Total Energy Systems, LLC

KOHLER

Your Reliable Guide for Power Solutions **Information Sheet # 139**

To fulfill our commitment to be the leading supplier in the power generation industry, the Total Energy Systems, LLC. team ensures they are always up-to-date with the current power industry standards as well as industry trends. As a service, our **Information Sheets** are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power industry.

When Solar Power Systems Require Standby Power

1.0 Introduction:

In the last few years there has been a significant increase in solar array power system applications, both industrial and commercial. This increase has been driven as the solar cell cost per kW continues to fall, and as more incentive programs at the Federal and State level are introduced to encourage more renewable energy sources. Many users of solar arrays, both for personal and business, frequently have the assumption one advantage of going solar is power is still available when for some reason the utility goes off-line. However, in most applications where the solar array feeds surplus power to the utility grid, this is not the case. In fact, when the utility goes off-line, the solar array is also switched off-line.

This information sheet discusses solar array applications, why some systems do not allow solar power feed when the utility is off-line, and how setting up a standby power system to the utility grid will permit solar power to the load when the utility grid is off-line.

Solar Power Systems in Grid Tied Mode and Emergency Power Mode

Figure 1

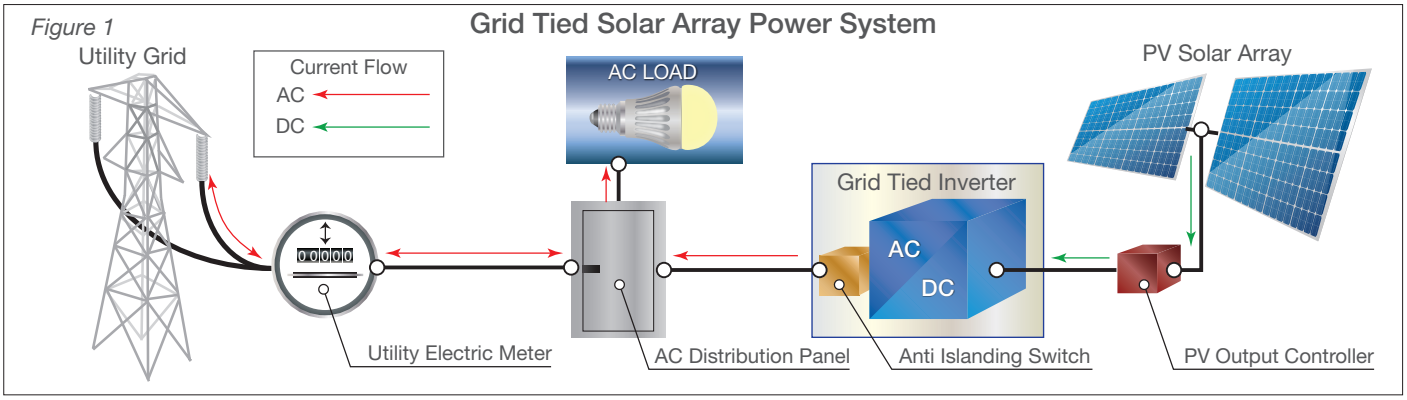
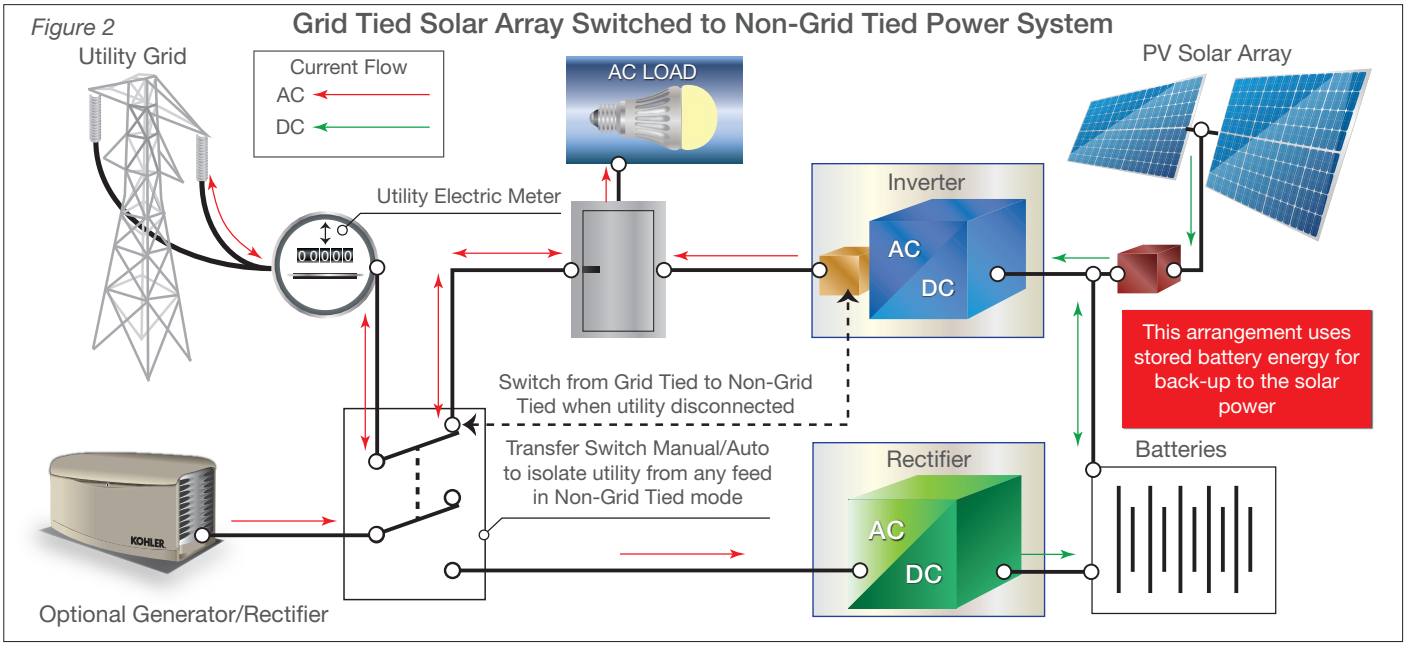


Figure 2



2.0 Solar Array Systems Promoted by Utility Power Providers:

Various regulations and incentives are being offered to utility companies to lower their reliance on power plants fueled by fossil fuels such as coal and gas, with the aim to reduce the amount of carbon dioxide these fossil fuel plants are releasing into the atmosphere (a high contributor to global warming). The incentives encourage utility companies to generate a higher proportion of their power output from renewable energy such as nuclear, wind, hydro and solar.

Most nuclear and hydro power plants were established many years ago. The largest growth in renewable energy has been the adoption by utility companies of wind and solar farms. However, there are incentives for the utility companies to also buy power from consumers generating their own power, and the most common of these is residential and commercial solar arrays.

3.0 Utility Customers Generating Solar Power:

In addition to Utility companies building their own, or contracting with others, large solar farms, they are also taking advantage of incentives for their customers to fit solar arrays to their buildings and/or property. Incentives for utility consumers to install solar panels are:

3.1 Reduced Costs:

Tax rebates and other financial incentives can greatly reduce the installed cost. Most power consumers only demand maximum power from the utility for short periods, most likely while heating, cooling, and cooking. As such, the panels installed may only produce 30% to 50% of the total connected load in any given day. In high demand periods the customer would be buying extra power from the utility, but when the sun was shining and power demand was low the remaining solar power would feed back into the utility, power which would be paid for by the utility.

3.2 Environmentally Friendly:

Consumers who wish to adopt green power solutions have this option with solar power.

4.0 The Workings of a Grid-Tied Solar System:

Most solar installations are termed grid-tied where the system is always connected to the grid.

In a grid-tied solar application utility power will be fed into an electrical meter that can move forwards and backwards to record how much power is flowing from or to the grid. Installed solar panels (sized for the most effective power/cost output) produce DC power (when the sun is shining) that feeds through a grid-following inverter to produce AC power transformer synchronized to the grid voltage waveform output and controlled to match the AC power of the Utility input *see figure 1*.

When the load is not very high (during a period larger loads such as an air conditioner are not connected) the load will be met by the solar power, and any surplus solar power will be fed back into the grid via the meter that in this case will move backwards. When the connected load is higher than that produced by the solar the additional power will be taken from the grid through the meter that will now move forward recording the power taken from the grid.

Grid-tied systems are the most common residential and commercial solar powered applications. They satisfy the requirement to use the bulk of the power requirement from renewable energy and give the user the ability to be paid for the surplus solar power fed into the grid. However, NEC regulations prevents the solar power going into "Island Mode" when the utility grid goes off-line, which means the solar power to the load will also be disconnected from the load.

5.0 Island Mode:

In traditional grid-tied solar systems a utility power sensor disconnects the solar power feed to the load when there is a power outage, even if the sun is still shining. The process for disconnecting the solar power is called anti-islanding and is a safety requirement of regulators in North America (NEC codes in the US), and other countries, for all grid-tied solar energy systems.

Note: Anti-islanding protection is required for UL1741.

Island Mode is when the solar panels continue to supply the connected load, even when the grid is down. This is a potential safety hazard to any utility service personnel working on the utility grid line during a power outage. NEC codes stipulate grid-tied inverters (see information on inverters) automatically shut down and disconnect the solar power output when the utility power goes off-line.

6.0 Options for Retaining Emergency Power to the Load in a Solar Application:

The least expensive and most straight forward solar installation is grid-tied. However, if the application has critical loads with no tolerance power interruption, other systems are available. With appropriate switches and controls, systems can be made to operate in both grid-connected mode as well as off-grid. These systems will isolate any Island Mode feed to the utility grid when it is off-line, *see figure 2*.

Types of standby power solutions include:

6.1 Off-Grid System:

Taking your load totally off the grid means there will be no reimbursement from the utility for any surplus power generated. Whether the grid is operational or not is not a concern. However, in a pure solar off-grid system power will only flow to the load when the sun is shining. This of course is not an option for critical loads and limits power to daylight hours.

6.2 Battery Storage Backup:

Adding an Energy Storage System (ESS) is the most common way to ensure power when the grid is off-line. When the grid is available the system operates in grid-tied mode, when the grid goes off-line a transfer switch automatically or manually switches from grid-tied mode to emergency mode. The inverters also switch from grid-tied mode to emergency mode.

Dual function inverters provide AC power to the load from batteries sized to manage the critical load for a designed period.

6.3 Additional Engine Driven Generator System:

Some battery systems will also include a generator system. When the system is in emergency mode a sensor will monitor the EES and when that has fallen to a preset level a signal will start up the generator to power the load and start to recharge the batteries.

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