

The Impact of Solar Power Plants on the Electricity Grid

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Abstract: At the heart of any solar energy system lies the solar inverter, a crucial component responsible for converting the direct current (DC) generated by the solar panel array into alternating current (AC) that can be used in our homes and businesses. However, the seamless integration of solar energy into the existing electrical grid requires precise synchronization between the solar inverter and the grid itself.

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I. INTRODUCTION

Adding a solar energy system to your home or business is an effective investment that can reduce your monthly bill by up to 70% to 90%, and directly contributes to supporting the national grid by reducing loads and lowering carbon emissions. How does the system reduce your bill? Self-reliance: The panels provide electricity during the day to power appliances directly, reducing your dependence on the national grid or private generators. Net metering: If the system is connected to the national grid, surplus electricity can be fed back into the grid and credited towards your nighttime consumption. Supporting the national grid: Reducing peak pressure: The panels produce their maximum power during the midday hours, when electricity consumption increases (especially due to air conditioning), thus easing the heavy burden on power plants. Improving grid stability: Distributed systems (such as rooftop panels) help reduce energy loss during long-distance transmission and act as backup power sources. Reliable local energy.

➤ What are the Benefits of a Grid-Tied Solar Power System?

- **Lower Upfront Costs**

Grid-tied systems do not include expensive batteries, which significantly reduces the initial investment. The absence of a storage component also simplifies installation and helps lower labor costs.

- **Lower Electricity Bills**

By using solar energy during the day to power appliances, grid-tied systems reduce the need for grid electricity. Any excess energy is fed back into the grid, earning credits through net metering, which can further reduce monthly electricity bills.

- **Energy Efficiency**

Grid-tied systems ensure minimal energy waste by feeding any unused solar energy back into the grid. Real-time power transmission maximizes efficiency, with solar energy being used directly during peak production hours.

- **Environmental Impact**

These systems help reduce greenhouse gas emissions by decreasing reliance on fossil fuels. Feeding excess energy back into the grid also supports a cleaner energy supply for the community.

- **Financial Incentives**

Grid-tied solar installations are often eligible for tax breaks, deductions, and grants offered by federal, state, or local governments. Net metering allows homeowners to save money by offsetting grid electricity costs with energy credits.

- **Reliable Backup Support**

With the utility grid acting as a backup, grid-tied systems ensure a consistent power supply even during periods of low solar output, such as at night or during cloudy weather. This eliminates the need for energy storage systems.

- **Scalability**

Grid-tied systems can be easily expanded by adding more solar panels as energy needs increase. They are also compatible with emerging technologies, such as battery storage, which can be added later to enhance functionality.

- **Low Maintenance and Durability**

With fewer components, such as batteries, grid-tied systems require minimal maintenance. Solar panels and inverters are designed to last 20-25 years, providing reliable and long-lasting energy solutions.

- *Increased Property Value*

Homes equipped with grid-connected solar power systems are often more attractive to buyers, as these systems offer built-in energy savings and lower utility costs. Related reading: Do Solar Panels Increase Your Home's Value?

- *Ease of Use*

Once installed, grid-connected solar power systems operate automatically and require no manual intervention. Many systems also come with real-time monitoring tools, allowing users to easily track energy production and consumption.

➤ *How to Choose the Best Grid-Tied Solar System for Your Home?*

To choose the best grid-tied solar system for your home, consider the following factors:

- *Assess Your Energy Needs*

- ✓ Review Your Electricity Bills: Check your monthly and annual energy consumption in kilowatt-hours (kWh). Look for trends, such as seasonal variations.
- ✓ Determine Your Daily Use: Divide your total energy use by 30 to estimate your daily energy consumption.
- ✓ Consider Future Needs: Take into account planned additions, such as an electric vehicle or new appliances, which may increase your energy use.

- *Assess Your Roof and Location*

- ✓ Roof Size and Orientation: Ensure your roof has enough space to accommodate solar panels and faces south, east, or west for optimal sunlight exposure. Related Reading: Is Your Roof Suitable for Solar Installation?
- ✓ Shading: Check for obstructions such as trees, chimneys, or nearby buildings that might block sunlight.
- ✓ Solar Potential: Use tools like the Google Sunroof Project or consult a solar energy provider to assess your home's solar potential.

- *Choose the Right System Size*

- ✓ Meeting Energy Needs: System size is typically measured in kilowatts (kW). For example, a 5 kW system produces approximately 6,000–8,000 kWh per year.
- ✓ Avoid Oversizing: While larger systems produce more energy, they may not always be cost-effective if you cannot utilize or store excess electricity.
- ✓ Net Metering Considerations: Check if your utility company offers net metering and how they handle credits for excess energy.

- *Choose Quality Equipment*

- ✓ Solar Panels: Choose panels with high efficiency, durability, and a good warranty (typically 25 years). Brands like SunPower, LG, and Canadian Solar are known for their reliability. Shilden Solar Panels has partnered

with these brands, and you can also check out our solar panel series.

- ✓ Inverters: Choose a high-quality inverter, such as a series inverter, micro inverter, or power optimizer, depending on your budget and shading conditions. Monitoring System: Ensure your system includes monitoring tools to track energy production and usage in real time.

- *Understand System Costs and Financing*

- ✓ Get Multiple Quotes: Request at least three quotes from reputable solar installation companies to compare prices, system design, and warranties. Recommended Reading: How to Compare Solar Offers
- ✓ Check Incentives: Take advantage of federal tax breaks, state rebates, or local incentives to reduce upfront costs.
- ✓ Explore Financing Options: Options such as solar loans, leases, or power purchase agreements can make solar energy more affordable without high upfront costs.

- *Evaluate Installer Experience*

- ✓ Reputation and Reviews: Look for customer ratings and reviews to find reliable solar installers.
- ✓ Experience: Choose a company with a proven track record of designing and installing grid-tied systems.
- ✓ Warranty Support: Ensure the installer offers warranties on both equipment and labor during installation.
- ✓ Related Reading: How Can I Find a Good Solar Installation Company Near Me?

- *Consider Future Upgrades*

- ✓ Battery Integration: Even if you don't need a battery now, choose a system compatible with energy storage for future flexibility.
- ✓ Scalability: Ensure your system can be easily expanded if your energy needs increase.

- *Review Warranties and Maintenance*

- ✓ Panel Warranty: Look for a 25-year warranty on solar panels to ensure long-term reliability.
- ✓ Inverter Warranty: Inverters typically have a 10- to 15-year warranty, so check the terms before purchasing.
- ✓ Installer Warranty: Many reputable installers offer a quality warranty that covers installation errors for 5 to 10 years.

- *Check Utility Policies*

- ✓ Tie-In Requirements: Find out your utility company's policies regarding grid-tied system connections.
- ✓ Net Metering Rules: Confirm how excess energy is calculated and whether there are limits on the amount of solar panels you can install.

- *Get a Professional Assessment*

Before making a final decision, have a professional inspect your property and provide recommendations tailored to your specific needs.

- *What is Grid Synchronization?*

Grid synchronization in solar power is the process of aligning the output of a solar inverter with the grid's voltage, frequency, and phase, enabling safe and efficient power

transmission. This ensures the seamless integration of electricity generated by solar panels with the grid, supporting a reliable and stable power supply without interruptions or safety risks fig 1.

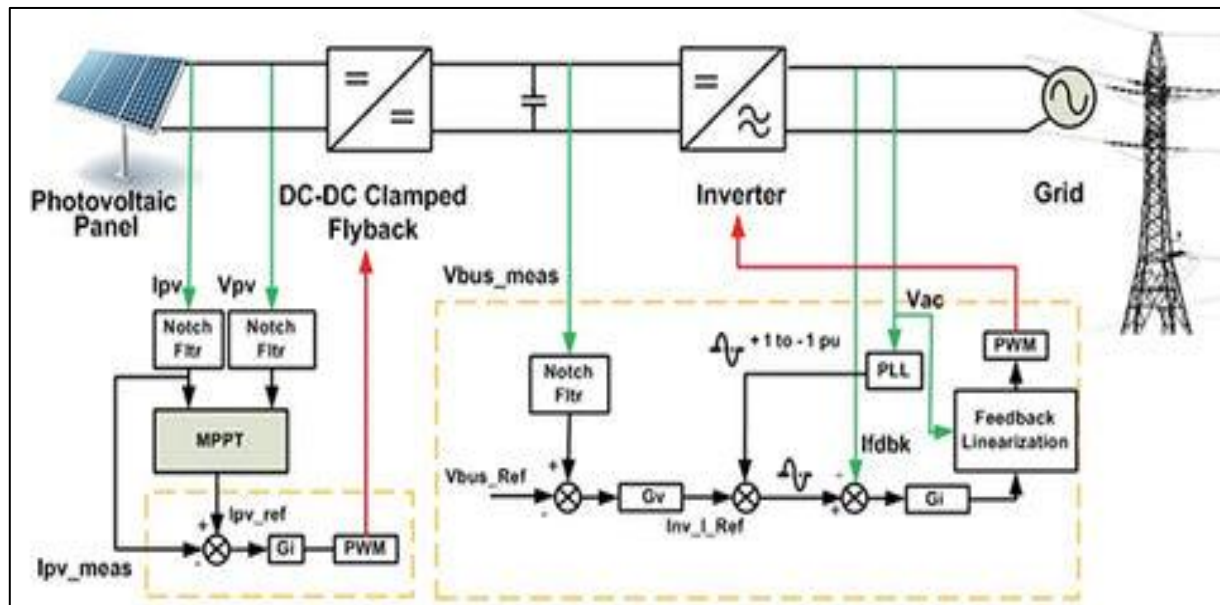


Fig 1 Solar System

- *Importance of Grid Synchronization:*

Grid synchronization is crucial for several reasons:

- ✓ **Safety:** Synchronizing a solar inverter with the grid prevents back feeding of electricity into the grid during maintenance or outages, reducing the risk of electrical hazards to utility workers and the public.
- ✓ **Grid Stability:** Proper synchronization helps maintain the stability and reliability of the electrical grid by ensuring that the solar power system operates in coordination with other power sources and loads connected to the grid.
- ✓ **Efficiency:** Synchronization facilitates efficient power transfer between the solar power system and the grid, maximizing the utilization of renewable energy resources and minimizing energy losses.

- *How Do Solar Inverters Synchronize with the Grid?*

Solar inverters work by converting the DC output from solar panels into AC electricity suitable for use in homes, businesses, and the grid. However, to synchronize with the grid, its output voltage, frequency, and phase must be dynamically adjusted to match those of the grid.

- *Solar Inverters Achieve Grid Synchronization Through a Multi-Step Process:*

- ✓ **Voltage and Frequency Detection:** The solar inverter continuously monitors the grid voltage and frequency to

determine its operating parameters. This information is essential for aligning the inverter's output with the grid.

- ✓ **Phase Locking:** Once the grid voltage and frequency are detected, the inverter's control system adjusts the phase angle of its output to match the grid angle. This ensures that the inverter's AC waveform accurately matches the grid waveform, enabling seamless integration.
- ✓ **Grid Connection:** After phase synchronization is achieved, the solar inverter connects to the grid, allowing bidirectional power flow between the solar system and the grid.

II. THREE COMMON SYNCHRONIZATION METHODS

- *Synchronized Grid Synchronization Method:*

In this method, a device called a "synchronizer" helps the solar inverter synchronize with the grid. The synchronizer displays the phase difference between the solar system and the grid. When both systems are in phase (i.e., synchronized), a rotating dial on the synchronizer aligns with a fixed reference point. By monitoring the position of this dial, the inverter can adjust its output to maintain phase alignment with the grid.

- *Two-Light-One-Dark Grid Synchronization Method*

This method uses three lamps connected in series and relies on their brightness levels to indicate phase alignment. The inverter gradually adjusts its output voltage until two lamps appear bright and one appears dim. This specific light

configuration indicates that the inverter's output phase is close to matching the grid phase, thus indicating synchronization.

➤ Three-Dark Grid Synchronization Method

In this method, three lamps are connected in parallel. The inverter adjusts its output until all three lamps turn off. This occurs when the phase difference between the inverter and the grid reaches zero, balancing the current through the lamps and causing them to switch off. This "off" state indicates that the inverter is synchronized with the grid.

• Synchronization Control Algorithms:

Solar inverters use advanced control algorithms to achieve and maintain grid synchronization. These algorithms continuously adjust the inverter's output parameters based on real-time measurements of grid voltage, frequency, and phase. Some common synchronization control algorithms include:

- ✓ Proportional Derived Integrated (PID) Control: PID control algorithms adjust the inverter's output voltage and frequency based on the error between measured grid parameters and desired values. PID controllers provide precise and stable control, ensuring accurate synchronization under varying grid conditions.
- ✓ Phase-Locked Loop (PLL): PLL algorithms detect the phase difference between the inverter's output voltage and the grid voltage and adjust the inverter's phase angle to minimize this difference. PLLs are widely used in grid-tied inverters due to their robustness and fast response times.
- ✓ Drop Control: Drop control algorithms adjust the inverter's output frequency based on grid frequency deviations. By mimicking the behavior of synchronous generators, inverter droop control allows the output frequency to be regulated in response to changes in grid frequency, ensuring grid stability.

These control algorithms work together to guarantee precise and stable grid synchronization, enabling solar power systems to operate seamlessly alongside conventional power sources within the electrical grid.

III. KEY COMPONENTS FOR ACHIEVING GRID SYNCHRONIZATION

➤ The Grid

The grid, also known as the "public grid," is a power distribution network that connects power plants to users, transmitting and distributing electricity. It is a large-scale infrastructure system typically consisting of power plants, substations, transmission lines, and distribution lines. The grid provides a stable electricity supply to homes, commercial buildings, and industries. For solar power systems, the grid can also serve as a source for storing and distributing energy. In a grid-tied solar power system, excess solar energy can be fed back into the grid, while energy can be drawn from the grid when solar generation is insufficient (such as at night or on cloudy days).

➤ Solar Inverter

A solar inverter is a key component in a solar power system. It is primarily responsible for converting the direct current (DC) produced by the solar panels into alternating current (AC), which can then be used directly by the grid or household appliances. Most household appliances and the grid operate on AC. Alternating current (AC), so the solar inverter ensures that the power produced by the solar system is compatible with the grid. The inverter handles grid synchronization, meaning it matches the solar system's voltage, frequency, and phase with the grid, allowing the solar system to seamlessly integrate into the grid and ensuring stable and safe operation.

➤ Solar Inverter Synchronization Technologies

• Phase-Locked Loop (PLL) Technology:

Phase-locked loop (PLL) technology is one of the most widely used methods for grid synchronization in solar inverters fig 2. PLL algorithms continuously monitor the phase difference between the grid voltage and the inverter's output voltage and adjust the inverter's phase angle to minimize this difference. PLL-based synchronization offers several advantages, including:

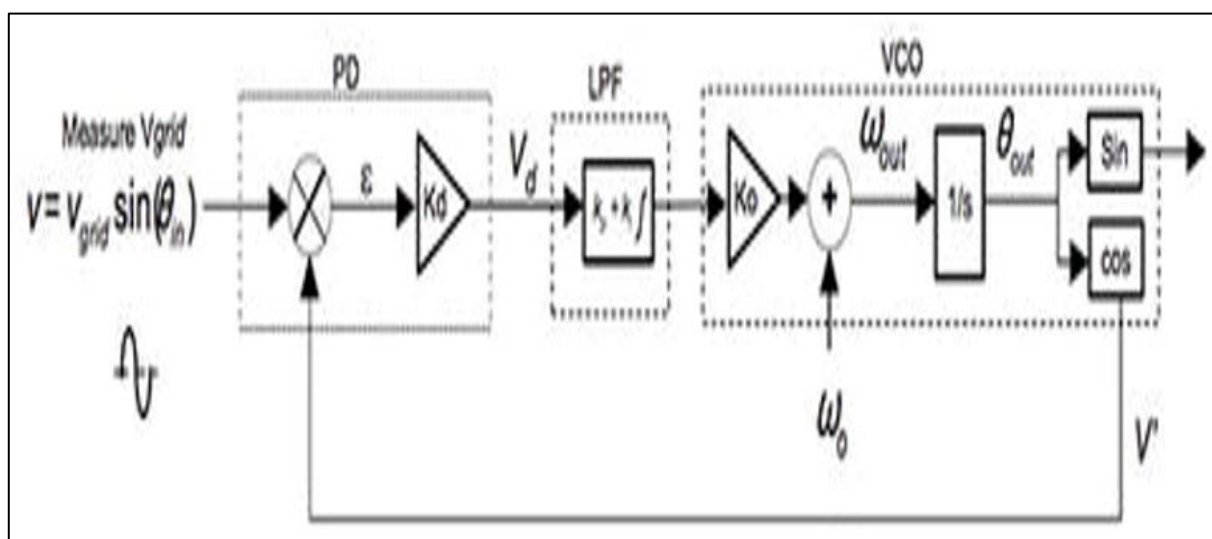


Fig 2 Solar Synchronization

- ✓ **Fast Response:** PLL algorithms can quickly detect and respond to changes in grid conditions, ensuring rapid synchronization during startup and grid disruptions.
- ✓ **Resilience:** PLL-based synchronization is inherently robust and can maintain stable synchronization under various grid conditions, including frequency and phase fluctuations.
- ✓ **Compatibility:** PLL technology is compatible with a wide range of grid configurations and is widely adopted in grid-connected solar inverters worldwide.

- **Frequency Wattage (FW) Control:**

Frequency Wattage (FW) control is another synchronization technology used in grid-connected solar inverters to regulate power output in response to grid frequency fluctuations fig 3. FW control algorithms adjust the inverter's output power based on changes in grid frequency, helping to stabilize the grid and prevent frequency instability. Key features of FW control include:

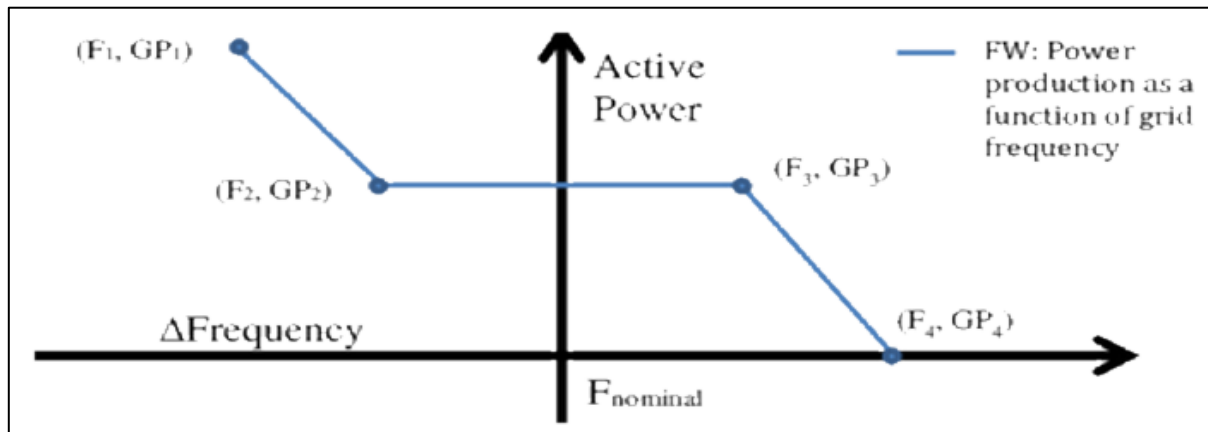


Fig 3 FW control

- ✓ **Grid Support:** FW control enables solar inverters to provide additional grid services, such as frequency regulation and voltage support, contributing to grid stability and reliability.
- ✓ **Dynamic Response:** FW control algorithms can dynamically adjust the inverter's power output in real time, making them effective at mitigating grid frequency fluctuations caused by transient events or changes in demand.
- ✓ **Grid Code Compliance:** Many grid codes and standards require solar inverters to support FW control functionality to participate in grid services and ensure grid stability during both normal and abnormal operating conditions.

- **Virtual Synchronous Generator (VSG) Control:**

Virtual Synchronous Generator (VSG) control is an emerging synchronization technology that mimics the behavior of conventional synchronous generators in grid-connected solar inverters. VSG control algorithms mimic the inertial and damping characteristics of synchronous generators, enabling solar inverters to provide inertial response and frequency regulation similar to conventional power plants fig 4. Key features of VSG control include:

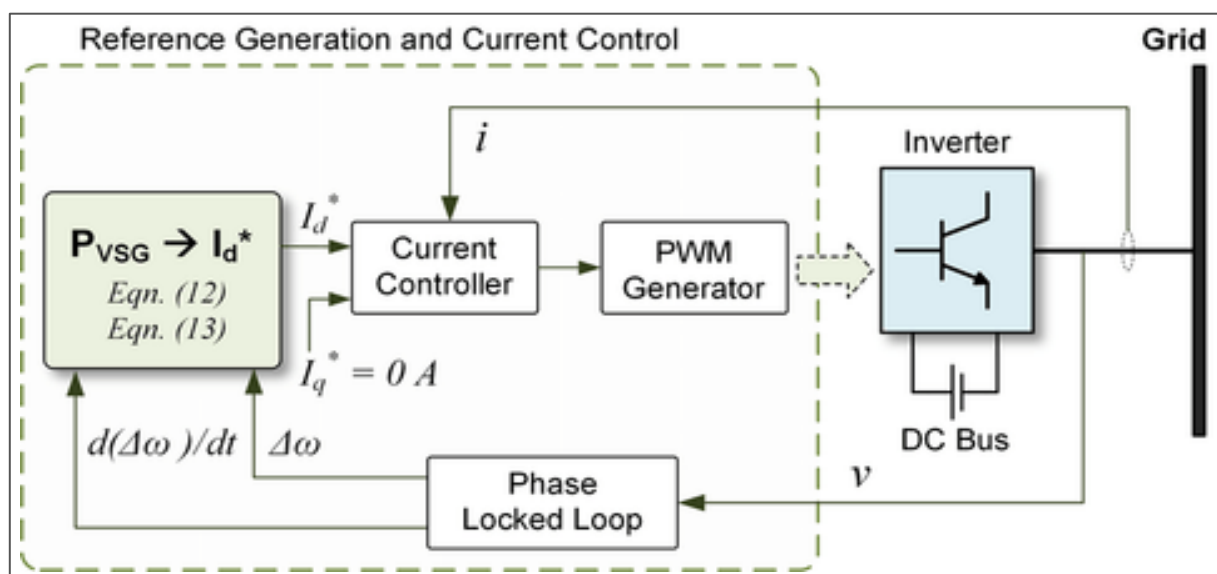


Fig 4 VSG

- ✓ Inertial Response: VSG-controlled inverters can mimic the inertial response of synchronous generators, providing inertial frequency support to the grid during disturbances or sudden load changes.
- ✓ Frequency Regulation: VSG control allows solar inverters to effectively regulate grid frequency by adjusting their output power in response to frequency deviations, enhancing grid stability and resilience.
- ✓ Grid Resilience: By replicating the behavior of synchronous generators, VSG-controlled inverters can enhance grid resilience in the face of disturbances such as faults, power outages, and renewable energy intermittencies.

• *Understanding Synchronization Delays in Solar Inverters*

While solar inverters are designed to synchronize with the grid quickly and efficiently, various factors can contribute to synchronization delays, impacting system performance and grid stability.

Synchronizing all home solar power systems with the national grid at sunrise results in massive, simultaneous changes in voltage and frequency. Because production increases rapidly and abruptly, it causes sharp voltage curve rises, voltage spikes, and grid instability. Advanced grid-tied inverters use phase-lock loops (PLLs) to safely match the grid's phase angles and frequencies, thus reducing strain on the local grid. Proper coordination of a massive influx of solar power with the national grid has several specific operational and economic implications:

- ✓ Sudden Voltage Curve and Supply Surge: Rapid Increase in Production: With sunrise, solar power generation increases simultaneously in thousands of homes. This creates a sharp rise in the power supply to the distribution system. Grid Balancing Challenges: Grid operators must significantly reduce the output of conventional power plants (such as natural gas or coal) to accommodate the sudden influx of solar power.
- ✓ Voltage and Frequency Fluctuations: Voltage Surge: When many homes simultaneously supply power to a local distribution line, the grid voltage may rise above safe limits, potentially damaging sensitive electronic equipment. Frequency deviations: Inverter-based systems lack physical inertia. If clouds cover the area, the resulting rapid drop in generation poses a challenge to the grid's ability to maintain a stable 50 Hz or 60 Hz frequency.
- ✓ Integrating and mitigating the effects of smart inverters: Phase alignment: Grid-connected inverters use phase-lock loops (PLLs) to precisely align AC voltage and frequency with the national grid before transmitting any power. Reactive power control: Modern smart inverters assist the grid operator by injecting or absorbing reactive power, stabilizing line voltage even with fluctuations in solar power generation.
- ✓ *Economic Impacts and Net Metering Effects:*
 - Peak demand offset: Solar power generation at sunrise coincides with the morning peak energy consumption (when households switch on appliances before work).

Direct use of solar power significantly reduces electricity bills.

- Export to the grid: Any surplus energy produced after direct household consumption is exported to the grid, typically compensating the homeowner through net metering programs. to understand...

• *Factors Contributing to Synchronization Delays:*

- ✓ Grid Voltage and Frequency Variations: Rapid fluctuations in grid voltage and frequency can affect the synchronization process, leading to delays as the inverter adjusts its output parameters to match grid conditions.
- ✓ Grid Disturbances: Grid disturbances such as faults, voltage drops, and frequency deviations can disrupt the synchronization process, requiring the inverter to re-establish synchronization once grid conditions stabilize.
- ✓ Inverter Control Algorithms: The complexity and responsiveness of inverter control algorithms can affect synchronization times. Inverters with more complex control systems may require additional processing time to synchronize accurately with the grid.
- ✓ Communication Latency: Communication delays between the inverter and grid control systems can lengthen synchronization times, especially in large-scale solar installations where multiple inverters must coordinate their operations.
- ✓ Grid Code Requirements: Grid rules and standards may impose specific synchronization requirements on solar inverters, such as response times and performance criteria, which must be met to ensure compliance and grid stability.

• *Strategies for Mitigating Synchronization Delays:*

- ✓ Advanced Control Algorithms: Deploying solar inverters equipped with advanced control algorithms, such as fast-acting PLLs and predictive control techniques, can reduce synchronization delays by improving the inverter's response to grid disturbances.
- ✓ Grid Support Function: Solar inverters with grid support functions, such as FW control and VSG simulation, can enhance grid stability and resilience by actively participating in grid frequency regulation and voltage control, thus reducing the likelihood of synchronization delays.
- ✓ Real-Time Monitoring and Diagnostics: Implementing real-time monitoring and diagnostic systems enables operators to detect synchronization issues immediately and take corrective action to minimize downtime and improve system performance.
- ✓ Redundancy and Backup Systems: Integrating redundancy and backup systems into the solar power system design can mitigate the impact of synchronization delays by providing backup paths. A backup system to deliver power during grid disruptions or inverter failure.
- ✓ Continuous Performance Optimization: Regular maintenance and performance optimization of solar inverters ensures efficient and reliable operation, minimizing synchronization delays and maximizing power output over the system's lifetime.

➤ *How do Solar Inverters Respond to the Grid?*

Solar inverters provide grid feedback through their control algorithms, which continuously monitor grid parameters such as voltage, frequency, and phase. Based on these measurements, the inverter adjusts its output to match grid conditions, ensuring seamless integration and stable operation. Additionally, many inverters support communication protocols such as Modbus or IEEE 1547, enabling them to communicate with grid control systems and provide real-time data for monitoring and control purposes.

➤ *How do Solar Inverters Connect to the Grid?*

Solar inverters connect to the grid through a process known as grid synchronization, which involves aligning the inverter's output voltage, frequency, and phase with grid parameters. Once synchronization is achieved, the inverter closes its output connectors, allowing bidirectional power flow between the solar system and the grid. Grid connection typically occurs automatically during system startup or when grid conditions meet predefined criteria, ensuring safe and reliable operation.

➤ *What Happens When the Grid Goes Down?*

When the grid goes down, grid-connected solar inverters must comply with safety regulations and be disconnected from the grid to prevent back feeding, which could endanger utility workers and damage equipment. Depending on the system configuration and local regulations, the solar inverters may switch to island mode, continuing to operate independently of the grid and supplying power to local loads, or they may go into standby mode until grid power is restored. In some cases, backup energy storage systems can be used to provide uninterrupted power during a grid outage.

➤ *Can Solar Inverters Help Stabilize the Grid?*

Yes, solar inverters can play a significant role in grid stability by providing additional services such as frequency regulation, voltage support, and reactive power control. Advanced control algorithms and grid support functions enable solar inverters to respond dynamically to changes in grid conditions, helping to maintain grid stability and reliability. By actively participating in grid support activities, solar power systems contribute to the integration of renewable energy sources and the transition to a more sustainable and resilient grid infrastructure.

➤ *How Can I Ensure Optimal Grid Synchronization Performance?*

To ensure optimal grid synchronization performance, it is essential to select high-quality solar inverters with advanced control features and compliance with relevant grid codes and standards. Sheldon's grid-connected inverters can provide excellent grid synchronization expertise. Working closely with experienced solar installers and system integrators can help stakeholders navigate the complexities of grid synchronization and maximize the reliability and performance of their solar installations.

➤ *Introduction Solar in Iraq :*

Key challenges and obstacles facing the solar energy sector in Iraq and neighboring countries. Despite the urgent

need for solar power due to electricity crises and rising temperatures, the sector faces several significant issues:

- **High Initial Costs :** Solar power systems are expensive for the average citizen, requiring large cash payments. The government intervention, investor support, or subsidized financing could make these systems more accessible.
- **Harsh Climate Conditions :** The region's environment, characterized by dust and extreme heat, significantly impacts the efficiency of solar panels. Dust acts as a barrier to sunlight, and high temperatures have an inverse relationship with panel productivity. The that system designers must account for these factors when sizing installations.
- **Poor Quality Components :** A lack of strict quality control leads to the importation of low-quality components, particularly inverters and batteries. This often results in premature system failures, leading to negative public perceptions of solar energy.
- **Lack of Technical Expertise :** Insufficient training and experience among some installation companies can lead to errors that damage systems and reduce their lifespan.

To overcoming these challenges is essential for the success of the solar energy sector in Iraq, which has the potential to move away from traditional, less sustainable energy sources.

➤ *Solar Disadvantages*

• *Environmental Pollution*

Numerous studies, research, and data from the International Renewable Energy Agency (IRENA) describe the solar panel lifecycle as a "dirty process from start to finish," making it more expensive and one of the biggest disadvantages of solar energy for homes.

The manufacturing of solar cells relies on sand as a raw material from which high-purity quartz is extracted. This quartz is then heated to high temperatures, producing a colorless gaseous compound under normal pressure and temperature conditions, but which is highly toxic: silicon tetrachloride, as reported by the specialized energy platform.

Solar panels have a lifespan (averaging 25 years). After their lifespan ends, they are either sent to landfills in the manufacturing countries or to developing countries for reuse. In both cases, the environment is severely damaged by the byproducts of burning the panels' components, exposure to high temperatures, or the leakage of toxic chemicals from the panels after burial.

• *The Risk of Electrocution and Fire*

One of the drawbacks of home solar energy is the potential exposure of workers in the solar industry to a variety of hazards, such as arc flash, electric shocks, falls, and thermal burns, which can cause injury and death.

Several countries have warned their citizens of the risk of electrocution as a major disadvantage of home solar energy, according to a specialized energy platform.

The Swedish Electrical Safety Authority has issued warnings about the dangers of placing electrically connected panels on balconies or similar areas within homes, according to PV Magazine.

Screws, staples, and handles attached to home solar panels are also a concern, as they can conduct and leak current, potentially causing a short circuit if other flammable materials are introduced.

Screws and handles attached to solar panels on top of a house - Image from Marketplace.

➤ Solar Progress

Due to frequent power outages and to avoid high electricity bills, there is a noticeable trend towards installing solar energy systems in the Kurdistan Region. Within the Koya district fig 5, a synchronization process is underway as follows:

- A consumer installs the complete solar energy system and begins generating power.
- The consumer requests permission from the electricity department to feed excess energy back into the national grid.
- After inspection, if it is determined that the consumer has a smart meter and can handle any damage to their equipment that may occur during the synchronization process, approval is granted. The relevant department then activates the synchronization feature, i.e., feeds energy back into the smart meter. The amount of energy fed back into the grid cannot exceed the meter's capacity.

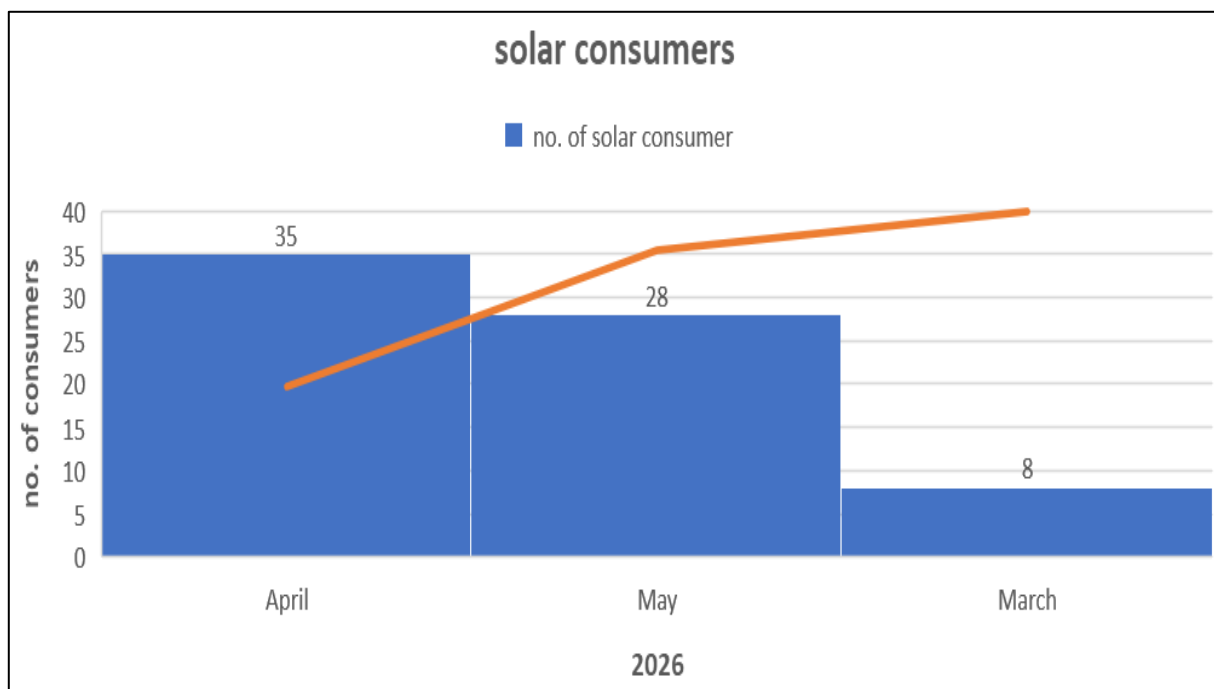


Fig 5 Solar Progress in Koya / Erbil / Iraq

More than 5 MW of solar electricity has been added in Sulaimani in 35 days

- ✓ According to the statistics of the Renewable Energy Department of the Technical Directorate of our General Directorate in Sulaimani province, the installation of solar electricity systems is increasing day by day and the total electricity production from solar energy until 14/6/2026 reached more than (97) megawatts.
- ✓ As of 14/6/2026, the number of electricity partners who have installed solar systems and registered in the

department of renewable energy, reached (4061) partners and the amount of electricity production reached (96.140) MW, while on 6/5/2026 the number of electricity partners installed (3746) partners and their electricity production was (91.623) MW.

According to the data, as of 14/6/2026, the partners who have installed solar systems are (3354) household partners, (579) commercial partners, (15) industrial partners, (106) agricultural partners and (7) government partners. fig 6.

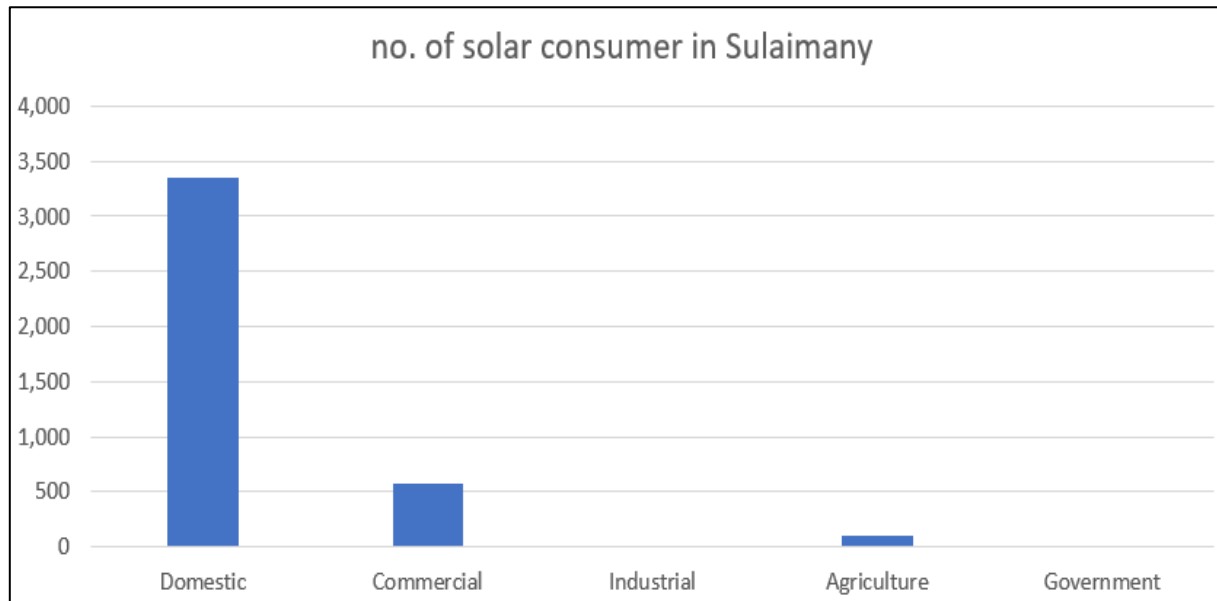


Fig 6 / Solar in Sulaimani

IV. CONCLUSION

The trend of citizens turning to solar energy has significant advantages in terms of reducing electricity bills and providing uninterrupted power, especially in countries that lack 24-hour electricity. This is from an individual perspective, but if we examine this issue and its impact on a broader scale, we find that synchronizing all this energy with the national grid reduces pressure on the grid, as consumers rely on their own energy sources and feed some of their generation into the national grid. Therefore, solar power plants should be encouraged and supported, and all possible facilities should be provided to maintain existing generation capacity without expansion, thus preventing further environmental pollution and mitigating the effects of global warming, the consequences of which we pay for daily.

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