EKOVAR - HOME ENERGY RECOVERY (recovery of energy for domestic use)

Report on energy saving

Scope

EKOVAR was born to be used in domestic environment and similar, in large spread in the and has the function to automatically correct the power factor, tending to a phase shift close to unit (in all situations of load, Ekovar is able to transform an inductive load , in a load with a power factor up to 0,999. It is suitable for network with nominal voltages included between 90 and 250V ac, 50/60Hz and voltage systems type IT-TT-TN. It is in no way, comparable to the industrial power factor correction, since operation, results, size, safety, low environmental impact and energy characterize substantial differences, with an applicable scope, functionally and structurally 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 fact is proved that over the past two decades there has been a substantial change in the types of loads, especially for what concerns the appliances and the lighting. Decrease the amount of energy absorbed by a load many times is costly and sometimes impossible. It is possible instead decrease the absorption of such a load when it is an integral part of an electrical installation. The good utilization of the electricity is not achieved with only reduce or avoid wastage, but also with the technology of lowering the 'absorption of user system, for the same load. We are now in the principle of operation of the **Ekovar**, created to exploit the smallest portion of energy in the residential and commercial sector, otherwise the energy would be irretrievably lost. It born then, for civil use, for installed power of 3-4,5-6-10KW-115/230Vac,50-60Hz and 6-10-15KW-230/400Vac, 50/60 Hz. In supplies with power less than or equal to 16,5 kW, the reactive energy is counted (the electronic meter detects all the electrical parameters). All user is still charged all the energy consumed, is the active energy that the reactive energy. Ekovar has reason to be installed in the following activities: housing units; areas of the apartment buildings, public lighting systems; Businesses small or medium; crafts small or medium; Local doctors, professional offices, places of worship, tourist Residence, Camping, Parks caravans and caravan; place for boats, etc .. Loads present in units or activities listed above, which create a phase shift between voltage and current, are the following occur: circuit intercom, TV power supply circuit; TV closed circuit, intruder alarm circuit, blender, refrigerator , freezer, dishwasher, washing machine, fluorescent lamps, cold cathode tubes, low voltage spotlights, boiler, heat generator, vacuum extractor, bathroom extractor fan, vacuum cleaner, air conditioner, computer, printer, calculator, fax, air blower, pump for lifting water; aquarium, hydro, pool pump, automation gates and overhead doors, shutters automation, etc. ..

Basic Theory on the reactive compensation

The active current is that which produces the useful work by acting through the machine or equipment on the product of the active current in amperes for the system voltage in volts provides the watts absorbed by the user to be converted into useful work, for example, on the motor shaft. The magnetizing current (also called reactive current) is that required to produce the magnetizing flux necessary for the operation of all those users, in alternating current, which require the presence of magnetic fields. Although this reactive current not used to produce mechanical work on the motor, it must be remembered that without the magnetizing current induction, electric motor or transformer could not function. In other words, the operation of these users is related to a current absorption greater than that corresponding to the mechanical work, including losses, which provides the user himself. The power factor can be defined as the ratio between the active current of the circuit and the total current of the same. In an electrical system are at stake, the following powers: - **active power P** [kW], P = S x cosfi; - **reactive power Q** [kvar], Q = S x sinfi**; apparent power S** [kVA], S = P + Q. The power factor of an installation is the ratio between the active power and the apparent power absorbed by the load, and can vary from zero to a unit value. Power factor cosfi= P / S. Maintain a power factor next to units, means: reduction of apparent power contract [kVA]; limitation of active power losses in the cables (Joule losses); possibility of reducing the section of electrical cables; increase the active power [kW] available the secondary of the MV / LV transformer; decrease the voltage drop (with the same cross section). The presence of components in the system and users with a high absorption reactive energy, causes the lowering of the power factor to unacceptable values. When in an electric plant, the power factor is too low, it is necessary to provide for compensation of reactive- inductive energy absorbed by users. Such compensation is performed using batteries of capacitors, which absorb and give to the network a current schifted by 90 degree in advance of the voltage. It is obtained in this way an increase of the power factor that corresponds to a decrease of the phase shift angle, between voltage and current (power factor correction). In the face of an active power P required by the users, employing a capacitor reactive power Qc, the reactive power drawn from the power supply passes from the value at the Q value Q ', the apparent power is changed from S to S' while the power active consumption remains unchanged. The capacitor bank must have a power equal to Qc = P x (tgfi - tgfì1). The battery power factor correction is calculated using the formula: Qc = Kc x P [kvar]. Kc represents the power of the capacitor required to compensation for every kW of power absorbed by the electric plant. Industry improves the power factor by the 'use of complex automatic power factor correction, on networks using a 230/400V three-phase capacity combined with the inductance, damping, because without them, the condenser was of high inrush currents and very limited life . The contactor insertion of the contacts must have anticipated and provided with further inductances, otherwise these contacts would have a very short duration. These power factor correctors have the sole purpose of bringing the power factor to a value of more than 0,9 in order to eliminate the share in the bill due to 'excess of reactive, more than 50% of active energy. In Italy, for supplies more than 16,5 kW, is the distribution utility that forces the user to refocus the electrical system, as if this is not done, would need much more Apparent Energy to power the same load, with the risk of having to reinforce the entire distribution system in low and medium voltage, by the fact to the increased current in the game.

Report of theoretical calculation on energy savings in general

The power of a central electricity generation, is given in KVA (Kilovoltampere), that is Volt x Ampere, since the power factor is taken equal to 1. If the load has a powered cosfi less than 1, there are many more amperes to generate the lower is the power factor. We deduce that the distributor has no interest in supplying loads with low power factor, as the current corresponding to the active power taken, it adds a current determined by the reactive power of the load, whith current circulating between the generator and the load, resulting in a greater flow of current which goes to further load the network. If the loads that we use every day were purely resistive loads (heaters), the problem would not exist. But when we are going to connect the equipment to our plant, are the inductive or resistive-inductive, that's a different aspect and hence the concept of "misuse of energy." The electricity that we use in the world, is an energy and voltage alternating current with a frequency of 50/60Hz. This means that this energy has a sinusoidal shape, with 50/60 cycles per second. A resistive load absorbs from the mains a current in phase with the voltage determining a zero phase shift between voltage and current, then power factor = 1 (power factor is the cosine of the angle whose tangent is fi). An inductive load, such as a halogen low voltage transformer, fluorescent tubes, or any type of appliance with motor (blenders, refrigerators, vacuum cleaners, fans, pumps, air conditioners, etc..) create a phase angle between voltage and current, which is much larger as it is more inductive load. Now we do a comparison between the absorption of a small motor from 200W to power factor = 0,7 and an incandescent lamp from 200W to power factor = 1. Considering the electric motor of 200W at 230V that we will have the current drawn by the same will be I = P / Vxcosfi = 200/220x0, 7 Ampere = 1,29 (P = power V = voltage I = current). If the load is purely resistive (incandescent lamp) we have: I = P / Vxcosfi = 200/220x1 = 0,9 Amps. Being the power of a load is directly proportional to current absorbed by the same, we note that the two loads in object differ from each other for the power factor in a decidedly determinant. For the same power absorbs 0,9 A resistive load and inductive load 1,29 A. If with an electronic circuit that feels the phase shift we go to enter on the network, small portions of capacitive energy to compensate for the inductive, we would obtain a load with a power factor close to 1, more close to 1 as it is near the value of the capacity which serves to bring the voltage in phase with the current, with the result that our motor absorbs from the network 0,9 A. The difference between the energy absorbed by the same load, to two different values of power factor is 74,4 Wh (watt-hours), which corresponds exactly to the size of the energy recovered. In another example, a load of 1000W, with power factor equal to1, and a load of 1000W whith a power factor equal to 0,75. In both cases the instantaneous power measured by the energy meter is of 1000W, which connected to the 1 hour time create an energy absorption equal to 1 kWh (kilowatt hour).

In the first case, the current consumption is equal to**: I = P / V x cosfi = 1000/230 x 1 = 4,3478 A.**

In the second case, the current consumption is equal to**: I = P / V x cosfi = 1000/230 x 0,75 = 5,7971 A.**

It is clear that the energy distribution, in this specific case, to user that has a load with a power factor equal to 1, must deliver 1,4493 a less. The benefits are substantial, because every Ah (Ah) generated by the central electricity generation, corresponds to a certain amount of energy consumed (water power, generated from flowing water, thermal energy, given by natural gas or diesel fuel, or nuclear energy at high temperature) to rotate the alternator. Each ampere removed from the network corresponds to an ampere that the central electricity generation, does not have to generate.

Therefore the apparatus **Ekovar** is able to obtain instant by instant, an energy recovery much higher, has it is higher the phase shift of 'electrical system, in the context of the type of electrical equipment in homes, with reference to the supply of energy for household**. Ekovar** explain therefore the function of "energy optimizer" and is able to recover that portion of energy that would otherwise usellessly and irretrievably lost. In simple language the apparatus is able to transform any load that is connected to the system, in a load for all similar to an incandescent lamp.

Calculation of theoretical economic savings in the national network

After performing hundreds of surveys of energy savings, especially in the laboratory and especially in homes, with measurements of all energy parameters, using laboratory equipment, certified, we can say that the average energy recovery in domestic and tertiary sectors, is **1,5-2 KVAh in a period of 24 hours** (data are available in over 300 sizes. A certain quantity of houses, where the power factor has values much lower of 0,9, the amount of energy is almost twice). In Italy, l 'Authority of electric energy, issued in 2011, a document to regularize the injection and withdrawal of reactive energy, the distribution network. This document called **DCO 13/11,** also shows the quantification of energy consumption of all home users, with deliveries of less than or equal to 16,5 kW. The calculations of all energy flows in the network, have been prepared by the **Politecnico di Milano**, on behalf of the Authority. The results of this study, it appears that such users, account for around **62.000 GWh/year** of energy, and approximately **26.400 GVARh / year** of reactive energy, power factor with an average of 0,89 to 0,90. Through the mass installation of Ekovar supplies of less than or equal to 16,5 kW, would be eliminated almost completely from the network, the **26.400 / GVAh year**. Considering that in Italy there are about **25.000.000** of energy meters for domestic energy-intensive users, and we assume a mass installation of Ekovar, we have: **1,5 x 25.000.000 = 37.500.000 KVAh / day** equivalent to **37.500 MVAh / day x 365 days = 13.687.500 / MVAh year** of energy savings. A central production by **10 MVA,** generates in a daily cycle, an energy of **160 MVAh**, which is reported to be **58.400 MVAh** in a year. **13.687.500 : 58.400 = <u>234,37 CENTRAL PRODUCTION.</u>**
This means that, if energy production in Italy, was entrusted to a number of stations, each with a capacity of **10 MVA (MegaVoltAmperes),** through the mass installation of Ekovar**, 234** of these electric power generation, can stand still. Considering a cost of production and distribution of **€ 130,00 per MVAh**, we will, **€ 130 x 13.687.500 = € 1.779.375.000,00** that the nation Italy can save. The national network in low voltage, can be downloaded theoretically up to about **10.000.000 Ampere**, in moments of maximum absorption of domestic users. The energy saved is reflected both on the MV(middle voltage) network that on the HV (hight voltage), with very high values of recovery of energy losses, for Joule effect and the possibility to eliminate any danger of Black-Out nationwide.
The decrease of Joule losses on the network, cannot be quantified exactly, but it is assumed that both of order of 20-30% of energy saved by home users. Clearly the calculations are theoretical and referred to an ideal network, but certainly very close to reality. A production plant for profitable deals KVAh product emits on average **0,6 kg of Co2 + NOx** (nitrogen oxide + carbon dioxide). Neither follows that **37.500.000 KVAh / day x 365 x 0,6 = 8.212.500.000 Kg = 8.212.500 Tons /co2 + NOx / year** of avoided emissions into the atmosphere. The quantification of the damage to environment is given by the value of the emission allowance equal to: **8.212.500,00 t/Co2/anno x € 17,00 = € 139.612.500/anno damage to the environment. (Value € 17 x ton of CO2** emitted into the environment, determined by the **European Comunity.**

In relation to white certificates (answer that Italy has taken on the ratification of the Kyoto Protocol), the Authority established a value of **€ 100,00 for TOE** (ton of oil equivalent) as an input unit tariff for the costs incurred by distributors required for the achievement of energy savings. it was established that 1 TOE is equal to 11.628 KWh thermal or 4.545,45 KWh electricity. 13.687.500.000 KVAh / year saved: 4545,45 =

3.011.253,01 TOE.

In the specific case we will have: 3.011.253,01 **TOE** x € 100 = **€ 301.125.301,12.**

This is the annual fee, which may rely on energy distributors, whether to adopt them, the project Ekovar.

NB: The calculations were performed with the data of measurements made, and in part with data available on the Internet.

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