PRESENTATION

EKOVAR

(ENERGY RECOVERY SYSTEM)

(Recovery of electricity for residenzial use)

A central production of electricity from 1 MVA is capable of delivering, at 400 V, a current In equal to:

In = Pn / (√ (3) x cos x Vn) = 1000000 / (1.73 x 400 x 1) = **1445.08 A**

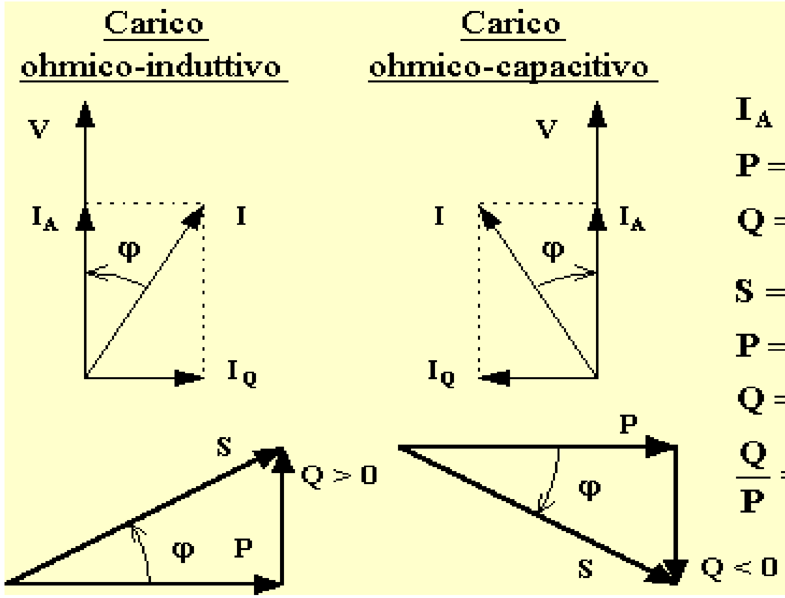
The nominal power Pn is always expressed in kVA or MVA as you consider the ability to sustain a purely resistive load, then cos = 1.
In the case in which such central food should such a load with a power factor = 0.9, at the same current consumption will have a power Pn equal to:
Pn = √ 3 x Vn x In x cos = 1.73 x 400 x 1445.08 x 0.9 = **900 kW** (about)
In the case in which such central food should such a load with a power factor = 0.8, at the same current consumption will have a power Pn equal to:
Pn = √ 3 x Vn x In x cos = 1.73 x 400 x 1445.08 x 0.8 = **800 kW** *(about)*
It follows that the same production station will be able to supply a load of:
1000 kW at pf = 1
900 kW at pf = 0.9
800 kW at pf = 0.8

Accordingly affirm that the power factor is a decisive parameter for the absorption of electrical energy to a load.
A plant with low power factor converts active power in a power value less as possible. In the case of a load with a power factor = 1 coincides with the apparent power, the active power**. In the case of a load with a power factor = 0.9 will have a loss of active energy P_{loss} = 10%; with cos = 0.8 P_{loss} = 20%; with cos = 0.7 P_{loss} = 30%.**

If we want to make the most of the energy produced by a power plant, we have to introduce into a number of capacitive reactive power to compensate the inductive reactive current surplus.
In so doing we tend to bring the phase angle between voltage and current to a value tending to 1.
The power factor is the cosine of the angle φ between the current and the voltage in an electrical system in alternating current. The power factor is therefore also referred to as the cosine of the angle whose tangent is φ.

Ohmic-inductive load

Ohmic-capacitive load



$$I_A = I \cdot \cos\varphi \quad , \quad I_Q = I \cdot \text{sen}\,\varphi \quad [A]$$

$$P = V \cdot I_A = V \cdot I \cdot \cos\varphi \quad [W]$$

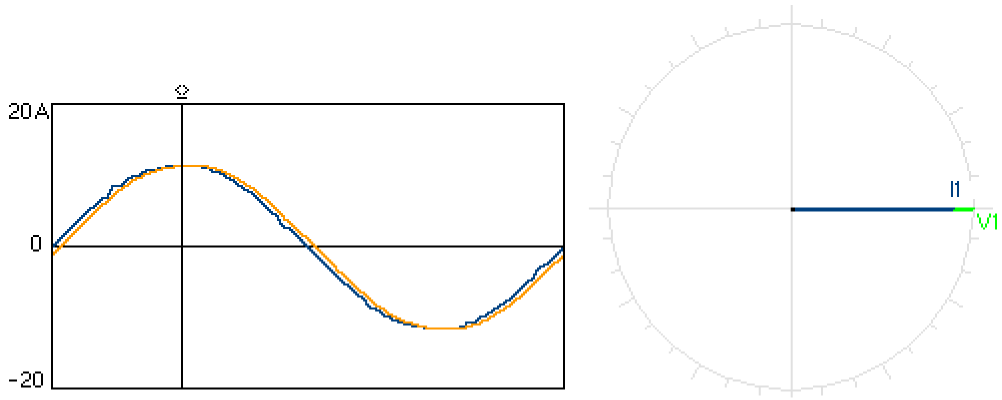
$$Q = V \cdot I_Q = V \cdot I \cdot \text{sen}\,\varphi \quad [VAR]$$

$$S = \sqrt{P^2 + Q^2} = V \cdot I \quad [VA]$$

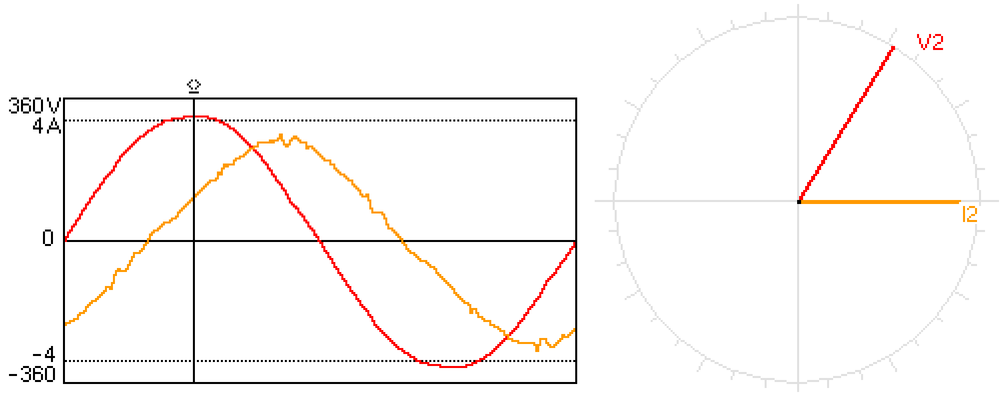
$$P = S \cdot \cos\varphi \quad [W]$$

$$Q = S \cdot \text{sen}\,\varphi \quad [VAR]$$

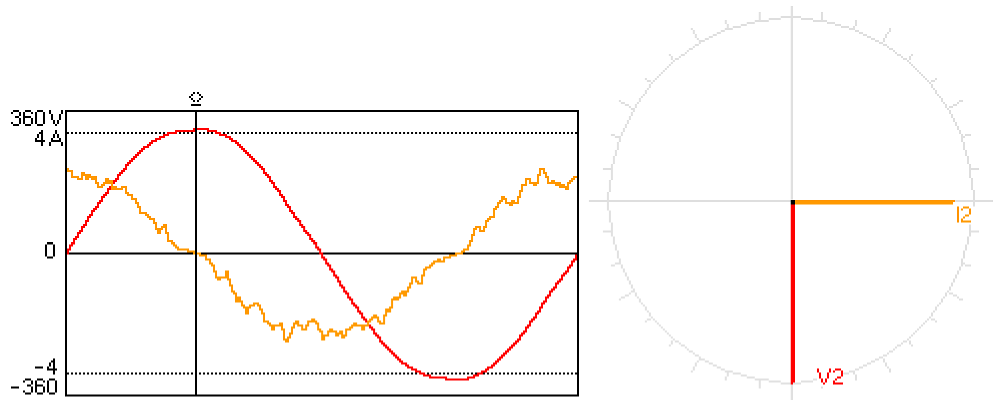
$$\frac{Q}{P} = \text{tg}\varphi$$



Graph representing the trend of voltage and current referred to a purely resistive load.



Graph representing the trend of voltage and current referred to a ohmic- resistive load.



Graph representing the trend of voltage and current referred to a purely capacitive load.

The reactive power can be inductive or capacitive.
The inductive reactive power it has when the energy is absorbed and returned alternately by a magnetic field (transformer, motor, inductance in gender, etc..).
The capacitive reactive power, it has instead when the energy is absorbed and returned alternately by an electric field (armatures of the condenser).
In a circuit Ohmic φ = 0 and senφ= 0
In a circuit with a 90 ° phase shift between V and I, senφ = 1, being:

Q = V x I x senφ = V x I = A

The amount of energy is defined by the instantaneous power for the unit of time, then we have the following expressions:

Ea = P xt = W x sec ◊ 1000W x 1 h = 1 kWh (active energy)
Er = Q xt = x VAR sec ◊ 1000VAR x 1h = 1 kVARh (reactive energy)
Es = A xt = Va x sec ◊ 1000VA x 1h = 1 kVAh (apparent power)

<u>Relationship between cosφ and tanφ</u>

cosφ 0,45	→	*tanφ* 1,98	*cosφ* 0,82	→	*tanφ* 0,70
cosφ 0,50	→	*tanφ* 1,73	*cosφ* 0,83	→	*tanφ* 0,67
cosφ 0,55	→	*tanφ* 1,52	*cosφ* 0,84	→	*tanφ* 0,65
cosφ 0,60	→	*tanφ* 1,33	*cosφ* 0,85	→	*tanφ* 0,62
cosφ 0,65	→	*tanφ* 1,17	*cosφ* 0,86	→	*tanφ* 0,59
cosφ 0,70	→	*tanφ* 1,02	*cosφ* 0,87	→	*tanφ* 0,57
cosφ 0,71	→	*tanφ* 0,99	*cosφ* 0,88	→	*tanφ* 0,54
cosφ 0,72	→	*tanφ* 0,96	*cosφ* 0,89	→	*tanφ* 0,51
cosφ 0,73	→	*tanφ* 0,94	*cosφ* 0,90	→	*tanφ* 0,48
cosφ 0,74	→	*tanφ* 0,91	*cosφ* 0,91	→	*tanφ* 0,46
cosφ 0,75	→	*tanφ* 0,88	*cosφ* 0,92	→	*tanφ* 0,43
cosφ 0,76	→	*tanφ* 0,86	*cosφ* 0,93	→	*tanφ* 0,40
cosφ 0,77	→	*tanφ* 0,83	*cosφ* 0,94	→	*tanφ* 0,36
cosφ 0,78	→	*tanφ* 0,80	*cosφ* 0,95	→	*tanφ* 0,33
cosφ 0,79	→	*tanφ* 0,78	*cosφ* 0,96	→	*tanφ* 0,30
cosφ 0,80	→	*tanφ* 0,75	*cosφ* 0,97	→	*tanφ* 0,27
cosφ 0,81	→	*tanφ* 0,72	*cosφ* 0,98	→	*tanφ* 0,25

EXAMPLES OF CALCULATION OF CAPACITY 'OF CAPACITORS FOR SMALL ELECTRICAL RESIDENZIAL PLANTS (EKOVAR WAS BORN FOR THESE ELECTRICAL PLANTS)

We have a load that absorbs I=5A, V_n=225V, $cos\varphi_1$=0,9

$P = V\ x\ I\ x\ cos\varphi_1 = 225\ x\ 5\ x\ 0{,}9 = 1012{,}50$ W

To a power factor ($cos\varphi_1$)= 0,9 corresponds to a tangent of the angle fi ($tan\varphi$)=0,48

We want to get a $cos\varphi_2$=0,98 which corresponds to a tangent of angle fi ($tan\varphi$)=0,25

We calculate the capacity you need to bring the power factor from 0.9 to 0.98

$Q = P\ x\ tan\varphi_1 = 1012{,}50\ x\ 0{,}48 = 486$ VAR

$$C = \frac{P\ x\ (tan\varphi_1 - tan\varphi_2)}{\omega\ x\ V^2} = \frac{1012{,}50\ x\ (0{,}48-0{,}25)}{2\ x\ 3{,}14\ x\ 50\ x\ 225^2} = \frac{232{,}87}{15869250} =$$ **0,000014649 F = 14,649 µF**

Type of load: Refrigerator 1

P_n = 150 W, I_n = 230 V,

$cos\varphi_1$ 0,55 → $tan\varphi_1$ 1,52 $cos\varphi_2$ 0,98 → $tan\varphi_2$ 0,25

$Q = P\ x\ tan\varphi_1 = 150\ x\ 1{,}52 = 228$ VAR

$$C = \frac{P\ x\ (tan\varphi_1 - tan\varphi_2)}{\omega\ x\ V^2} = \frac{150\ x\ (1{,}52-0{,}25)}{2\ x\ 3{,}14\ x\ 50\ x\ 230^2} = \frac{190{,}5}{16610600} =$$ **0,000011468 F = 11,46 µF**

Type of load: Refrigerator 2

P_n = 110 W,

I_n = 230 V,

$cos\varphi_1$ 0,55 → $tan\varphi_1$ 1,52

$cos\varphi_2$ 0,98 → $tan\varphi_2$ 0,25

$Q = P\ x\ tan\varphi_1 = 110\ x\ 1{,}52 = 167{,}2$ VAR

$$\boldsymbol{C = \frac{P\ x\ (tan\varphi_1 - tan\varphi_2)}{\omega\ x\ V^2} = \frac{110\ x\ (1{,}52 - 0{,}25)}{2\ x\ 3{,}14\ x\ 50\ x\ 230^2} = \frac{139{,}7}{16610600}}$$ = **0,00000841 F = 8,41 μF**

Type of load: Example 1 residential

P_n = 1000 W,

I_n = 225 V,

$cos\varphi_1$ 0,88 → $tan\varphi_1$ 0,54

$cos\varphi_2$ 0,95 → $tan\varphi_2$ 0,33

$Q = P\ x\ tan\varphi_1 = 1000\ x\ 0{,}54 = 540$ VAR

$$\boldsymbol{C = \frac{P\ x\ (tan\varphi_1 - tan\varphi_2)}{\omega\ x\ V^2} = \frac{1000\ x\ (0{,}54 - 0{,}33)}{2\ x\ 3{,}14\ x\ 50\ x\ 225^2} = \frac{210}{15896250}}$$ = **0,000013210 F = 13,21 μF**

Type of load: Example 2 residential

P_n = 1500 W,

I_n = 220 V,

$cos\varphi_1$ 0,85 → $tan\varphi_1$ 0,62

$cos\varphi_2$ 0,95 → $tan\varphi_2$ 0,33

$Q = P\ x\ tan\varphi_1$ = $1500\ x\ 0{,}62$ = 930 VAR

$\boldsymbol{C} = \frac{\boldsymbol{P\ x\ (tan\varphi_1 - tan\varphi_2)}}{\boldsymbol{\omega\ x\ V^2}}$ = $\frac{\mathbf{1500\ x\ (0{,}62-0{,}33)}}{\mathbf{2\ x\ 3{,}14\ x\ 50\ x\ 220^2}}$ = $\frac{\mathbf{435}}{\mathbf{15197600}}$ = **0,000028623 F = 28,623 μF**

Type of load: Example 3 residential

P_n = 1800 W,

I_n = 230 V,

$cos\varphi_1$ 0,80 → $tan\varphi_1$ 0,75

$cos\varphi_2$ 0,95 → $tan\varphi_2$ 0,33

$Q = P\ x\ tan\varphi_1$ = $1800\ x\ 0{,}75$ = 1350 VAR

$\boldsymbol{C} = \frac{\boldsymbol{P\ x\ (tan\varphi_1 - tan\varphi_2)}}{\boldsymbol{\omega\ x\ V^2}}$ = $\frac{\mathbf{1800\ x\ (0{,}75-0{,}33)}}{\mathbf{2\ x\ 3{,}14\ x\ 50\ x\ 230^2}}$ = $\frac{\mathbf{756}}{\mathbf{16610600}}$ = **0,00004551 F = 45,51 μF**

Type of load: Example 4 residenzial

P_n = 2000 W,

I_n = 230 V,

cosφ₁ 0,87 → *tanφ₁* 0,57

cosφ₂ 0,96 → *tanφ₂* 0,30

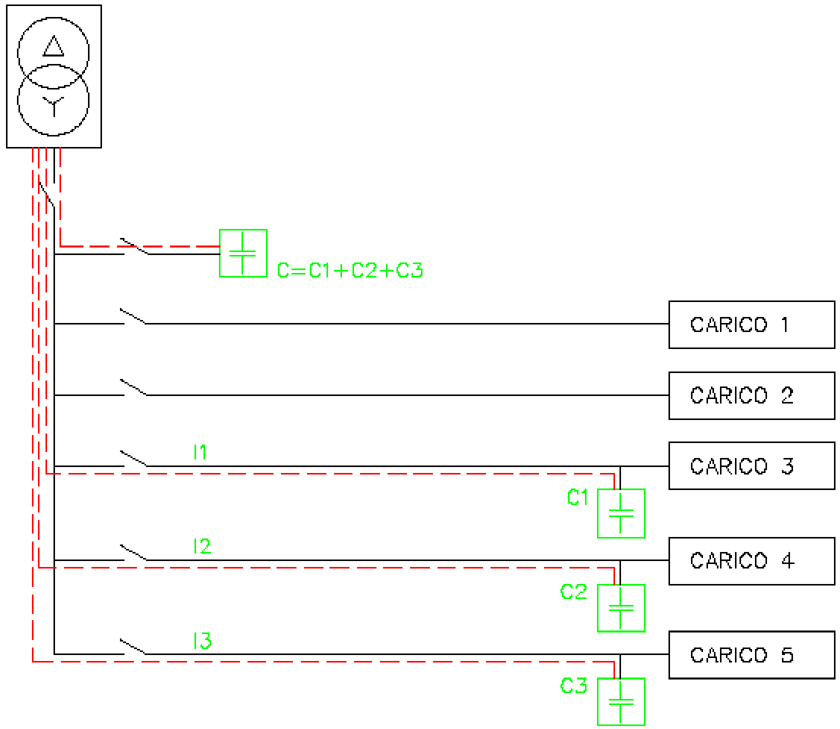
$Q = P \; x \; tan\varphi_1$ = $2000 \; x \; 0{,}57$ = 1140 VAR

$$\boldsymbol{C = \frac{P \; x \; (tan\varphi_1 - tan\varphi_2)}{\omega \; x \; V^2} = \frac{2000 \; x \; (0{,}57 - 0{,}30)}{2 \; x \; 3{,}14 \; x \; 50 \; x \; 230^2} = \frac{540}{16610600}}$$ = **0,00003251 F = 32,51 µF**

These calculations performed show that the capacity needed for a domestic 230V ac power factor correction, is about 35 uF, which is also the capacity in microfarads of EKOVAR. With the new EKOVAR-MASTER CORE-ARM + n° 1 EKOVAR-SLAVE, we will have 35 +35 = 70 uF. With EKOVAR-MASTER + SLAVE-EKOVAR n° 2, we will have 35 +35 +35 = 105µF, and so on, up to n ° 8 SLAVE. in the case of networks at 115 Vac - 60 Hz, the values of capacity are higher With this technology, we can create so the amount of capacitive reactive energy we want and adapt it at a later time, itself the 'electrical system was expanded. Clearly, in addition to covering the civil household, is also interested in the tertiary sector and small industry, with very high efficiency, in terms of energy savings.

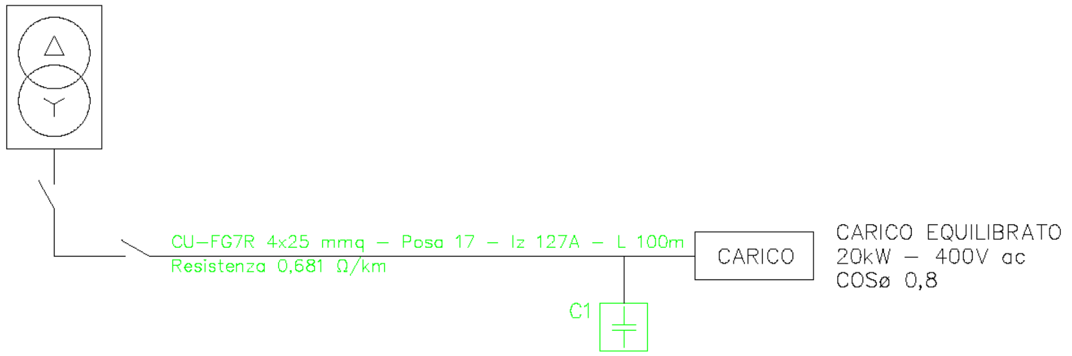
POWER FACTOR CORRECTION WITH INSERTION UPSTREAM AND DOWNSTREAM

With the power factor upstream, the capacitive reactive current Irc goes to compensate the inductive reactive current Iri only in the section of the line upstream of the power factor correction.



With the rephasing downstream of electric plant, instead you go to decrease the current absorbed by the load with a consequent reduction of losses by Joule effect. Such losses due to the reactive, are more than minor and you can make some examples to quantify.

EXAMPLE OF A POWER FACTOR CORRECTION DOWNSTREAM WITH ELECTRICAL BALANCED LOAD



JOULE EFFECT LOSSES WITH A LOAD WITHOUT PFC (power factor corrector)

$I_1 = \frac{P}{\sqrt{3}\ x\ V\ x\ cos\varphi} = \frac{20000}{1{,}73\ x\ 400\ x\ 0{,}8}$ = **36,12 A**

$P_d = R \times I^2 = 0{,}0681 \times 36{,}12^2 = 88{,}84$ W/fase

$P_d = 88{,}71 \times 3 =$ **266,52 W**

Taking as reference the load powered for 10 hours we will have:

$P_1 = 266{,}52 \times 10 = 2665{,}2$ Wh = **2,6652 kWh**

JOULE EFFECT LOSSES WITH A LOAD PROVIDED OF PFC (power factor corrector)

$I_2 = \frac{P}{\sqrt{3}\ x\ V\ x\ cos\varphi} = \frac{20000}{1{,}73\ x\ 400\ x\ 0{,}98}$ = **29,49 A**

$P_d = R \times I^2 = 0{,}0681 \times 29{,}49^2 =$ **59,22 W/fase**

$P_d = 59{,}13 \times 3 =$ **177,66 W**

Taking as reference the load powered for 10 hours we will have:

P_2 = 177,66 x 10 = 1776,6 Wh = **1,7766 kWh**

Improving the power factor load will have a reduction of current fed on the line equal to:

$I = I_1 - I_2$ = 36,12 – 29,49 = **6,63 A/fase**

Consequently we will have a saving of power in 10 hours amounted to:

$P = P_1 - P_2$ = 2,6652 – 1,7766 = **0,8886 kWh**

The supply of electricity over 15 kW 400V ac, the reactive energy is not be counted.
The reactive energy is counted by the distributor and charged to the consumer based on the following parameters:

- **Reactive energy ≤ 50% of the active is not counted**
- **Reactive energy> 50% but ≤ 75% of the active, is counted at € 0,323 / kVARh**
- **Reactive energy ≥ 75% of the active, is counted at € 0,421 / kVARh**

To eliminate this share can install central power factor correction that are able to eliminate a large part of excess reactive.
In these devices, the connection of the capacitors through contactors is anticipated that insert chokes first capacity building, in order to limit the physical deterioration of contacts. This deterioration is also limited by the time of switching on / off that are of the order of 20-30 seconds.
Generally, these units have the current sensor on a stage, so in case of unbalanced load, it is likely that no battery is inserted, even if the system needs it.
Another aspect unsatisfactory is that the control units have power factor correction capacitor banks of equal capacity, then the number of combinations is very limited (4-8 combinations) for which the effectiveness of the power factor correction occurs with the nominal load. Since generally the first battery, the remarkable ability (example 2,5-5-5 / 5-10-10 / 10-15-15 kVAR), power factor correction at low loads is not carried. The industrial control of power factor correction , has the aim to eliminate the share in Euro reactive energy bill and to get what is just enough to bring the power factor greater than 0.9 and is the result that they get the power factor correction in the market.
In terms of energy saving, power factor corrector stations in trade, omit a considerable portion of the reactive energy (8-10%) and is a percentage of losses true, because with 10% of reactive energy absorbed by a load, we have only 90 % apparent energy that we can harness.

KOVAR

SCOPE

EKOVAR born to be used in household and similar large spread in the environment and has the function to automatically correct the power factor, tending to a phase shift close to unity (in many situations load, Ekovar manages to transform an inductive load in a load with power factor up to 0,995; 0.996; 0.997; 0,998; 0,999). It is suitable for systems with nominal voltages between 100 and 250V ac, 50/60Hz. It is not in any way comparable to industrial power factor correction because his operation, results, size, safety, low environmental impact and energy characterize substantial differences, with a scope, functional and structural completely different from any other equipment that can be defined "automatic power factor corrector ", having purposes and uses much more" extended "and" eco-sustainable ".

It is in fact that over the past two decades there has been a substantial change in the types of loads, especially for what concerns the appliances and lighting. Decrease the amount of energy absorbed by a load many times is costly and sometimes impossible.

You can instead decrease the absorption of such a load, when it is an integral part of an electrical installation.

The good use of electrical energy is achieved only with the reduce or avoid waste, but also with the technology to lower the absorption of the plant with the same load. However, there are also users, such as incandescent lamps and resistance furnaces, which absorb only the second type of current, the active current.

We are now in the principle of operation of the Ekovar, created to exploit the smallest portion of the energy in the sphere of civilian housing, otherwise the energy would be irretrievably lost. It then comes to civil use, for 3-4,5-6-10 kW of installed power 115/230V ac single-phase , and 230/400V ac, three-phase, 06/10/15 kW. The single-phase supplies have always been let loose, as you check the cost of reactive power in single-phase systems, small power by the utility, is costly and is not 'convenient (although the electronic meter detects all the electrical parameters) , because the user still pays all the energy is that it will be misused or used diligently, ie the user pays is the active energy that the energy shifted. **Ekovar has reason to be installed in the following activities: rented units; areas of buildings; the apartment buildings, public lighting systems; Businesses small or medium; crafts small or medium; Medical studies; Professional Studies; Tourist residences, campsites, caravan parks and caravan , places boats , etc ...**

The loads present in housing units or activities listed above, which create a phase shift between voltage and current remarkable, are hereinafter listed below:
Intercom circuit, power supply TV, TV closed circuit, circuit burglar alarm, blender, refrigerator, freezer, dishwasher, washing machine, fluorescent lamps, cold cathode tubes, low voltage spotlights, generator of heating, heat pump, vacuum extractor, bathroom extractor fan, vacuum cleaner, air conditioner, computer , monitor, printer, calculator, fax, fan agitator air, water booster pumps, television, electric razor, clock radio, stereo, aquarium pump, hydro bath, swimming pool, electric toothbrush, garden lamps, automation gates and overhead doors, shutters automation; etc. ..

Example of installation of Ekovar in switchboard modular DIN rail support.

Example of installation of Ekovar directly on electronic meter of electricity

Example of installation of Ekovar plugged into an outlet of electricity for domestic use

CALCULATION OF RECOVERY OF LOSSES ON THE NET FOR THE JOULE EFFECT THROUGH INSTALLATION ON EKOVAR 'SYSTEM USER OF DOMESTIC ELECTRIC PLANTS

RESISTANCE PROPERTIES OF STRINGS IN COPPER FLEXIBLE INSULATION TYPE FG7R FOR TRANSPORT OF ELECTRIC ENERGY

CU 1x10 sq-mm:	1,73 Ohm/Km a 20°C	2,24 Ohm/Km a 80°C
CU 1x16 sq-mm:	1,047 Ohm/Km a 20°C	1,41 Ohm/Km a 80°C
CU 1x25 sq-mm:	0,681 Ohm/Km a 20°C	0,889 Ohm/Km a 80°C
CU 1x35 sq-mm:	0,481 Ohm/Km a 20°C	0,641 Ohm/Km a 80°C
CU 1x50 sq- mm:	0,344 Ohm/Km a 20°C	0,473 Ohm/Km a 80°C
CU 1x70 sq- mm:	0,272 Ohm/Km a 20°C	0,353 Ohm/Km a 80°C
CU 1x95 sq-mm:	0,206 Ohm/Km a 20°C	0,276 Ohm/Km a 80°C

The theoretical calculations to follow have the purpose to get closer to reality and have been made taking into consideration the following elements:

- Lengths of the lines below the average.
- Currents Ib lines, much lower than their capacities Iz.
- Do not overload the lines were considered.
- It is considered a value of ambient temperature of 20 ° C, as if it was taken as a reference temperature of 80 ° C, the losses increase considerably.
- The resistances of all connections before loading were ommesse,

(connections of the measuring apparatus; derivatives with pressure clamps, contacts with the disconnecting device and protection, etc. ..)

The time taken into consideration in the formulas and 'of 8 hours in order to have an average of 24 hours, to obtain the simplified calculations by extrapolation but they can get closer to reality.

- Type of installation and aerial cables spaced. In the case of lines with insulated conductors and a clover shape, posing aerial and buried, (as in most of the type.

- Installation), you must add the losses due to the Joule effect due to 'inductive effect between the individual wires. These losses are not negligible.
- To simplify the calculations, the load was considered kind of focused and not distributed.

- In the calculations to follow the energy conductors 3 are taken into account, In reality in a strongly unbalanced system as that, the neutral is possible affected by the phase current, then the wires for the calculation of the losses by Joule effect schould be 4 and not 3.
Clearly in networks to 115 Volt, the losses by Joule effect of entities are significantly higher.

EXAMPLE 1:

LINE 4x16 sq mm, L = 2000 m load consisting of n° 30 - 230V 3kW apartments
15A X 30 = 450 A x (K = 0,4) = 180 A: 3 Steps = 60 A / phase. (K is the coefficient of simultaneity factor) Pd (power dissipation) = R x I ^{2} = 1,047 x 2 x 60 ^{2} = 7538,40 W / Phase 3 Phase = 22.615,20 W = 22,615 Kw / 3FN.
Considering a hypothetical middle of such losses for a period of 8 hours we will have:
22,615 x 8 = 180,92 Kwh / day of losses by Joule effect.
Consider the'installation of Ekovar of all housing units in question, assuming defect for a current of 0,5 A recovered for each unit, we will have 0,5 x 30 = 15A/3FN: 3 = 5 A / Phase.
60A - 5 = 55 A / phase. Pd = R x I ^{2} = 1,047 x 2 x 55 ^{2} = 2,09 x 3025 = 6332,25 W = 6,332 Kw / Phase x 3 = 18,99 Kw/3FN. 18,99 x 8 = 152,00 kWh / Day. 180,92 - 152,00 = 28,65 Kw / Day. In conclusion the losses by Joule effect on the line object are 180,92 kWh / day in normal conditions and are reduced to 152,00 Kwh / Day by the installation of Ekovar, with a recovery of losses amounted to 28,92 Kwh / day..

EXAMPLE 2:

LINE 4x16 sq mm, L = 1000 m, load consisting of n° 30 - 230V 3kW apartments

15A X 30 = 450 A x (K = 0.3) = 135 A: 3 Phases = 45A/Fase.
Pd (power dissipation) = R x I^2 = 1,047 x 45^2 = 2120,17 W / Phase x 3 Phases = 6360,51 W = 6,36 Kw / 3FN.
Considering a hypothetical middle of such losses for a period of 8 hours we will have: 6,36 x 8 = 50,88 Kwh / day, of losses by Joule effect.
Considering the installation of Ekovar of all housing units in question, assuming defect for a current of 0,5 A recovered for each unit, we will have 0,5 x 30 = 15A/3FN: 3 = 5 A / Phase.
45A - 5 = 40A/Fase.
Pd = R x I^2 = 1,047 x 40^2 = 1,047 x 1600 = 1675,20 W = 1,675 kW / Phase x 3 = 5,02 Kw/3FN. 5,02 x 8 = 40,16 kWh / day.
50,88 – 40,16 = 10,72 kW / day.
In conclusion the losses by Joule effect on the line object are 50,88 kWh / day in normal conditions and are reduced to 40,16 kWh / day by installing Ekovar, with a recovery of losses amounted to 10,72 Kwh / day.

In reality in a strongly unbalanced system as that, the neutral is affected by the phase current, then the wires for the calculation of the losses by Joule effect schould be 4 and not 3.
Clearly in networks to 115 Volt, the losses by Joule effect of entities are significantly higher.

EXAMPLE 3:

LINE 4x25 sq mm, L = 500 m load consisting of n° 50 - 230V 3kW apartments

15A X 50 = 750 A x K = 0,5 = 375: 3Phase = 125 A / Phase.

CU 25mmq = 0,681 Ohm / Km : 2 = 0,34 Ohm / 0,5 Km

Pd (power dissipation) = R x I ^{2} = 0,34 x 125^2 = 0,34 x 15625 = 5312,50 W / x Phase x 3 Phases =21.250,00 W/3F + N = 21,25 Kw .

Considering a hypothetical middle of such losses for a period of 8 hours we will have:

22,572 x 8 = 170,00 Kwh/3F + N / Day of losses by Joule effect.

Consider the 'installation of Ekovar of all housing units in question, assuming defect for a current of 0,5 A recovered for each unit, we will have 0,5 x 50 = 25A/3FN: 3 = 8,33 A / Phase .

125A – 8,33 = 116,67 A / Phase.

Pd = R x I ^{2} = 0,34 x 116,67^2= 0,34 X 13.611,88 = 4628,03 W = 4,628 Kw / Phase x 4 = 18,51 Kw/3FN.

18,51 x 8 = 148,08 kWh / Day. 170,00 – 148,08 = 21,92 Kw / Day.

In conclusion the losses by Joule effect on the line object are 170,00 Kwh / Day in normal conditions and can be reduced to 148,08 Kwh / Day by installation of Ekovar, with a recovery of losses amounted to 21,92 Kwh / day.

EXAMPLE 4:

LINE 4x25 sq mm L = 800 m load consisting of n°50 - 230V 3kW apartments

15A X 50 = 750 A x (K = 0,3) = 225 A: 3 Phases = 75 A / Phase.

CU 25mmq = 0,681 Ohm / Km x 0,8 = 0,54 Ohm /0,8 Km

Pd (power dissipation) = R x I^2 = 0,54 x 75^2 = 0,54 x 5625 = 3037,50 W / Phase x 3Phases + N = 12,150.00 W/3F+N = 12,15 Kw .

Considering a hypothetical middle of such losses for a period of 8 hours we will have:

12,15 x 8 = **97,20 Kwh/3F + N** / **Day** of losses by Joule effect.

Consider the installation of Ekovar of all housing units in question, assuming defect for a current of 0,5 A recovered for each unit, we will have 0,5 x 50 = 25A/3FN: 3 = 8,33 A / Phase .

75 – 8,33 = 66,67 A / Phase.

Pd = R x I^2 = 0,54 x $66{,}67^2$ = 0,54 x 4448,89 = 2400,24 W = 2,40 kW / Phase x 4 = 9,60 Kw/3FN.

9,6 x 8 = **76,80 kWh / Day** - 97,20 – 76,80 = 20,40 kW / day.

In conclusion the losses by Joule effect on the line object are 97,20 kWh / day in normal conditions and are reduced to 76,80 kWh / day through the installation of Ekovar, with a recovery of losses amounted to 20,40 Kwh / day.

EXAMPLE 5:

LINE 4x35 sq mm L = 500 m, Iz 158A, load consisting of n° 40 - 230V 3kW apartments

15A X 40 = 600 A x(K = 0,4) = 240A: 3 Phases = 80A/Fase.

CU 35 sq-mm = 0,481 Ohm / Km x 0,5 =x 0,24 Ohm /0,5 Km

Pd (power dissipation) = R x I^2 = 0,24 x 80^2 = 0,24 x 6400 = 1536,00 W / x Phase x 3 Phases + N = 6.144,00 W/3F+N = 6,144 Kw .

Considering a hypothetical middle of such losses for a period of 8 hours we will have:

6,144 x 8 = 49,15 Kwh/3F + N / Day of losses by Joule effect.

Considering the installation of Ekovar of all housing units in question, assuming defect for a current of 0,5 A recovered for each unit, we will have 0,5 x 40 = 20A/3FN: 3 = 6.66 A / Phase .

80 – 6,66 = 73,34 A / Phase.

Pd = R x I^2 = 0,24 x $73{,}34^2$ = 0,24 x 5378,75 = 1290,90 = 1,29 kW / Phase x 4 = 5,16 Kw/3FN.

5,16 x 8 = 41,28 kWh / Day. 49,15 – 41,28 = 7,87 Kw / Day.

In conclusion the losses by Joule effect on the line object are 49,15 kWh / day in normal conditions and are reduced to 41,28 kWh / day through the 'installation of Ekovar, with a recovery of losses equal to 7,87 Kwh / day.

EXAMPLE 6:

LINE 4x35 sq-mm L = 500m Iz 158A, load consisting of N° 70 - 230V 3kW apartments

15A x 70 = 1.050 x (K = 0,5) = 525A: 3 Phases = 175A/Fase.
CU FG7R 70 sqmm = 0,272 Ohm / Km x 0,5 = 0,136 Ohm /0,5 Km
Pd (power dissipation) = R x I ^{2} = 0,136 x 175^2 = 4165,00 W / Phase x3Phases + N = 16.660,00 W/3F = 16,66 kW.
Considering a hypothetical middle of such losses for a period of 8 hours we will have:
16,66 x 8 = 133,28 Kwh/3F + N / Day of losses by Joule effect.
Considering the installation of Ekovar of all housing units in question, assuming defect for a current of 0,5 A recovered for each unit, we will have 0,5 x 70 = 35A/3FN: 3 = 11,66 A / Phase .
175 – 11,66 = 163,34 A / Phase.
Pd = R x I ^{2} = 0.136 x 163^2 = 3613 W x 4 = 14,452 Kw.
14,45 x 8 = 115,6 + Kwh/3F N/8ore
133,28 – 115,6 = 17,68 + Kwh/3F N/8ore.

Operating Characteristics

In particular, we highlight the following features:

- Modular dimensions for mounting in switchboard standards of living (7moduli Din);
- Use of capacitors MKP (metallized polypropylene) to 275V ac with insulation class X2, for operating temperatures from -40 to +110 ° C (VDE UL CSA CQC ...), the type long life, in order to obtain the maximum operational safety and electrical;
- Use of instrument transformers, current and voltage, double insulated, to make the secondary circuits secure, totally independent from the energy supply to 115/ 230V ac, in particular the use of the current transformer (current / voltage), which ensures high measurement accuracy even at low currents and no dissipation in the high-current assets;
- Use of protective devices, transient, on the line of 115/230V ac types up to 20kA, non-flammable with reaction time of less than 25ns, to dispel the very short lightning induced on the line providing that could cause harm to the user and to 'entire apparatus for energy recovery in all its parts;

- Use internal temperature sensor for sensing the actual operating temperature with auto-protection of the entire system of energy recovery (automatic standby), and in reporting on log data to be displayed on the LED status lights;
- Microprocessor control with sampling measuring less than 0,5 sec;
- Galvanic isolation of the pressure transducers for the capacity, in accordance with VDE (4kV) through the use of optoelectronic devices for switching and networking power of the batteries power factor correction;

- Operation muted through use of solid state switches (semiconductor switches) with the detection of activation synchronized on the passage for the "0" of the voltage of the power supply of the plant, in order to prevent even the possible disturbances induced by micro sags due to the triggering voltage capacitors;
- Soft on damping with rapid switch-off, through the use of optimized devices "inrush" on the batteries to hold pulse overcurrent and "ringing" in order to prevent possible harmonics induced on the power supply, due to the cue or the rapid discharge of the battery have occurred;
- Snapshot view of the state of batteries work occurred through the signaling function LED flashing permissible tolerance bandwidth and sampling took place, in order to have total control of the correct functioning of even by non-experts with simple control view;
- Snapshot view of the current flowing into the electrical appliance, using 3-digit LCD display, in order to facilitate the display of the instantaneous power consumption (instead of the power as it happens in electrical energy), more immediate, even by people not expert;
- Snapshot view of the presence of errors due to situations outside imbalance measurement, capacitive, and inductive power line, in order to signal the immediate incorrect connection and the possible malfunction due to breakage, or abnormalities of the user;

- Fast tracking algorithm for the activation and deactivation batteries, 16 useful combinations with instant error compensation on low currents, in order to optimize the correct power factor correction even on low loads, specifically on night work that forms part of the energy recovery , normally underestimated, through the use of the capacity of the base value of 2,2/3,3 uF;
- Construction of the device through the use of electronic devices to low power consumption, to contain the energy absorption "sub" from the power line of control, so as to minimize the environmental impact to the maximum energy consumption and consider their own equipment at no cost "zero "in practice

undetectable by the energy meter;
- Functionality and automatic display of the state "dormant", in case of no consumption on the power line user, in order to avoid improper actuations not relevant to energy saving and minimizing further the internal consumption of energy recovery apparatus;

Operation principle:

- Pre-processor
- A series of functions, analyze the electrical network connected to the apparatus and verify that all parameters of operation and provision are satisfied as the presence and value of voltage, the presence and value of current, typical frequency and the phase shift last in verifying the entity and the type, if negative (phase shift due to reactive load capacitive type), if inductive (phase shift due to the reactive load of the inductive type). In this phase is also made a series of local analysis with the purpose of establishing that the primary conditions are met for proper operation as the verification of the temperature inside the apparatus, the verification that the conditions of power, voltage, current, frequency, are met in the minimum time of analysis and reconfirmed for a certain cadence. After all of these conditions have been analyzed successfully, the firmware passes to the next stage. Having verified the persistence for a certain time, of a phase shift of the reactive type inductive, the Firmware control actuates a series of capacitor batteries, for combinations of increasing flow rate, in order to seek an optimal compensation on the line energy input that meets the best value for the correction of the power factor as possible, ie as close as possible and close to unity. During this phase, are in turn re-analyzed all the parameters of the power supply so that it is confirmed the status of the correct functioning of the entire apparatus, and if this additional control even after everything is confirmed,

including the stability of accurred phase compensation, the actuator stops on the optimal combination, until a change occurs in at least one of the parameters controlled.
Similarly, if the inductive phase shift is lost for detachment of the reactive load provocative, the apparatus also in this case, based on the analysis of the data of the mains input tends to track the optimal phase shift unit, acting on posting for decreasing combinations of capacitors, until needed.

SPECIFICATION CORE- ARM MASTER:

IMPORTANT:
EKOVAR SYSTEM BY THE' USE OF 32-BIT MICROPROCESSOR CORE ARM, E 'ABLE TO CHECK THE NETWORK, DEVELOP ALL SIGNALS, THE ABILITY TO CALCULATE YOU NEED, INSTANTLY, CHOOSE THE CAPACITY BETWEEN 16-32-64-128-256-512, ETC ... COMBINATION, RELEASE THEM GENTLY IN THE SYSTEM, IN A TIME VARIABLE OF 1-2-3 SECONDS , SO THAT DOES NOT REFLECT CAPACITIVE LOAD INPUT NETWORK .THE APPARATUS HAS ALSO PASSED ALL TESTS OF ELECTRICAL SAFETY AND ELECTROMAGNETIC EMISSIONS FOR THE PURPOSES OF CE MARKING.

TECHNICAL DATA:

Power supply: Vn 100-270Vac 50/60Hz-(LN terminals)
Amperometric signal :TA-75A Primary
Surge protector: class II, Imax ≤ 10kA, t ≥ 20ns
Nominal current: In 8 A
Protections: Short circuit, internal overheating;

Noise level: below the audible range;

Working temperature: 0 ° C to +60 ° C (at design -40 ° C to +65 ° C)

Degree of protection: IP40; Insulation: Class II;

Weight: 500g about;

Number of Units: 7 mod., attack rail DIN_ bxhx p_123x75x90

Steps: 4; Useful key combinations: 16 (0/1/2/3/4/1 +2 / 1 +3 / 1 +4 / 2 +3 / 2 +4 / 3 +4 / 1 +2 +3 +4 / 1 +2 +3 / 1 +4 +3 / 1 +4 +2 / 2 +3 +4).

The CORE-SLAVE ARM has the same features of the CORE-MASTER ARM.

- The ARM CORE-Master has 16 possible combinations.

- The system combined with a Master and one Slave, has 32 possible combinations;

- The system combined with a Master and two Slave, has 64 possible combinations;

- The system combined with one Master and three Slave, has 128 possible combinations;

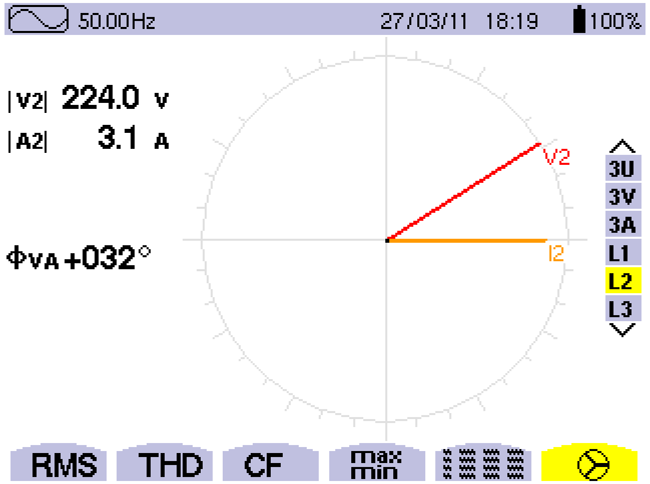
- The system with one Master and four slave, has 256 possible combinations;

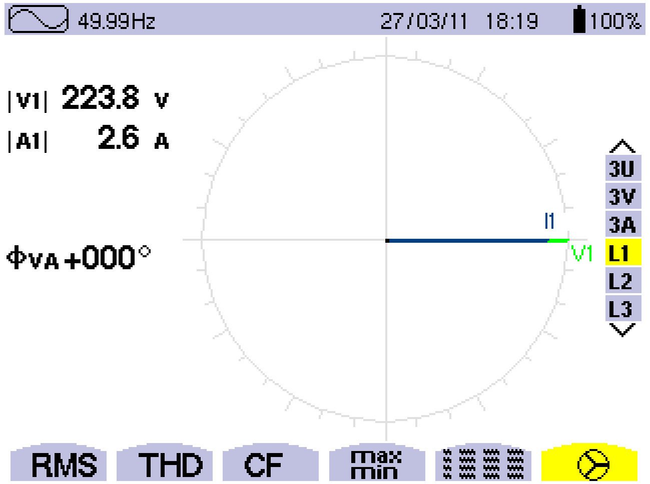
And so on, until to 8 slave.

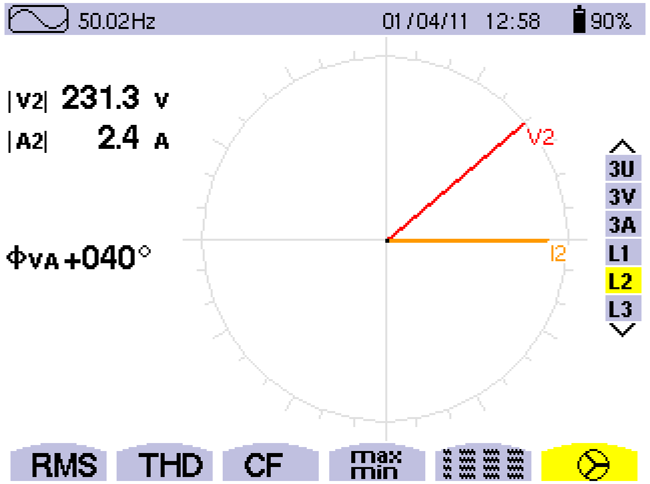
Indications and functions:

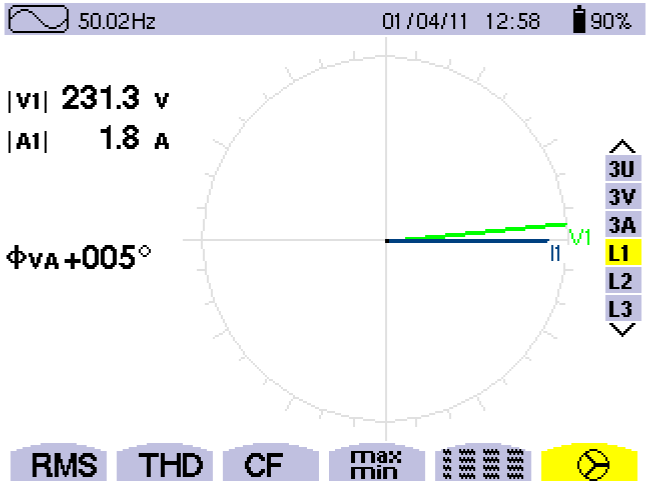
Inductive tollerance: LED off - Permissible tolerance inductive (no action),
LED on - not allowed tolerance inductive (insertion of capacitors)
Capacitive tollerance: LED off - Capacitive tolerance allowed (no action),
LED on - tolerance capacitive not permitted (disconnection of capacitors).
Fault: LED lit to signal status (and flashes different colors depending on the function of the moment).
Steps: 1-2-3-4 leds on, the capacitors entered.
Display: The display provides the data of the main parameters of the network, which flow with a residence time of about three seconds.
These data are: Volts, Amps, Cosfi; Hertz.

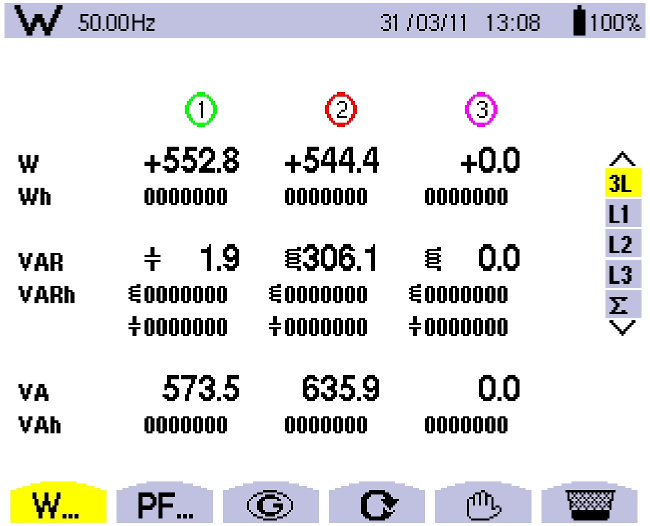
The following graphics represent the trend of network parameters, while some measures of energy absorbed by inductive loads.
In particular, A1, V1, W1; VAR1; VA1; DPF1, are the electrical parameters upstream of Ekovar, instead A2, V2, W2; VAR2; VA2; DPF2, the electrical parameters are measured downstream of Ekovar:

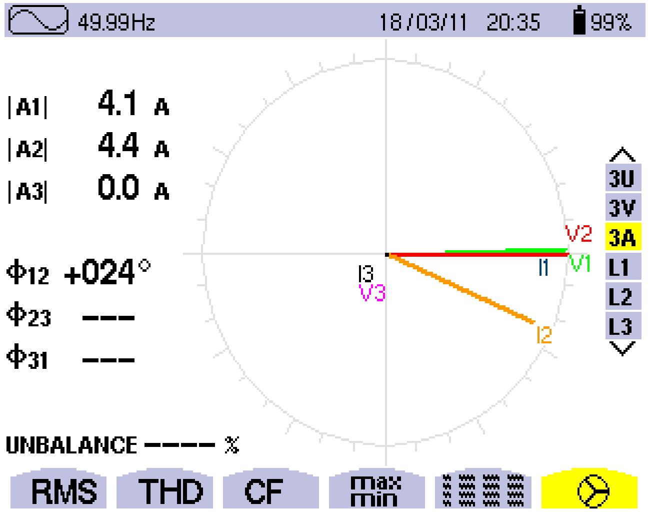

50.00Hz
27/03/11 18:19
100%
|V2| 224.0 V
|A2| 3.1 A
ΦVA +032°
V2
I2
3U
3V
3A
L1
L2
L3
RMS
THD
CF
max min

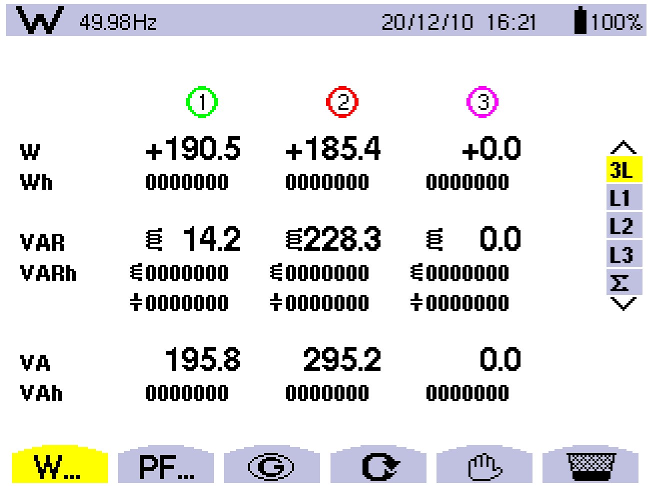

49.99Hz
27/03/11 18:19
100%
|V1| 223.8 V
|A1| 2.6 A
ΦVA +000°
I1
V1
3U
3V
3A
L1
L2
L3
RMS
THD
CF
max min

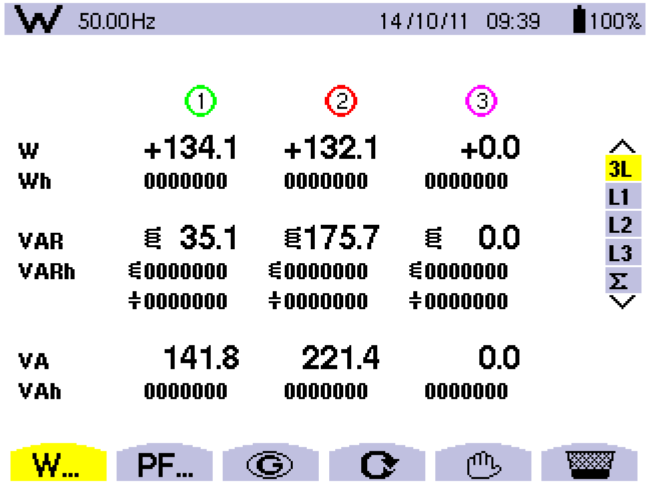

50.02Hz
01/04/11 12:58
90%
|V2| 231.3 V
|A2| 2.4 A
ΦVA +040°
V2
I2
3U
3V
3A
L1
L2
L3
RMS
THD
CF
max min

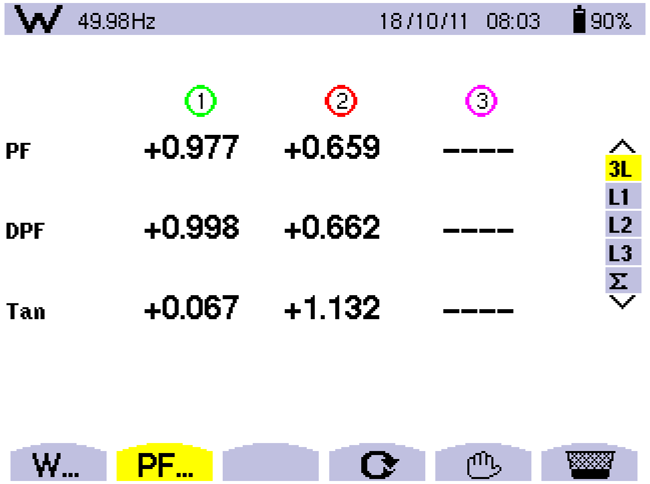

50.02Hz
01/04/11 12:58
90%
|V1| 231.3 V
|A1| 1.8 A
ΦVA +005°
V1
I1
3U
3V
3A
L1
L2
L3
RMS
THD
CF
max min


50.00Hz 31 /03/11 13:08 100%
1 2 3
W +552.8 +544.4 +0.0
Wh 0000000 0000000 0000000
VAR 1.9 306.1 0.0
VARh 0000000 0000000 0000000
0000000 0000000 0000000
VA 573.5 635.9 0.0
VAh 0000000 0000000 0000000
3L L1 L2 L3 Σ
W... PF...


49.99Hz 18 /03/11 20:35 99%
|A1| 4.1 A
|A2| 4.4 A
|A3| 0.0 A
Φ12 +024°
Φ23 ---
Φ31 ---
UNBALANCE ---- %
V2 V1 I1 I3 V3 I2
3U 3V 3A L1 L2 L3
RMS THD CF max min


49.98Hz 20/12/10 16:21 100%
1 2 3
W +190.5 +185.4 +0.0
Wh 0000000 0000000 0000000
VAR 14.2 228.3 0.0
VARh 0000000 0000000 0000000
0000000 0000000 0000000
VA 195.8 295.2 0.0
VAh 0000000 0000000 0000000
3L L1 L2 L3 Σ
W... PF...


50.00Hz 14/10/11 09:39 100%
W +134.1 +132.1 +0.0
Wh 0000000 0000000 0000000
VAR 35.1 175.7 0.0
VARh 0000000 0000000 0000000
0000000 0000000 0000000
VA 141.8 221.4 0.0
VAh 0000000 0000000 0000000
3L
L1
L2
L3
Σ
W...
PF...


49.98Hz 18/10/11 08:03 90%
PF +0.977 +0.659 ----
DPF +0.998 +0.662 ----
Tan +0.067 +1.132 ----
3L
L1
L2
L3
Σ
W...
PF...