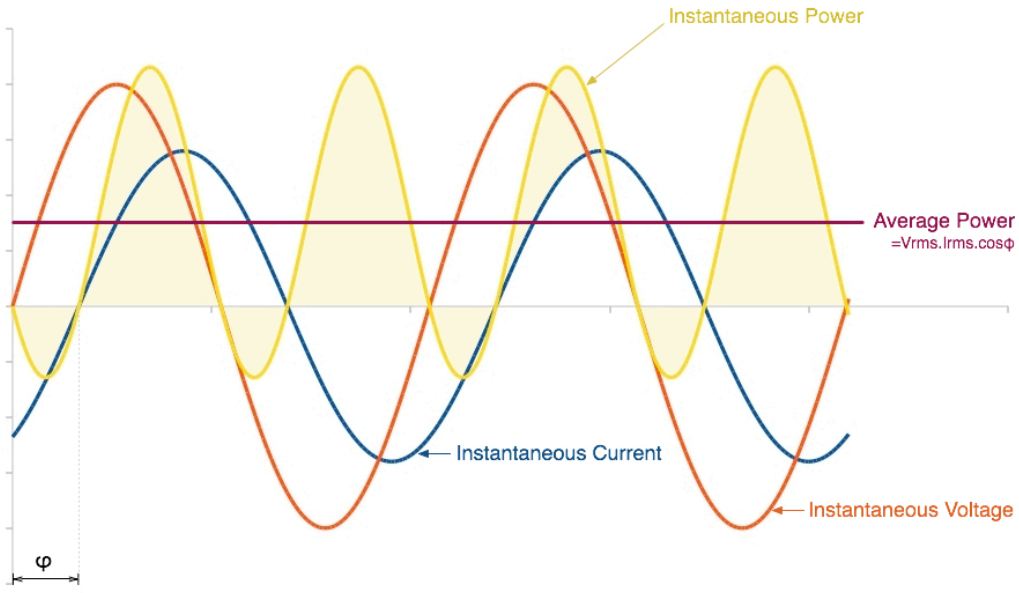
Reducing energy costs starts by understanding what's driving your energy use and how efficient your electrical installation is. You may be familiar with monitoring your kWh consumption from electricity bills and from more granular dashboard reports, but it's now time to get started with what's really happening with your electrical loads (appliances, machines, etc).

The theory part
In AC circuit analysis, both voltage and current vary sinusoidally with time. The presence of reactive elements like inductors and capacitors directly impact the current wave by shifting it with respect to voltage wave (φ), see below.



Power is the rate at which energy is consumed by an electrical load or produced by a generator, and the value of instantaneous power is obtained by multiplying instantaneous voltage with instantaneous current.

Instantaneous power varies with time sinusoidally, so we generally look at the average power within a given time frame, for example the period of the sinusoidal wave. The average power is calculated as:

$P = Vrms \times Irms \times \cos\varphi \ (W)$

Vrms = RMS Voltage = Vm/√2
Irms = RMS Current = Im/√2
Vm and Im the maximum values of the sinusoidal voltage and current

This average power formula is the basis to calculate the power consumed by the load over longer periods, for example your monthly electric energy bills are based on this power calculation. Note that the average power is also called 'Real', 'True" or 'Active' power within the industry, and is measured in Watts (W). At Wattics we talk about Active Power.

In ideal inductors and capacitors, voltages are respectively 90° ahead and behind the phase of the current, meaning that ideal inductors and capacitors do not, on average, take active power from the circuit ($\cos\varphi=0$). Current is instead used to charge a capacitor, or to create the magnetic field around a coil, as opposed to creating heat or lifting loads.

In real-world environments where resistors, inductors and capacitors are all combined within complex machines, the power that is wasted and not used to do work on the load is represented by the Reactive Power, calculated as:

$Reactive\ Power = Vrms \times Irms \times \sin\varphi \ (VAR)$

Note that the Reactive Power is also called 'Wattless' power within the industry, and is measured in VAR (VoltAmpereReactive). At Wattics we talk about Reactive Power.

Apparent power represents the power that is supplied to the circuit (voltage multiplied by all

the current that flows in it), and is measured in volt-amperes (VA). Apparent Power is calculated as follows:

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Apparent power = Vrms x Irms (VA)
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