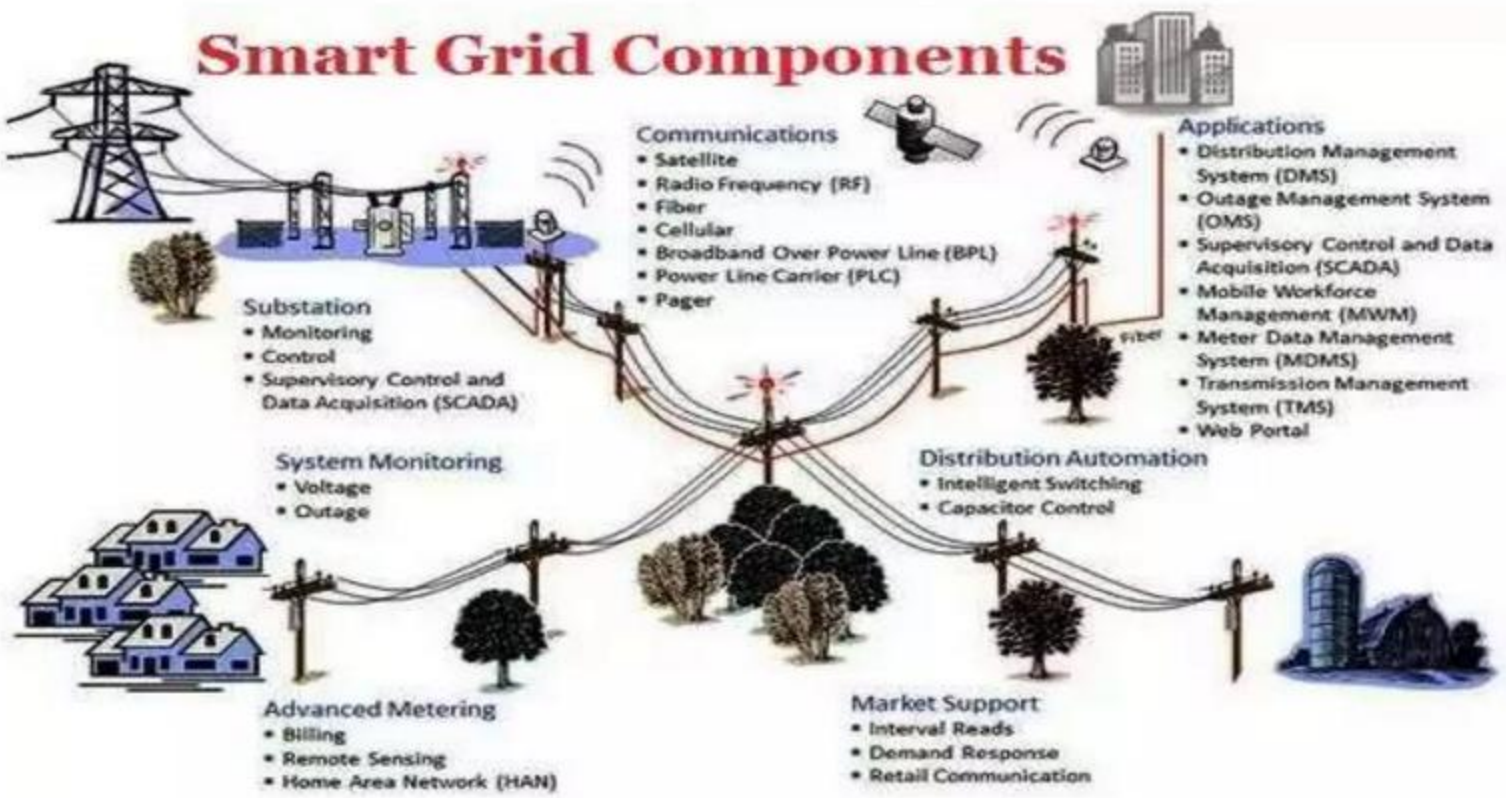
Components of Smart Grid

Smart Grid Components



Components of the smart-grid system

- Basically, smart-grid components combine intelligent appliances, along with heavy equipment that are mainly associated with the electricity generation, transmission and distribution.
- These intelligent appliances operate according to the predefined codes.
- These smart appliances are able to understand the input power supply and the way to use it.

- The main components of smart grid include,
- Smart appliance;
- Electric vehicles (EVs)
- Smart meter;
- Smart substation;
- Distributed generation;
- Phasor measure units;
- Integrated communications; and
- Sensing and measurement

Smart appliances

- To perform functions faster, cheaper and in a more energy efficient manner, smart appliances utilize recent computer and communication techniques.
- A predefined preference level is set by these appliances for the consumers to provide an idea on when to utilize electricity and on what level.
- To understand energy generation status and minimize the peak demands factors, these smart appliances have a vital impact on the utility generations.
- For example, energy will only be provided to the washing machine in the night while for coffee maker in the morning.
- For regulating and optimizing the utilization of energy at the community level, smart appliances have the ability to communicate with other neighboring appliances; as well as, the nearby smart grid.

Electric Vehicles

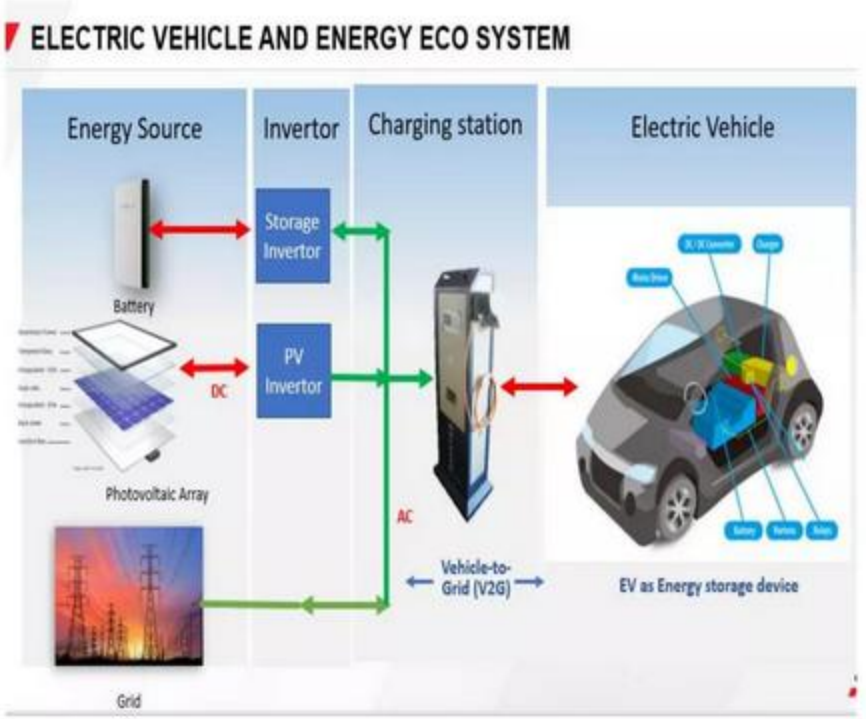
- An electric vehicle (EV) is a device that utilizes one or more electric or traction motors for the purpose of propulsion. There are various methods, which are utilized to energize EVs. Some of them are as follows:

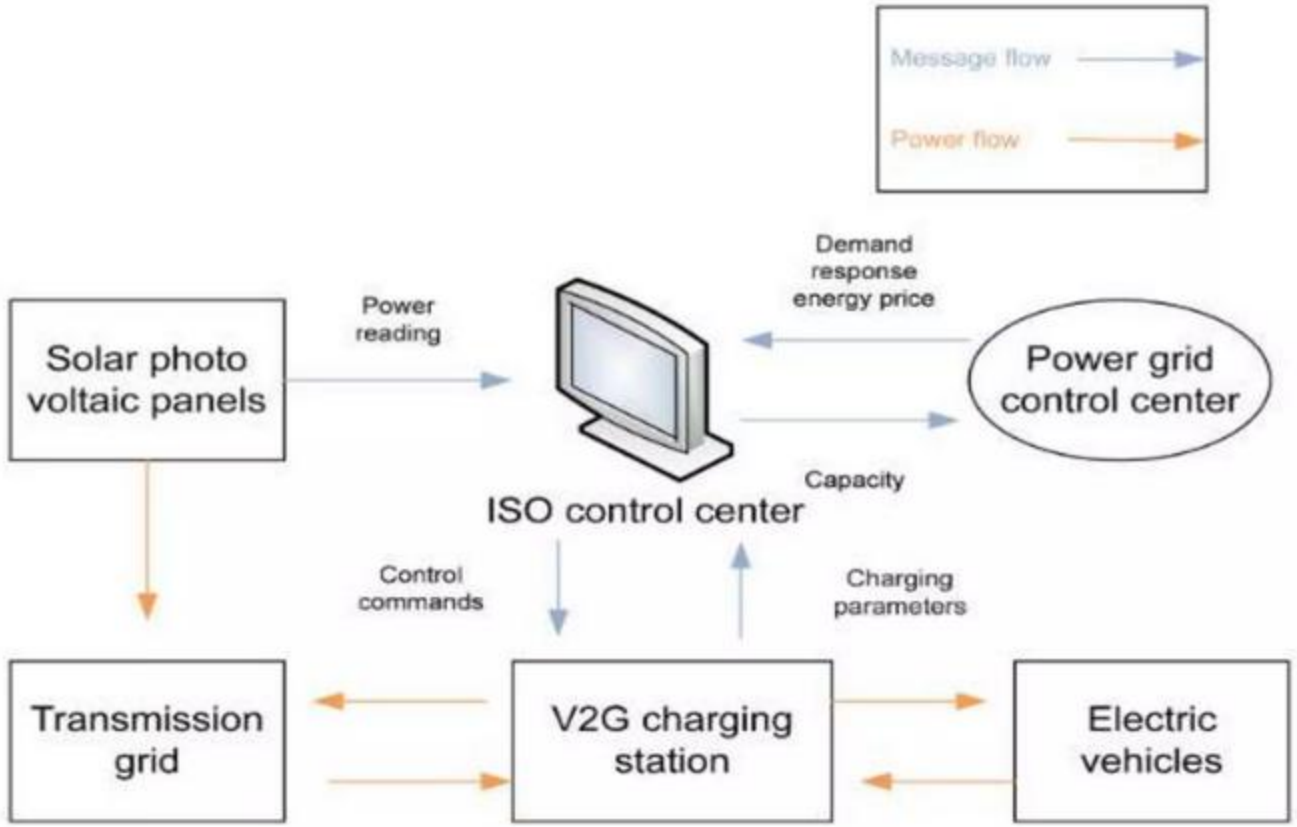
1. collector system that supplies electricity from off-vehicle sources;
2. self-contained battery system;
3. solar panels; and
4. an electric generator that converts fuel to electricity.

Smart charging essentially consists of controlling time and rate at which the car is charged according to signals from the grid operator, enabling the car to stop charging at peak times.

Electric Vehicles – Smart Charging

- Another viable option is enabling vehicle-to-grid (V2G) charging.
- This technology can be an essential tool for smart EV charging, turning the car into a temporary storage system to supply power to the grid at peak demand and charging the vehicle when overall demand is reduced.
- Projects utilizing V2G technology are getting substantial financial incentives to take off, making V2G a point of interest for utilities.
- Interoperability is critical for smart charging to be reliable and practical. Interoperable interfaces should coordinate data between the grid, the charging point, and the EV.




Message flow
Power flow
Demand response energy price
Power reading
Solar photo voltaic panels
Power grid control center
Capacity
ISO control center
Control commands
Charging parameters
Transmission grid
V2G charging station
Electric vehicles

Smart meters

- For developing a channel between the electricity providers and the end users, smart meter technology provides a two-way communication.
- Smart meter technology has numerous advantages such as it collects the billing data in very fast manner, senses failures of the systems and informs maintenance team much faster than the manual system because whenever there is a failure, utilities are reported instantaneously.
- Further, these utilized data for collecting revenue, detects failures in the system and sends out repair teams to the exact location more rapidly;
- The additional features, which make smart meters different from the conventional energy meters, are utilizing real-time sensors, notification of the power failures, and monitoring the power quality.
- Time of usage pricing can be documented in the data and transmitted to the utility for permitting them to find out amount of energy consumption during the day and charge users accordingly.

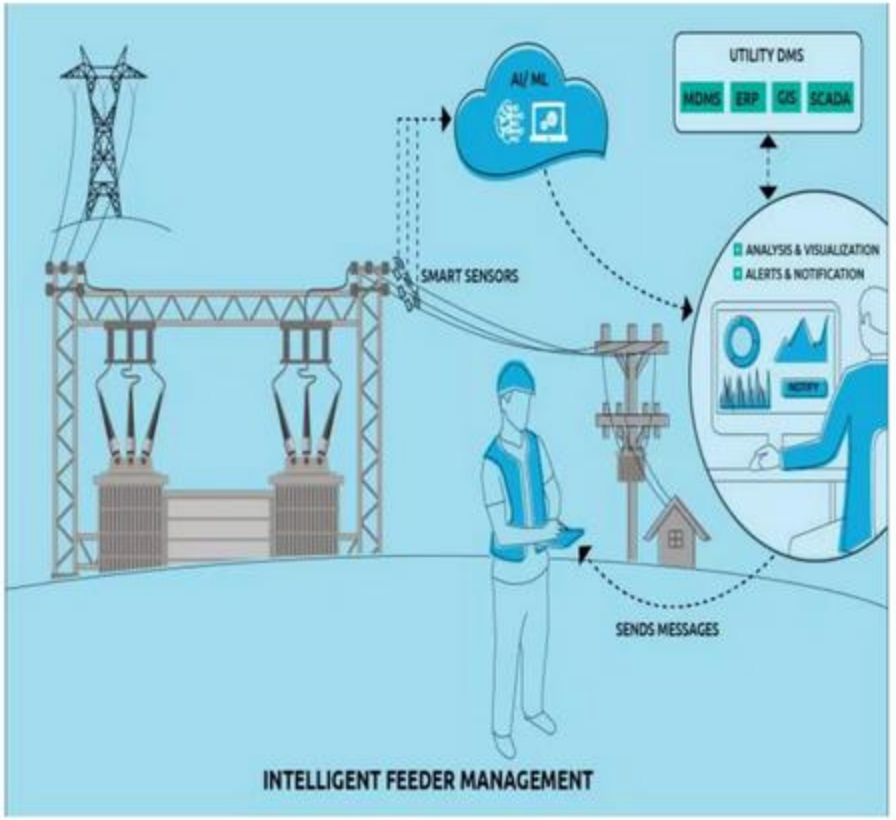
- ***For users advantages:***
- Large and detailed feedback regarding the electricity utilization.
- Capability of adjusting habits of consumers to minimize energy bills.
- Minimize the number of blackouts and system-wide energy outages.
- ***Disadvantages:***
- Extra investment for installing the smart meter.
- Privacy concerns related to the collected personal data and its utilization.
- Users face more responsibility of maintenance.

- *For electric utilities advantages*:
- Monthly manual meter readings eliminated.
- Real time monitoring of the electric system.
- Supports efficient utilization of the generated energy.
- To balance demands while minimizing the blackouts by supplying responsive data.
- Supports dynamic pricing.
- Minimized the cost of capital investment for constructing generation facilities.
- Supports for optimizing the revenue with the available resources.
- ***Disadvantages:***
- Extra investment cost to train employees, construct system and realize new procedures to store data.
- Supervising response and feedbacks of users related to new meters.
- Develop a long-term financial contracts related to the new system.
- Guarantee the safety and privacy of the metered data.

- Smart meters utilize the secure communication network for automatically and wirelessly transmit exact energy utilization to the service provider.
- Smart meters utilize the two-way communication to transmit the recorded data.
- Smart meters are available with an in-home display screen. This display provides the user real time information of the energy utilized and its respective cost.
- ***Smart meters generally display the following:***
- a budget market,
- battery status,
- time,
- text area,
- touch buttons,
- light indicators,
- costs and consumption,
- fuel view,
- energy display dial, and
- wireless signal strength and so on..

Smart Substations

- **By embedding the digital technology the different components of the substation has been enhanced, enriched, and augmented to make them function better at higher ratings with enhanced reliability as compare to before.**
- **The main challenge is to integrate these entire components into a completely digital substation and making them to operate in a demanding scenario.**
- **IoT is the system of devices, buildings, vehicles, and various types of physical objects those are integrated with sensors, coupled by the networks and controlled and monitored through the computer-based systems.**



Phasor Measurement Units(PMU)

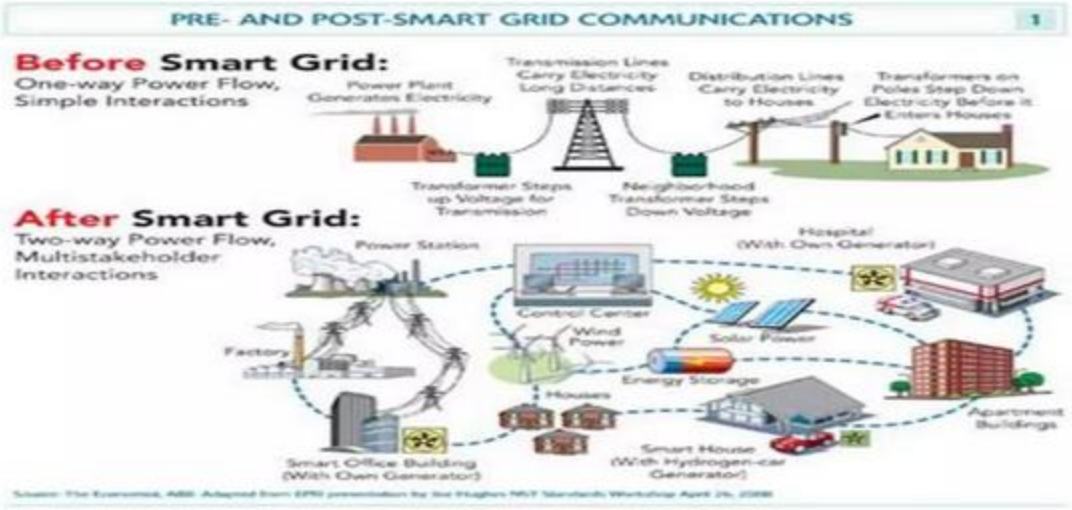
- The devices which measure the voltages and currents at predefined points in the utility grid and use the global positioning system (GPS) radio clock for synchronization is called Phasor measurement units (PMUs) or synchrophasors.

PMU

- Synchrophasors are placed at different locations and are synchronized with the GPS clock so that synchrophasor can be utilized for permitting power flow till to a line's dynamic limit rather than its worst case limit, which depends on the weather and load.
- The transmission line's actual capability of carrying power at any time instant is provided by its dynamic rating while satisfying its design limits.
- This technology provides the novel way of controlling the power flow through the utility grid and enhancing security and the transmission congestion management during over loading condition.
- PMUs are generally termed as the **"health meters"** of the power system, as they are capable of gathering sample voltages and currents at various time instants; and, perform the function to minimize congestion, bottleneck of the electricity grid and minimize or completely remove the blackouts from the system

Integrated communication system

- The basic element that is required to implement the smart grid is reliable and high-speed integrated communication system.
- It links various elements to an open architecture, which is utilized to collect real-time information, control, and exchange of data for optimizing the security and reliability of the system and utilizing of the assets.



- With the help of integrated communication system, collected data can be rapidly transmitted between different transmission substations from system control center.
- The design of the communication system must be such that so it is able to cope up with the present as well as future applications of the power system.
- The different integrated communication technologies are fiber optics, wireless mesh networks, and supervisory control and data acquisition (SCADA) system.
- This process incorporates the sending of data containing information from source to demand.
- Various protocols like Wi-Fi, ZigBee, Bluetooth, and infrared are the most utilized protocols.

Sensing and measurements

- To evaluate and monitor the equipment health, prevent the energy theft and control the strategies support, these technologies are utilized.
- The emerging sensing and measurement technologies will also be promoted the electricity markets and use the energy in better way. This will help users and utility to save their capitals.