment.*

## Overview

The need to save energy is prevalent in every aspect of business and life. As such, there are a number of solutions currently available in the market today for cutting down on energy consumption. This paper focuses on how voltage control is the most effective method to save money and eliminate wasted energy by your business.

We will focus on:

- The ways in which voltage fluctuation and overvoltage are detrimental to your business, your electrical equipment and your bottom line.
- Available technologies for implementing a voltage control and regulation solution that saves electricity and money.
- PowerSines' voltage control solution and how it solves business' voltage problems in a clear and definitive way, immediately saving money, meeting government standards and greening your business.

## Introduction

This white paper will discuss the best choice for businesses seeking energy saving and energy efficiency solutions. The technique of voltage optimization and regulation is already a known and acceptable method for reducing consumption and electric bills while helping to avoid peak demands. We will explain the financial and business detriments caused by voltage fluctuations on electrical equipment. Included will be an overview of the technologies behind the solutions that offer variations of voltage control, ultimately proving how only through the Right Voltage technology for voltage control and optimization will energy efficiency and savings be achieved.

## The Need for Voltage Control

The ultimate reason for using voltage control solutions is financial: (i) by regulating and stabilizing the voltage you control the power, current and energy (KW, KVAR and KVA) – voltage optimization enables you to control your electric bill and save money; (ii) voltage control helps improve overall power quality to minimize the costs associated with equipment damage and downtime, caused by overvoltage levels. Voltage control saves money.

Voltage control, also known as “voltage regulation”, “voltage stabilization” or “voltage optimization” is an energy-saving technique that controls and reduces the voltage supplied to a site in order to save electricity. It works by reducing losses in electrical equipment, which thereby reduces energy consumption, CO<sub>2</sub> emissions and your electricity bill. In addition, equipment running on lower voltages tends to be cooler, extending its lifetime and reducing maintenance costs.

## Why does Overvoltage Exist?

Voltage supplied by the utilities to many premises is often much higher than required, leading to excessive losses in many types of equipment. This is inevitable and as a result of infrastructure. Some specific reasons include: (i) the need to supply voltage at a level that meets the required demand by each end user; (ii) the fact that electricity consumption has been on the rise. Though there is a constant increase in the demand for electricity, the control abilities by the utilities are limited to changing the taps in substations only, thereby exposing the user to overvoltage.

## What is an Optimum Voltage?

The optimum voltage for a site is usually the low end of the nominal voltage. The main purpose of voltage optimization is to reduce the voltage to this optimum level. All electric equipment is designed to work within the legal range of 230v ± 10% (most 220). Reducing the voltage to 215V will safely provide energy savings, reduce losses and extend equipment lifetime.

## Voltage Control and Power Quality

Power quality problems, which compromise industrial productivity, fall under five main categories: electric noise or transients, voltage fluctuations, brownouts, harmonics and blackouts or power interruptions. At the end of the day, the impact of power quality problems can be financially devastating for businesses through increased costs and reduced productivity.

Voltage levels are often highest during the nighttime hours and weekends, when the electric demand is minimal and lowest on weekdays when electricity peaks. The ultimate solution for reducing electricity consumption and improving power quality would be a combined voltage control system, which supplies a constant voltage level to equipment despite the fluctuation of the line voltage, and a technology for suppression of harmonics and transients.

*Note: Power interruptions have conventionally been handled through the use of a backup power source such as a generator or UPS which are a fairly expensive solution since they rely on batteries for energy storage,(or liquid gasoline/diesel); this topic however is not covered in this paper.*

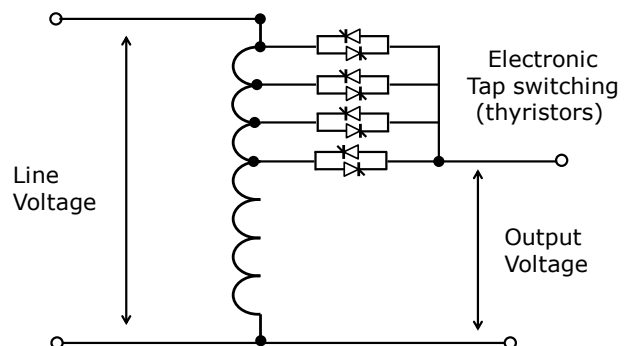
## Voltage Control Solutions

All the facts discussed so far are well known in the market and there are many types of voltage control technologies to choose from. Most of the solutions, though they may seem beneficial for your business and electric equipment, in general come with certain drawbacks that may negatively affect some types of loads as well as the entire electric infrastructure.

In the following sections we will examine the commercially available technologies and solutions and compare their performance attributes, ultimately elaborating on the most preferable solution for ensuring energy savings in commercial applications.

### Tap-changing Voltage Controllers

An autotransformer is a type of transformer that has one winding, a portion of which is common to both the primary and the secondary circuits. The voltage control is implemented with a rather simple concept of back-to-back thyristors with a tap-changing transformer as shown in the diagram. This technique has a reasonable response time (1 cycle) and is popular for small and medium power applications (> 20kVA).



The drawbacks however, include high control resolution, which requires a large number of thyristors (60 thyristors for +/- 3% regulation with +10/-20% input range).

In addition, although autotransformers provide sinusoidal output voltage to the load, they have several disadvantages:

- Complicated switching control (make before break).
- One shortened thyristors will completely block the control of the entire system.
- Bulky size and heavy weight which makes it an expensive solution.
- Costly installation and difficulties to find sufficient room to install such a bulky device.
- Copper Losses. Typical copper losses in transformers are about 3% -5%. This requires special considerations for heat dissipation. For example 50KVA autotransformer generates about 1,500W – 2,500W of heat. This makes it not suitable for installations in commercial indoor applications such as retail, offices, etc.
- Difficult to control. Multi-tap systems are not reliable and can't provide flexible control of output voltage.

## Electronic Voltage Controllers

Electronic voltage controllers fall into two categories: 1) phase controllers or; 2) high frequency switching inverters.

Phase controllers are based on thyristors to control output voltage. These devices control RMS voltage by chopping part of each voltage cycle. They have high electric distortion especially with non-linear loads, require over-sized filters, very poor input line harmonics and will not handle surge currents such as motor starting.

The second type, Inverter- based, implements various switching and modulations technologies based on IGBTs and thyristors to control AC voltage, frequency and current. These devices provide flexible and continuous control over all electric parameters; however the main drawbacks are very high THD and high losses (6-10%). The power quality of the output voltage may be improved using at 12 or 18-steps inverters' technology, but they are very complex and costly.

Taking into consideration power quality and reliability issues make both these options ineffective for most of commercial voltage control applications.

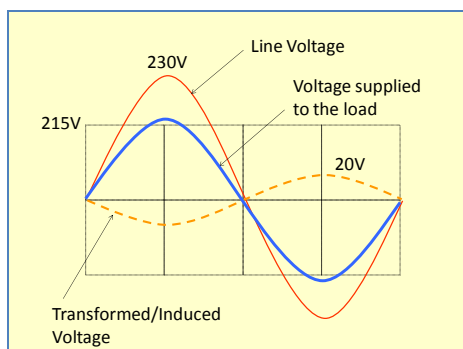
## PowerSines Universal Energy Efficiency Controller – ComEC

PowerSines develops energy efficiency and energy saving solutions for over 30 years. The company's solutions implement the most effective method to control and optimize voltage; they are built around a proprietary and patented design using sophisticated control algorithms. They provide the RightVoltage™ - an optimized and pure sinusoidal voltage to the load.

### Voltage Control and Optimization

The core of the ComEC system is based on a proprietary topology of power transformers controlled by a microprocessor. The system ensures that only the right amount of energy required maximizing efficiency of the load, reducing the voltage by up to 20V and stabilizing it.

PowerSines invented the following voltage control technologies, which lay in the foundation of all the company's products:



**I N V – Induced Negative Voltage** – Inducing non-relevant voltage via a combination between voltage and current transformers to provide a high power transfer ratio (the ratio between load power and continuous power).

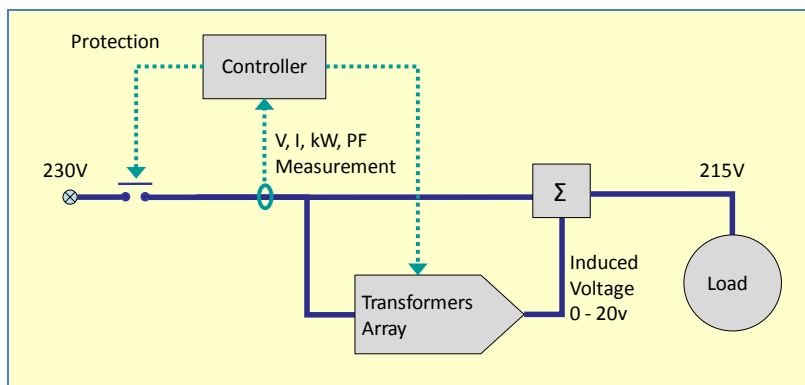
**V V C – Voltage Vector Combination** –controlling the voltage utilizing the voltage vectors angle and magnitude of 3-phase electric systems.

The principle of the INV and VVC are via reducing the non-relevant voltage (up to 20V). This will result in a very high "power transfer ratio" PTR (the ratio between the load power and the controllers power). In the ComEC the PTR is about 12, whose main advantages result in a small footprint, low losses, and high efficiency. For example, a typical autotransformer system of the same power is 12 times larger than

ComEC, generating more losses and heat. In addition, ComEC produces a pure sinusoidal waveform to the load and even suppresses harmonics and electrical distortions; therefore improving power quality. Since the system core is composed of power transformers, the overall design of the system is robust and reliable.

The ComEC provides energy savings up to 18% savings on the electricity bill\* in commercial applications. It is installed between the main circuit breaker and the load, on the existing electric infrastructure.

Unlike multi-tap autotransformer systems that control the voltage by switching the desired tap, the ComEC selects the right combination between voltage and current transformers to induce the right magnitude of negative voltage. As seen in the image below.



Furthermore, unlike electronic voltage controllers that alter sinusoidal voltage waveform and generate harmonics to both loads and network, the ComEC is truly a “Power Quality Friendly” system. The ComEC provides low THD and a pure sinusoidal waveform to the load.

ComEC is an all-in-one energy controller providing programming features, built-in energy management and measurements, and protection mechanisms, including an automatic internal Bypass and manual Bypass switch gear for isolation in case of failure. It is a cost-effective, highly reliable, small footprint solution that does not compromise on power quality when providing energy efficiency.

### Estimated Energy Savings with the ComEC

Since the ComEC controls the supplied voltage, one benefits from immediate savings. The table shows a range of estimated savings generated when utilizing the ComEC:

Load Type	Savings
Discharge lighting systems: fluorescent and HID with electromagnetic ballast	18% – 21%
Time-based or continuously working heating equipment	13% – 16%
Refrigerators, freezers and cooling appliances, compressors	6% – 14%
Kitchen appliances, coffee machines, tea kettles, toasters, microwaves	8% – 16%
Split air conditioner units and ventilation	3% – 7%
Electronic and computer equipment, lighting systems with electronic ballasts, inverter-based system air-con, etc.	1% – 5%

Regulating voltage for inductive loads such as air conditioners, compressors and pumps helps reduce reactive power (KVAR), contributing to the environment and minimizing the risk of utility penalties.

✍ *Note:* Saving percentages are estimated according to numerous field and lab tests and depend on electrical infrastructure, line voltage level and type of equipment. Some equipment, which require constant amounts of energy (e.g. to bring water to a boiling point), will only generate power reduction without savings on electricity consumption (kWh).

## Summary

Choosing an energy savings solution to meet your voltage control problems may seem complicated with all the different technologies and solutions available in the market today. The ideal choice should be a solution that provides a quick return on your investment. Choosing the wrong technology may result in poor power quality, which will inevitably lead to inefficiencies in your businesses productivity.

With the growing awareness of energy efficiency products, the preferable choice is an energy saving solution that installs on your existing electric infrastructure, with support for your future electrical infrastructure growth, while most importantly providing you immediate energy savings today, such as the offering you get with PowerSines ComEC system.

ComEC is built around a proven technology platform, which is the foundation of all PowerSines' voltage control product systems. PowerSines systems are installed worldwide in blue-chip customers, utilities and global companies.

PowerSines is available for consultation and electric surveys, to help your business succeed.

## About

PowerSines is a global provider of energy efficiency solutions leveraging decades of expertise in voltage regulation and control technologies. The Lighting Energy Controller (LEC) significantly reduces electricity costs for commercial and public lighting, the Sinusoidal Motor Efficiency Controller (SinuMEC) improves overall efficiency of electric AC motors, and the universal Commercial Efficiency Controller (ComEC) provides energy savings for all electric loads in commercial facilities. With energy savings systems installed worldwide, customers receive proven electricity savings and a reduction in the total cost of ownership.

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