TerraWatt Power™

The Energy To Make A Difference

The *eco*Joule® 2500 Inverter

Solar 101: Solar Photovoltaic (PV) Systems

A solar PV system begins with the solar cell. A ***solar cell*** or ***photovoltaic cell*** is a device that converts light energy into electrical energy. Solar cells are typically made of semiconductors, just like the integrated circuits that go into computers. Individual cells are used for powering small devices such as electronic calculators or solar powered landscape lights. For larger applications solar cells are assembled together into ***solar panels***, also known as ***solar modules***. For even larger applications these panels can then be linked together to form a ***photovoltaic array***. PV arrays are what you see on the roofs of homes and buildings (they can also be mounted in a racking system on the ground).

The electrical energy generated by the PV array is in the form of Direct Current (DC). However, most electrical equipment and appliances operate on Alternating Current (AC). Therefore, solar PV systems require an electrical device to convert the DC flowing from the solar panels to usable AC. This device is called an ***inverter***.

The inverter is the heart of a solar PV system. It is the interface between the PV array and the home or building's electrical system.

The ecoJoule Inverter: Superior Functionality

Solar PV inverters today are available in three distinct configurations or operating modes:

1. Synchronous inverters (a.k.a. utility interactive inverters, string inverters, or grid-tied inverters). These inverters represent the vast majority (>90%) of all inverters that are being sold in the market today. Synchronous inverters change the DC power that is

generated by the solar panels into AC power in a form that can be used by the home or fed directly into the utility grid. This reduces the amount of power the user must draw from the utility, thereby reducing the user's electric bill.

When the sun is shining, the electric power generated by the PV panels flows, via the inverter, into the home. If the PV panels are generating more power than is being used by the home, the excess power flows back to the utility company, "spinning the meter backwards" and selling the excess power to the utility. If the sun is not shining, or if more power is needed in the home than the PV panels can supply, the power required by the user is drawn from the utility.

In this scenario, the utility meter takes care of all of the accounting. The user pays the utility for the net energy drawn from the utility, automatically taking into account all of the energy produced by the PV panels. This is called "net metering".

THE PROBLEM: If utility/grid suffers an outage *(blackouts, brownouts, or outages caused by utility overloads or storms such as blizzards or hurricanes)*, these kinds of inverters will cease to operate and the user will be without power…even if it is a sunny day! This is required by Underwriters Laboratories (UL) to ensure the safety of utility workers. This is because they could be injured if they are working on a section of the utility grid that is believed to be de-energized but is not because a home's "islanded" PV system is still generating power and putting it into the grid.

THE ECOJOULE SOLUTION: With the ecoJoule inverter, if the utility/grid fails, the inverter will automatically disconnect from the utility/grid, thereby meeting the UL requirements, but will still continue to direct the power being generated by the PV panels into the critical loads of the home.

2. Stand-alone inverters (used in battery-based systems). Stand-Alone inverters convert the DC power that is stored in a large battery bank to AC power that can be used as needed. When the sun is shining, the power that comes from the PV panels is used to charge the batteries.

THE PROBLEM: Because they are not connected to the utility, these types of systems must be quite large (*i.e. very expensive*) to supply all of the power required to meet the user's demand. Besides a large battery bank and a device to charge the batteries called a charge controller, the capacity of the inverter in one of these systems must be larger than the total wattage of all of the AC loads that the user plans to run at one time. And, on top of that, if the inverter is expected to run induction motors, like the ones found in automatic washers, dryers, dishwashers and large power tools, it must be designed to support the surge in power required when these motors are starting up. A surge may require power many times the motor's rating during the short time interval when the motor starts.

THE ECOJOULE SOLUTION: With the ecoJoule inverter, the DC power being generated by the PV panels can be converted to AC power and then supplied directly to the critical loads within the home without the need for an expensive battery back-up system. The ecoJoule inverter is the ONLY inverter in the world to offer this capability. In addition, the ecoJoule inverter has been designed to meet the surge demand of induction motors.

3. Multifunction inverters. These inverters can operate both as a synchronous inverter and as a stand-alone inverter. In a typical residential installation, for example, a multifunction inverter is connected to a battery bank, the utility power lines, and the home. An additional device called a charge controller is used to charge the batteries from the PV panels. When the batteries are in a charged condition, the inverter supplies AC power to the home from the batteries as would a stand-alone inverter. If the batteries become discharged, the utility supplies power to the home, while the batteries are recharged with the power generated by the PV array. When the batteries become fully charged, the power generated by the PV array is used to reduce the amount of power drawn from the utility as it would be in a synchronous inverter system. Because of the batteries in the system, if utility power fails, the inverter can still operate, supplying critical loads, so long as adequate battery power is available.

THE PROBLEM: As with stand-alone inverters, having the security of battery back-up during power outages has a price…*a* *significantly higher system cost*.

THE ECOJOULE SOLUTION: The *eco*Joule is designed to take the DC provided by the photovoltaic panels, and deliver this power to both the home and the AC utility without the need for an expensive battery back-up system. The unique ability to supply power to the user from the solar panels when the grid is down is a part of what sets the ecoJoule inverter apart.

The *eco*Joule inverter is intelligent and has the capability of effectively operating in all three of these modes. The *eco*Joule automatically determines whether or not the utility is present, safely delivering power to home.

The ecoJoule Inverter: Superior Productivity

The PV panels that make up the solar array can be wired together or configured in different ways. If all of the panels are connected in series (like a chain), the voltage supplied to the inverter is relatively high and the current is relatively low. However, because all of the panels are in series, anything that reduces the output of even a single panel ends up reducing the output of the entire array. The most shaded panel becomes the weakest link in the chain and defines the power output of the entire solar array. The *eco*Joule inverter is designed to be a low input voltage, series parallel, inverter. Because of its innovative design, patented software configuration, and relatively low input voltage, the *eco*Joule inverter offers superior productivity compared to the other inverters available on the market.

- One of the "dirty little secrets" of the solar industry is that the power produced by PV panels drops significantly when the panels become shaded, even just a little. With its low voltage input configuration, however, the ecoJoule inverter maximizes the power output of the solar array in partial shade situations. This is because to achieve low input voltage, the ecoJoule inverter requires that the solar panels be wired in short series strings that are then connected in parallel. Therefore, the power output will decrease only from those panels affected by the shade. The remaining panels will continue to produce to their maximum capability.

The ecoJoule inverter extracts more energy from partially shaded arrays than string inverters do, thereby providing increased energy capture every day.

- Shade or no shade, using patented Maximum Power Point Tracking (MPPT) technology, the ecoJoule inverter always maximizes the energy drawn from the solar panels.

The ecoJoule Inverter: Superior Design

The ecoJoule inverter was created with both the homeowner and the installer in mind.

1. Expandability. Unlike other inverters, the ecoJoule inverter readily allows for incremental system expansion:
    a. a solar system can be installed in stages, a few panels at a time, up to the capacity of the inverter; and
    b. a battery back-up system, if desired, can be added at any time.

2. Ease of Installation. Every detail has been considered to make inverter installation as easy and straightforward as possible:
    a. the use of a high frequency isolation transformer has kept the ecoJoule compact and lightweight for ease of handling;
    b. the inclusion of a simple mounting bracket makes hanging the inverter a 5-minute task; and
    c. the use of a hinged door provides easy access to the wiring terminals.

3. Straightforward User Interface. An LCD display on the unit allows the user to easily monitor the performance of the inverter.

Let your solar power system achieve its true potential.

Install an ecoJoule inverter!