

**RENEWABLE ENERGY AND ENERGY INDEPENDENCE:
THE FUTURE OF SMART HOMES**

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Energy depends on the consumer's power and the time of consumption. The source continuously generates energy according to its generation power, while the consumer uses energy non-linearly: a different amount at different time intervals.

One of the most convenient and popular sources of renewable energy is photovoltaic (PV) modules, which convert sunlight directly into electricity. They

serve as the foundation of most modern solar power systems, enabling homes and businesses to generate clean energy independently. To ensure the efficient operation of such a system, it must include several essential components that work together to collect, convert, store, and distribute electricity. (U.S. Department of Energy, 2019).

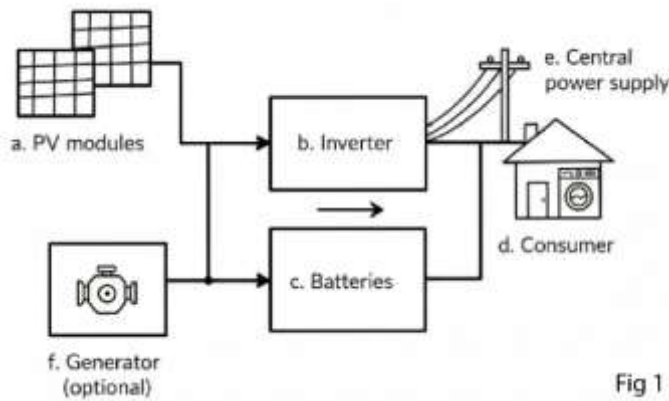


Fig 1

The solar energy system (SES) consists of the following components:

- a. PV module
- b. Inverter
- c. Batteries
- d. Consumer (Load)
- e. Central power supply

(Grid)

- f. Generator (optional)

The principle of operation of a solar energy system (SES) is based on the conversion of sunlight into electricity. Photovoltaic (PV) modules capture solar energy and convert it into direct current (DC), which is then transmitted to the inverter. The inverter transforms this current either into alternating current (AC) for the consumer or into another DC format for storing excess energy in batteries. During the nighttime, when there is no sunlight, the stored energy from the batteries is used by the consumer to power electrical devices. (Kroposki et al., 2024)

The inverter plays a key role in managing energy flow within the system. It can combine energy from the grid, batteries (AKB), PV modules, and the generator, and then redirect these flows either to the consumer, to the batteries for charging, or even back into the grid. Unlike a generator, batteries can supply only the required amount of energy to the consumer, while the unused portion remains stored for later use.

A generator, on the other hand, constantly produces a fixed amount of energy, and if the consumer does not use it, that energy is wasted – meaning that fuel is

consumed for generation that is not utilized. PV modules operate similarly, generating a continuous and predetermined amount of energy. If the produced energy is not required by the consumer, it can also be lost, which highlights the importance of storing it and using it when needed.

The central power supply system functions in almost the same way as a local one. It includes an energy source, such as a thermal, nuclear, or hydroelectric power plant, and a network of consumers. Energy companies continuously work to maintain a balance between energy generation and consumption. During peak consumption hours, energy shortages may occur, while during periods of low demand, there can be an energy surplus. To address this, energy providers develop programs for private investors who build their own SESs for power generation and storage, using price mechanisms to regulate consumption peaks. With the help of batteries, energy can be stored during active daylight hours and supplied back to the grid during times of high demand.

To manage complex processes of storing, consuming, and returning stored energy to the grid, smart home controllers or servers are used, allowing automation and optimization of energy flows. A smart home system also enables real-time energy monitoring and helps conserve stored energy during outages or disruptions in the central power supply, ensuring stability and independence in energy usage.

References:

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