Inverters

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1. Inverter Function

Inverters are essential devices in solar photovoltaic (PV) systems that convert direct current (DC) from solar panels or batteries into alternating current (AC) used to power household and commercial loads. This report outlines the various types of inverters, their functions, and sizing requirements in solar energy systems.

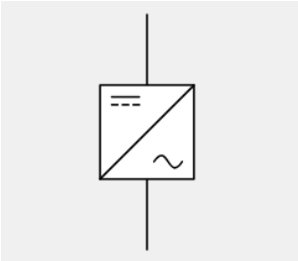

Figure 1: Inverter symbol.

2. ON-Grid System

An on-grid, or grid-tied, system is a PV setup directly connected to the utility grid. Key features include:

- **Grid-Tie Inverter Functionality**: Converts DC from solar panels to AC suitable for the grid, typically at 120V RMS (60Hz) or 240V RMS (50Hz).
- **No Battery Usage**: Energy flows directly to the grid without the need for storage.
- **Net Metering**: Surplus energy sent to the grid is credited, reducing energy bills.
- **Voltage and Phase Matching**: Inverters must synchronize perfectly with the grid's voltage and phase to avoid disruptions.
- **Safety**: Automatic shutdown occurs in the event of a grid failure, protecting utility workers during maintenance.

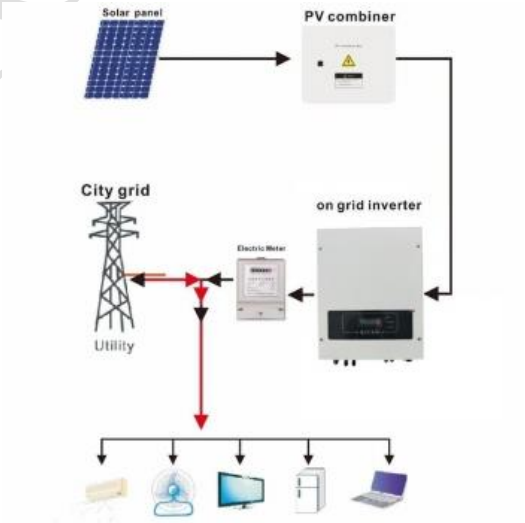

Figure 2: ON-Grid system.

3. OFF-Grid System

Off-grid systems are designed for locations without access to the utility grid. Characteristics include:

- **Independent Operation**: Not connected to the utility grid.
- **Battery Storage**: Solar panels charge batteries, which power loads through an inverter.
- **Continuous Power Supply**: Batteries provide energy during the night or when solar power is unavailable.

Figure 3: OFF-Grid system.

4. Hybrid Inverter

Hybrid inverters are versatile devices that combine the features of on-grid and off-grid systems:

- **Grid-Tie Capability**: Functions similarly to on-grid inverters, feeding energy to the utility grid.
- **Backup Power**: Equipped with battery storage for backup power during grid outages, maintaining power to critical loads.
- **Increased Energy Independence**: Allows users to manage both grid and stored energy efficiently.

Figure 4: Hybrid system.

5. String and Centralized Inverter

In PV systems, inverter configurations can vary between string and centralized setups:

- **String Inverters**: Each solar string is connected to an individual inverter. This configuration is highly reliable because if one inverter fails, only the corresponding string is affected, not the entire system.

- **Centralized Inverters**: All strings are connected to one large inverter. However, a fault in the centralized inverter results in the loss of power across the entire system.

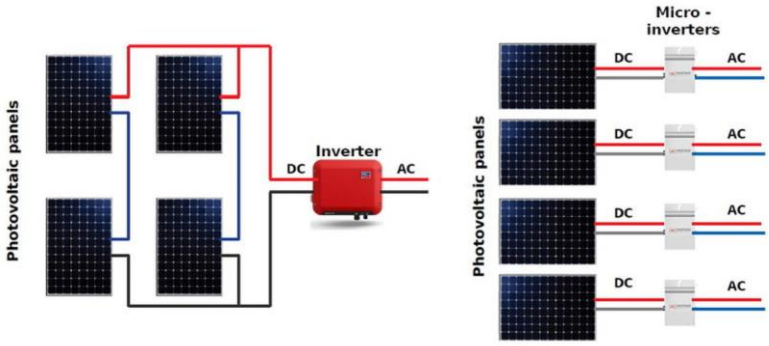

Figure 5: Centralized and string Inverter.

6. Inverter Size

Inverters are sized based on the power requirements of the system:

- **Single-Phase Inverters**: Typically under 10kW, suitable for small residential applications.
- **Three-Phase Inverters**: Starting at 5kW, designed for larger installations such as commercial or industrial applications.