STORAGE DESCRIPTION

When you have installed a photovoltaic system in your home, you probably thought to reduce the costs of the electricity bill, almost to zero, at least in the summer when the productivity is higher. Surely you will have noticed that the reduction in electrical drawings was not as high as you expected. This happens because the plant produces energy during the day when it is sunny, while most of the residential consumption takes place in the evening or at night. All electrical consumption can hardly be concentrated in the hours of increased photovoltaic productivity; moreover, even if the withdrawals are moved during the day, almost always it is not possible to calibrate the instantaneous consumption with the solar power available at the same time. This means that for most of the hours of daytime operation, the power supplied by the photovoltaic plant is largely superabundant compared to the current consumption and therefore the corresponding energy generated is "sold on the network". While in the evening or at night to serve user consumption you are forced to withdraw energy from the network.

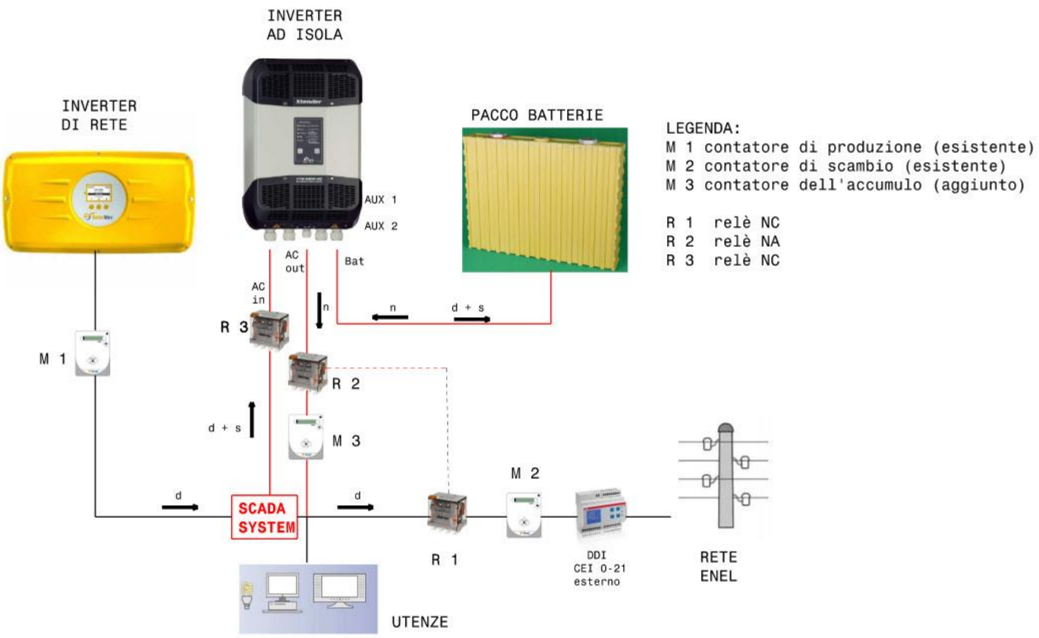
The energy sold on the network is remunerated (with the SSP or the RID) about half of what is paid in withdrawal. It would be convenient to store a part of the energy produced by the sun during the day and not used, to use it when the sun is not there, avoiding expensive withdrawals from the network. This is the concept behind the "photovoltaic accumulation". In other words, all the photovoltaic systems have an AUTOCONSUMO PROPRIO (ratio between diurnal consumption and energy produced by the photovoltaic system) that is limited to about 25-30% (annual average). If the total self-consumption is to be increased (ratio between total consumption and energy produced), an external storage system must be installed. The goal is to reach 100% that is to cover all the consumption of the building with photovoltaic production.

The photovoltaic storage systems that we currently offer have been developed for residential users with single-phase meters and have the exclusive feature of "off-grid" operation, ie completely disconnected from the electricity grid at night and during the night, while during the day they work normally connected.

Another unique feature of having accumulation capacity can be customized based on the consumption of current or future users. For example, if you already own an electric car or intend to buy it in the future, it is likely that you want to recharge it with the energy produced by your photovoltaic system, but you can do it only in the evening or at night, when your plant does not produce. With an accumulation dimensioned on the basis of consumption in the F2 and F3 time slots and a photovoltaic plant of adequate size, you can really recharge it with self-produced and renewable energy.

The storage systems, which we propose, are based exclusively on packs of high capacity lithium iron phosphate (LiFePo4) rechargeable prismatic cells selected within the Winston or Sinopoly range with sizes specifically designed for the accumulation of energy in photovoltaic systems or wind turbines. The cells have a nominal voltage of 3.2 V, so the packs are 4, 8 or 16 cells, to have nominal voltages of 12, 24 or 48 V respectively. They have been selected to allow a nominal storage capacity range of about 2 kWh daily up to about 35 kWh. The kits we offer are complete with the accessories necessary for their application (BMS, connectors, etc.). The adoption of packs made with separate cells instead of 12V batteries is due to the limited capacity of the latter.

The cells (of new production and therefore with integral durability) are supplied by the manufacturer only partially charged and must be filled completely before their use. The first charge is a delicate operation that can limit the real storage capacity of the cells, if not done correctly. This operation is carried out under controlled conditions (4 V of maximum voltage and maximum current equal to 0.5C for Winston cells) in our laboratories, at no additional cost, to provide you with ready-to-use and tested cells one by one. The charge is made for each cell individually. At the end a certificate is produced that certifies the result.
As shown in the following functional scheme, they are installed on the post-production side (AC side) and therefore allow direct management of the 220V loads of the entire building. Not being installed on the CC side of the photovoltaic system, if this is existing, they do not alter the production profile in any way: a fundamental feature in incentive plants.
In the future we can imagine to dedicate the accumulation only to the service of privileged users (for example to the recharge of the family electric car or to the power of particularly energy-consuming PDC), rather than to all.



The accumulation is installed in parallel to the photovoltaic system; this may already be connected (installation in "retrofit") or newly installed. If already existing, an adjustment of the system without power increase is required from ENEL. Simultaneously with the installation of the storage tank, an increase in power or the installation of a totally new photovoltaic system may be required. In both cases, in order to comply with the CEI 0-21 standard that regulates the connections of photovoltaic systems to the public ENEL network, with or without storage, the installation of an external DDI compliant with the standard and the installation of a new bidirectional meter M3, which measures energy exchanged by the accumulation (installation by ENEL).
In any case (unlike many products on the market) the installation of new panels simultaneously with the accumulation is NOT required, but completely optional: the plant if already existing remains unchanged and it is not necessary to intervene with devices that " optimize the operation.
The accumulation obviously works automatically and is managed by STUDER-INNOTEC inverters of the

XTENDER series. By installing the special XCOM-LAN communication module, it is possible to remotely access an internet portal that duplicates the interface of the inverter control module and therefore allows complete remote monitoring and programming.
The accumulation works with the duration of a cycle a day equal for 7 days a week. However, in a native way to the control system of the inverter it is possible to have different cycles for different days of the week or to activate the cycle only for certain days of the week.
During the day the photovoltaic system continues to operate connected to the grid and exchanges energy based on photovoltaic production and instantaneous consumption, like a normal system without accumulation. During the central hours of the day, when the intensity of the sun is greater, the possibility of charging the batteries is activated. The "SCADA SYSTEM", an application based on the monitoring device, is under development. When the energy produced by the photovoltaic system exceeds a certain power threshold, it divides the energy produced by the photovoltaic system partly to charge the batteries and part to serve domestic users, like a normal system in "exchange on site". Arrived then at evening time chosen by the user during installation and remotely modifiable if desired, the operating mode switches "off-line" ie the system is completely disconnected from the network and works as an "off-grid" system without any pick-up from the network but only from the batteries. This mode ends the next morning, when the photovoltaic production starts to rise and is able to cover the average consumption of the users. If during the night operation the voltage reaches the minimum level, "off-grid" operation is interrupted and the system returns connected to the grid.

To ensure correct charging of the battery packs, the XTENDER battery charger is programmed according to the charging profile described HERE (document in English). The charge is divided into 3 phases:
1. a first phase with constant current, with a progressive increase over time of the voltage of the battery pack (bulk charge), up to a maximum
2. This charging period ends with a second phase at constant voltage, if the maximum charge voltage (absorption charge) is reached. The constant voltage mode must show a progressive decrease of the charge current absorbed by the batteries and terminate when the residual current becomes lower than 0.015-0.02C (C = nominal capacity of the cells in Ah).
3. Maintenance charge (floating charge) in which the batteries are kept at a constant voltage, slightly lower than the maximum voltage.
For the first 2 phases sometimes we talk about charge with CC-CV phases. If during phase 1 the charging time ends, without reaching the maximum voltage, the charging process ends without steps 2 and 3 and the energy stored in kWh is equal to the sum of the product A xhx V (charging current x n ° hours x voltage reached) moment by moment. For example if you charge the batteries with 20 A constant for 5 hours, the capacity accumulated by the batteries increases by 100 Ah and the energy is equal to 100xVm (average voltage in 5 hours). Due to the conversion efficiency of the battery charger, the energy absorbed by the photovoltaic system will be higher (on average 10-15%).
In the charging process, lithium cells, unlike conventional technology, should not be kept under maintenance charge for a long time after the absorption phase. Therefore, if the cell pack reaches full charge, that is the holding voltage (floating voltage) following the maximum absorption voltage, the relay that allows the charge is opened, interrupting further absorption.

The photovoltaic storage we propose, as mentioned, has been developed for residential users with a single-phase meter, which requires only one inverter. However, it is possible to install up to 3 inverters in parallel and run them in three-phase systems, always in residential applications. On the other hand, it is possible to imagine different uses, such as for small businesses or artisanal activities in which the energy of the batteries can be used during the day to supplement the normal meter to support energy requests with consumption peaks ("over- boost "of the batteries).