Environmental Potentials

Power Quality For The Digital Age

INVERTING SOLAR POWER

AN ENVIRONMENTAL POTENTIALS WHITE PAPER

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Introduction

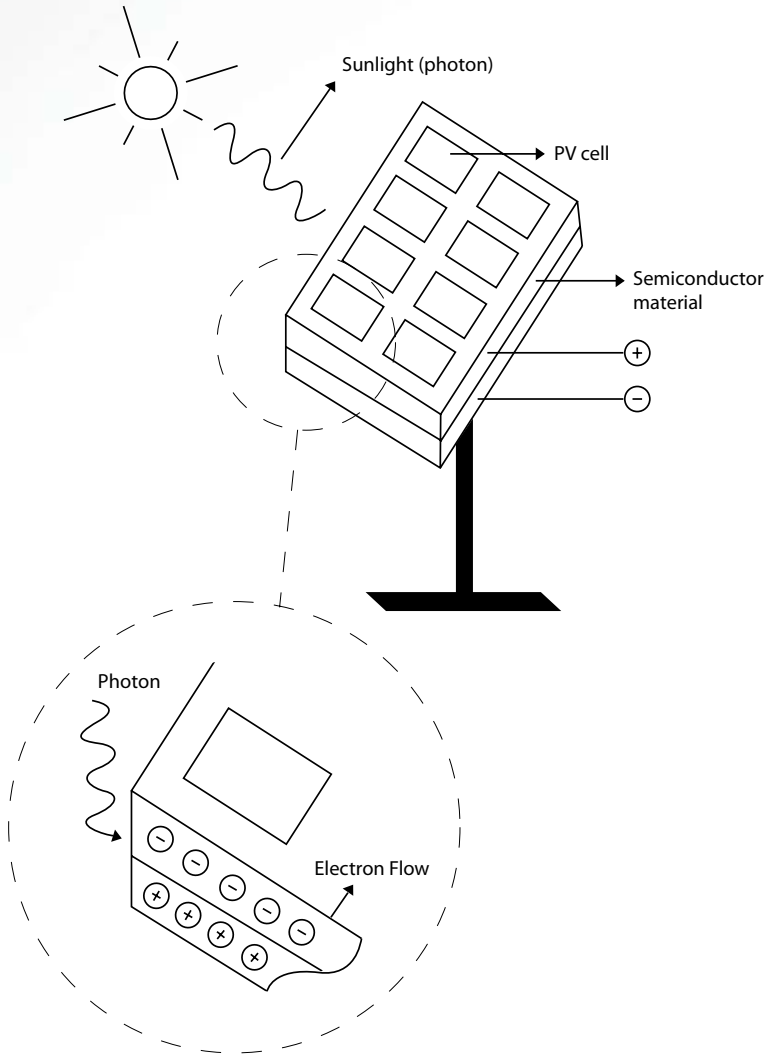
The fluctuation of oil and coal prices and concerns of global warming have significantly increased the demand for alternative energy. Oil and coal are diminishing resources which also contribute significant pollution to the environment with hazardous CO2 emission. Alternative energy has focused on wind, geothermal and solar generation. While the availability of oil and coal will be exhausted, solar energy is an infinite source of energy with no harmful residues such as CO2.

Solar generation can have a positive impact on energy prices and global warming. As the generation of solar power increases, some tough questions about the generation process need to be answered. Solar power unlike other power is generated in direct current (DC). However, the electrical distribution system requires alternating current (AC). This means solar power must be inverted from DC to AC before the power can be usable. However, inverting DC to AC creates noise and power pollution on the fundamental waveform.

Solar Generation

Solar power generation is adopting various new approaches, the most popular method is to use photovoltaic cells (PV Cells). PV cells are array shaped cells which are mounted on solar panels. Photovoltaic cells consist of semiconductor materials which help in the generation of electrical charge. The solar cell with the help of its semiconductor nature will convert the photon energy from the sun into an electron. Electrons created by this process can maintain an electrical charge and can easily flow through a medium resulting in electrical current.

The following picture demonstrates the photovoltaic effect.



The current generated by this process is DC. The voltage of the solar power is small in magnitude, approximately 48VDC. However, the distribution system is designed for AC. Industrial and commercial loads require AC in order to function. This means the power generated by the solar cells is not useful for industrial applications.

Solar generation facilities use inverters to convert this DC to a usable AC. These inverters convert the DC to AC directly after generation. Next, the AC is fed through the transformer, the voltage is stepped up and then transmitted through the transmission lines. From this point, the distribution of solar power behaves like any other method of power generation.

The use of inverters is the key difference between solar power generation and other power generation. Other power sources generate AC, but in solar generation, DC power is generated and then inverted to AC and then transmitted. This conversion of power from DC to AC creates electrical problems in the facility, such as switching transients and high frequency noise. Switching transients and high frequency noise will result in an inefficient electrical distribution system.

Noise Generation

There are different types of inverters used in the process of inverting DC to AC, however, quasi state AC sine wave inverters are the most common. These inverters use power semiconductor technology to convert DC to AC. The types of power semiconductor devices used are Insulated Gate Bipolar Transistor (IGBT), Gate Turn Off Thyristor (GTO), and Emitter Turn Off Thyristor (ETO).

In order to produce the required AC, the power semiconductor devices are turned on and off at a specific frequency. This turning on and off of the power semiconductor device requires extreme precision. Because of improper turning on and off of the gates, inverters are transient noise generators. Any change in the timing of frequency due to noise will result in surge or transient in the AC output voltage. This can damage equipment and decrease the efficiency of the electrical system.

Panel Mounting System

There are two types of solar panel mounting systems: fixed system and tracking system. The fixed system is comprised of stationary solar panels. These panels are fixed to the mounting station and cannot move. This system is inefficient because the panels are not capable of tracking the movement of the sun. This means that the solar panels only receive the maximum amount of sunlight for a few hours while the rest of the day the panels receive only partial amounts of sunlight.

In order to achieve maximum solar energy, the solar panel needs to track the sun movement and direct the PV cell towards the sunlight. This is also called active tracking. Motors are used to rotate the solar panel so that is tracks the sun. This tracking system is extremely sensitive and a minor change in the speed of the motor can significantly change the direction of the solar panel. This can decrease the efficiency of collecting solar energy and significantly reduce return on investment for solar generation. Changes in the speed of the motors are caused by disturbances on the power line, such as noise and switching transients.

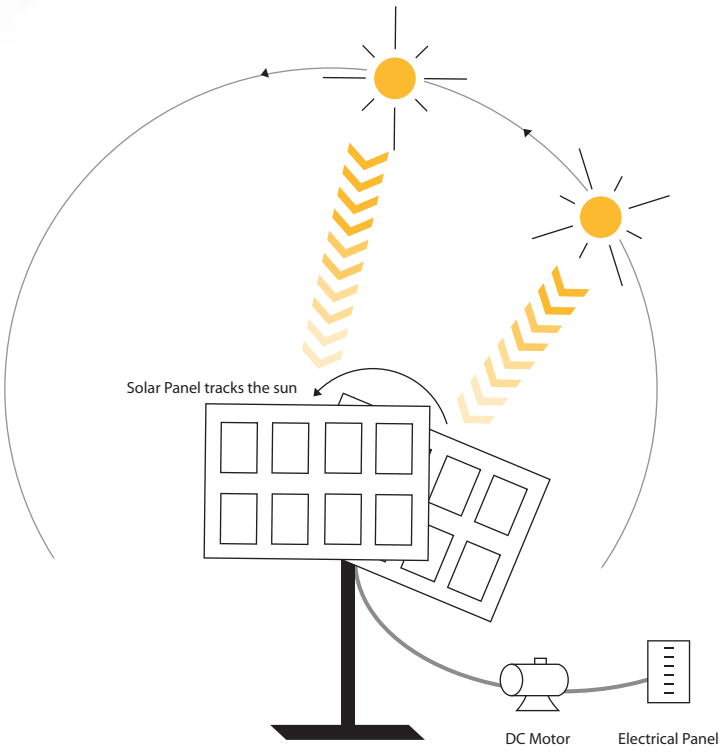


Figure 2: Active solar tracking system.

Figure 2 demonstrates the movement of the solar panel with respect to a change in the position of the sun. The motor used at the solar panel will tilt the panel's position according to the sun's position so that maximum sunlight is collected by the solar panel.

These tracking devices and solar panels are controlled and monitored by sophisticated technology such as data acquisition systems and remote monitoring systems. Since these loads are sensitive, and recording or monitoring data requires high precision, high frequency noise must be limited at these loads. High frequency noise will cause data loss, miss programming of the computerized load, bit loss, improper encryption and decryption, erratic behavior of devices.

Solar Storage

Solar energy is intermittent, meaning all available output must be taken when available. This energy must be stored or transported over transmission lines. Batteries are used to store the excess solar energy so it can be used during night or a day without sufficient sunlight.

Adding all these devices together, a solar power plant looks like the following.

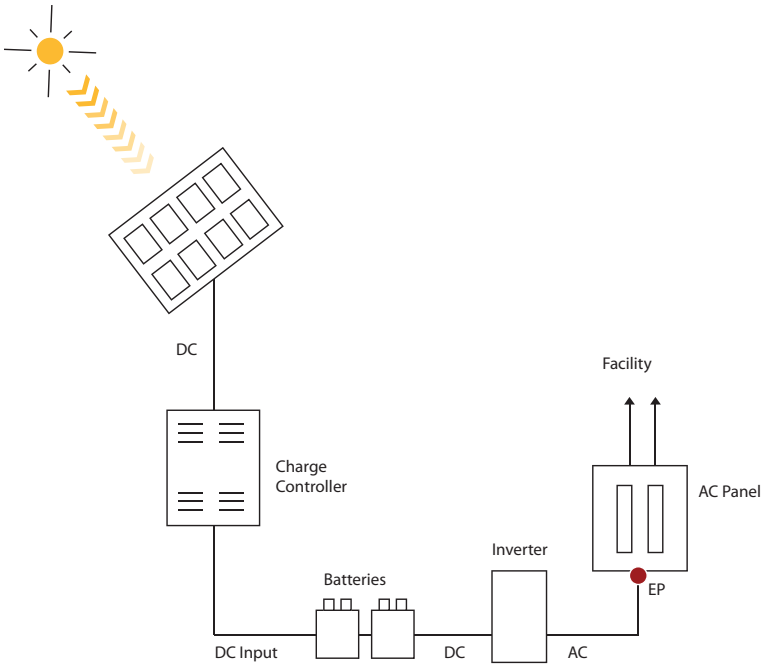


Figure 3: Solar Generation Facility

Power stations like hydral, coal and nuclear generate pure power free from electrical noise. However, due to the use of inverters, solar energy facilities generate polluted AC power. This pollution must be filtered before feeding this power to transmission lines, otherwise the electrical losses on the transmission lines will increase. The electrical noise will also cause malfunction of solar panel active tracking system and degrade the charging capacity of the batteries.

The EP Solution

High frequency noise on the fundamental waveform must be removed after the power is inverted from DC to AC. Environmental Potentials' waveform correction technology is designed to filter high frequency noise from 1kHz to 2MHz. EP waveform correction technology will absorb the high frequency noise and thermally convert the noise into heat. This ensures noise will not distribute to any part of the system including the ground. Environmental Potentials will not only protect the inverter from external noise, but it will also protect the computerized programmable loads that control the solar panels. EP will also increase the efficiency of the motor used for active tracking and therefore increases the solar energy generation.

Conclusion

Inverters and nonlinear devices are a crucial step in the process of generating solar power. Inverters are used to convert DC to AC. However, inverters use semiconductor devices which create switching transients in the electrical distribution system. The waveform generated by inverters is non-sinusoidal and contains high frequency noise. This results in an inefficient electrical distribution system, increased electrical losses and an increase of electrical maintenance in the system.

High frequency noise on the signal can cause erratic behavior of programmable logical circuits used for the solar panels which will decrease the efficiency of the solar panels. The motor used to rotate the solar panels will also be affected by the noise on the fundamental waveform which can result in misalignment of solar panels. This will cause a reduction of solar energy generation.

Correcting the sinusoidal nature of the waveform and removing high frequency noise will increase the efficiency of the generation process and ensure clean power is distributed to equipment. Environmental Potentials' patented waveform correction technology eliminates noise, improves the sinusoidal nature of the waveform, and protects all sensitive electric equipment. This ensures the solar tracking system performs at its maximum capability and that the power generated is free from noise and transients.

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