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Smart Grid Concepts and Comparison With Traditional Grid

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ABSTRACT: Smart Grid integrates the traditional Electric power grid with information and communication technology. The integration empowers electrical utilities provider and consumers to improve efficiency and availability of power system, while constantly monitoring, controlling, Demand of customers. This paper Deals with the concepts of smart grid, starting from introduction of smart grid, what is need of smart grid in today's world and components used in smart grid. This paper attempted to give an overview about smart grid and concepts related to it and how it is different from traditional grid.

KEYWORDS: Introduction, Components of smart grid, Need of Smart Grid, Comparison with Traditional grid.

I. INTRODUCTION

A Smart Grid is an electricity network that can cost efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety. A smart grid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies. The smart grid principle is rather based on a hierarchical structure and on the acceptability of intermittent resources such as renewable energies. SG acceptability of the choppy different renewable energy sources and its power outage self-healing capability are the major advantages over traditional power grid. Electric power grid includes three main generation systems with similar assets; systems that are responsible for the production of electricity from fossil fuel, renewable energy sources such as solar and wind, and nuclear power through centralized power plants that may include generators, diesel engines, gas turbines, step-up power transformers, motors, compressors, pumps, switchgear equipment, etc. Smart grid enhancements include various technologies used to improve the stability and reliability of the generation in addition to intelligent controls and generation mix consisting of various renewable energy resources.

A smart grid is an electricity network based on digital technology that is used to supply electricity that is used to supply electricity to consumers via two-way digital communication. The system allows for monitoring, analysis, control and communication within the supply chain to help improve efficiency, reduce the energy consumption and cost, and maximize the transparency and reliability of the energy supply chain. The smart grid was introduced with the aim of overcoming the weakness of conventional electrical grids by using smart net meters. A smart grid also facilitates switch from case of conventional energy to renewable energy. In case of having a source renewable energy in the facility, the grid allows an easy access to integrate it into the grid Smart grid permits greater penetration of highly variable renewable sources of energy, such as wind power and solar energy .Smart grid is new gateway to a green future. It not only provides better energy benefits but also opens up new avenues of employment for youngsters. For example, conversion of normal operating units into smart ones capable of connecting to the smart grid is full of new and exciting opportunities.

II. COMPONENTS OF SMART GRID

- A. Smart Meter
- B. Phasor measurement unit
- C. Information transfer
- D. Distributed Generation



a) Smart Meter:

Smart meters are advanced meters that identify energy consumption in more detail than a conventional meter. They look much like the electric meters that are in your home now, but their technology is far more advanced. They have the ability to communicate information via a secured network back and forth between your home and utility.



Figure No.1 Shows Smart Meter

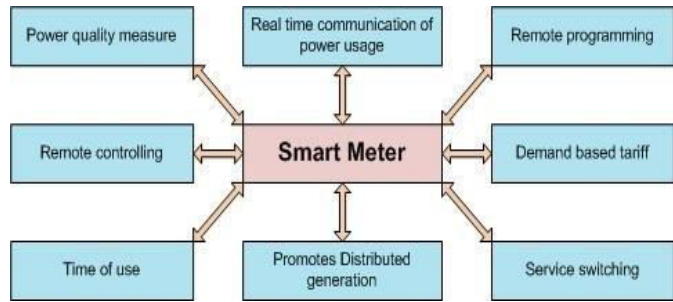


Figure No.2 Block diagram of smart meter use

Smart meters are foundation for updating existing electrical system into smart grid because they have two way communication between utility and user that is it receives information from utility and also transmits energy usage information to utility.

➤ **Smart meters are safe and secure:**

Smart meters have been thoroughly tested for safety and reliability. They have undergone extensive tests by utilities in USA. Smart meters operate at a level that is much lower (1.4%) than the maximum permissible exposure limits for radio frequency.

b) Phasor Measurement Units:

A Phasor measurement unit (PMU) or Synchrophasor is a device which measures the electrical waves on an electricity grid, using a common time source for synchronization. Time synchronization allows synchronized real-time measurements of multiple remote measurement points on the grid. High speed sensors called PMUs distributed throughout a transmission network can be used to monitor the state of the electric system. Phasors are representations of the magnitude and phase of alternating voltage at a point in the network. Using a PMU, it is simple to detect abnormal waveform shapes.

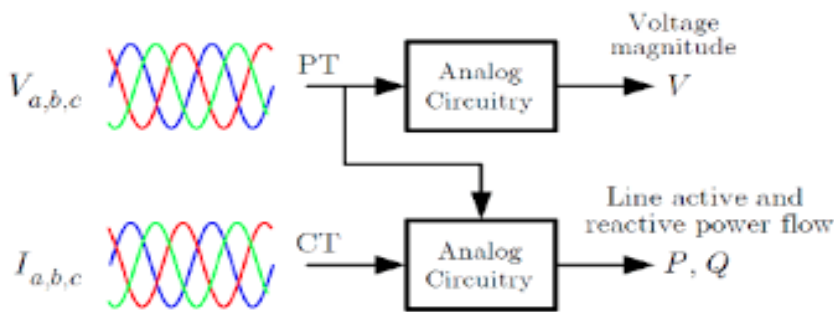


Figure No. 3 Working of Phasor Measurement Unit

c) Information Transfer:

Information transfer technology is needed to extend the two-way communication feature into home application. It is just the process of moving messages containing information from a source to a sink. Protocols such as WiFi, ZigBee, Bluetooth, and infrared are most popular in smart grid systems. It is encouraged for all these technologies to be compatible with one another. ZigBee is a specification for a high-level communication protocol suite that uses the IEEE 802.15.4 standard, the IEEE 802.15.4 IS A standard which specifies which physical layer and media access control



to use for wireless system. ZigBee uses very low energy and goes to sleep mode when not in use. ZigBee devices are often used in a mesh topology to be able to load, which reduces transmission line construction cost and transmission power losses, thus improving efficiency.

d) Distributed Generation:

Distributed generation refers to the use of small-scale power generation technologies located closer to the consumer, capable of reducing costs, increasing reliability, diminishing emission and expanding energy options. Generation will be closer to the load, which reduces transmission line construction cost and transmission power losses, thus improving efficiency. Supply and demand is one of the basic concepts of all industries. It is the one with which the current grid struggles a lot, as the moment electricity is being generated, it has to be consumed. It is imperative to have the “right” supply available to deal with every contingency at any time a problem may arise. When an amount of electricity generated does not meet the required demand during peak demand period.

III. NEED OF SMART GRID

➤ **Smart Grid Technology: Why do we need it?**

Well, talking about smart things, there are a lot of new technologies growing up in the smart sector.

Everything is becoming smart nowadays. So let us talk about the concept of smart grid technology.

➤ **What exactly is a smart grid?**

Wikipedia defines it as “an electrical grid which includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficiency resources.”

So, to be precise, just like the internet is the networking of people, the smart grid is the networking of things that generate, distribute and transmit energy.

Conserve energy and improve the environment.

The smart grid will eliminate the need for thermal power plants and enable greater use of renewable energy sources.

In addition, the smart grid will generate new and industries and energy sectors with that in mind, it is essential that everyone and budding engineers be aware of the role this technology will play in our energy future.

Effective roll out of this technology will demand coordinated effort and collaboration among a phenomenal disciplines, including communication controls frameworks for generation, transmission, distribution, operations, markets and administration supplier.

A smart grid is an electricity network based on digital technology that is used to supply electricity that is used to supply electricity to consumers via two-way digital communication.

The system allows for monitoring, analysis, control and communication within the supply chain to help improve efficiency, reduce the energy consumption and cost, and maximize the transparency and reliability of the energy supply chain.

The smart grid was introduced with the aim of overcoming the weakness of conventional electrical grids by using smart net meters.



A smart grid also facilitates switch from case of conventional energy to renewable energy. In case of having a source renewable energy in the facility, the grid allows an easy access to integrate it into the grid.

Smart grid permits greater penetration of highly variable renewable sources of energy, such as wind power and solar energy.

Smart grid is new gateway to a green future. It not only provides better energy benefits but also opens up new avenues of employment for youngsters. For example, conversion of normal operating units into smart ones capable of connecting to the smart grid is full of new and exciting opportunities. The global market for smart instruments is trending up with out-of-the-box ideas and innovations from young energetic minds.

IV. COMPARISON BETWEEN SMART GRID AND TRADITIONAL GRID ON THE VARIOUS BASIS:

Characteristics	Traditional Power grid	Smart Grid
Technology	Electromechanical: Traditional energy infrastructure is electromechanical. This means that it is of, relating to, or denoting a mechanical device that is electrically operated. The technology of this manner is typically considered to be “dumb” as it has no means of communication between devices and little internal regulation.	Digital: The smart grid employs digital technology allowing for increased communication between devices and facilitating remote control and self-regulation.
Distribution	One-Way Distribution: Power can only be distributed from the main plant using traditional energy infrastructure.	Two-Way Distribution: While power is still distributed from the primary power plant, in a smart grid system, power can also go back up the lines to the main plant from a secondary provider. An individual with access to alternative energy sources, such as solar panels, can actually put energy back on to the grid.

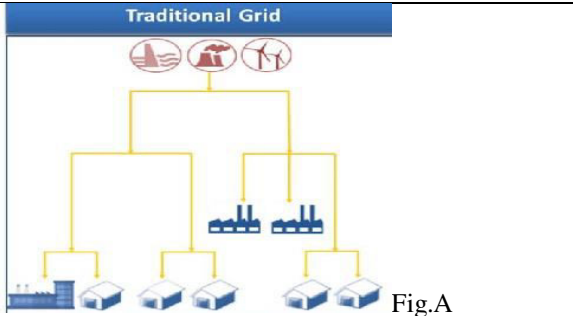
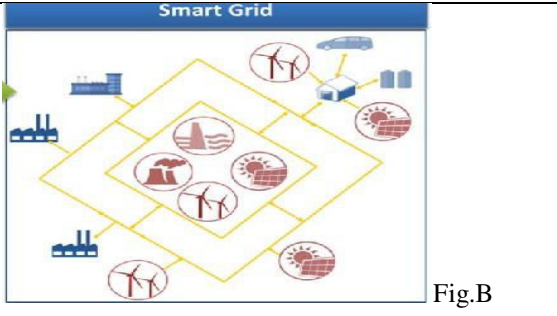


<p>Sensors</p>	<p>Few Sensors: The infrastructure is not equipped to handle many sensors on the lines. This makes it difficult to pinpoint the location of a problem and can result in longer downtimes.</p>	<p>Sensors Throughout: In a smart grid infrastructure system, there are multiple sensors placed on the lines. This helps to pinpoint the location of a problem and can help reroute power to where it is needed while limiting the areas affected by the downtime.</p>
<p>Monitoring</p>	<p>Manual: Due to limitations in traditional infrastructure, energy distribution must be monitored manually.</p>	<p>Self: The smart grid can monitor itself using digital technology. This allows it to balance power loads, troubleshoot outages, and manage distribution without the need for direct intervention from a technician.</p>
<p>Equipment</p>	<p>Failure & Blackout: As a result of aging and limitations, traditional energy infrastructure is prone to failures. Failure of infrastructure can lead to blackouts, a condition where the end customer receive power to their unit causing downtime.</p>	<p>Adaptive & Islanding: Using a smart grid system, power can be rerouted to go around any problem areas. This limits the area impacted by power outages and can do it on a per residence level.</p>
<p>Control</p>	<p>Limited: Using traditional power infrastructure, energy is very difficult to control. After leaving the power plant or substation, companies have no control over the</p>	<p>Pervasive: With the increased amount of sensors and other smart infrastructure, energy companies have more control than ever over</p>



	energy distribution.	power distribution. Energy and energy consumption can be monitored all the way down the line; from the moment it leaves the power plant, all the way to the consumer.
Customer Choices	Fewer: The traditional power grid system infrastructure is not properly equipped to give customers a choice in the way they receive their electricity.	Many: Using smart technologies, infrastructure can be shared. This allows more companies and forms of alternative energy.

V. COMPARISON OF TRADITIONAL GRID AND SMART GRID ON THE BASIS OF LAYOUT

Traditional Grid	Smart Grid
 <p>Fig.A</p>	 <p>Fig.B</p>
<p>Production is carried out by large power plants that generate electrical energy from various sources such as coal, oil, nuclear and large renewables. They are usually located away from urban areas.</p>	<p>The Smart Grid Conceptual Model provides a high-level representation of the interconnected networks and equipment that will compose the Smart Grid, dividing the whole system into seven domains.</p>
<p>The link between the production points and the users is realized by an electrical interconnection infrastructure, called the grid, classified in three main parts: Transmission, Sub Transmission and Distribution grid.</p>	<p>The electrical links are represented by the yellow dashed lines that connect the four domains Bulk Generation, Transmission, Distribution and Customer. The blue lines represent the information flows between all the domains involved in the management of the electrical system.</p>
<p>Different layouts can be used for these networks, e.g., open loop or radial, with different characteristics of reliability and redundancy. The connections among the different grids are made in electrical Substations.</p>	<p>In smart grid, Actors include devices, systems, programmes, and stakeholders that make decisions and exchange the necessary information for the performing applications: smart meters, solar energy generators, and control systems are some examples of devices and systems.</p>
<p>In this architecture, the electric system is fully governed by the system operator that, acting on the generation side, balances the production with consumpti.</p>	<p>These domains are key enablers of the Smart Grid because they represent the important economic actors and applications that influence the behavior o</p>



VI. ADVANTAGES

- Smart grids are a modern form of power grids that offers smoother and efficient power supply. Smart grids have the potential to reduce electricity consumption by 30%.
- Intelligent infrastructure technology for global energy distribution could reduce the greenhouse gas emissions of the energy sector.
- Another key advantage offered by Tele management systems is that bills are more accurate. They always reflect the real consumption of each month instead of estimates, reducing the cost of the old system of manual energy meter readings. In addition to being able to access information about the installation remotely, problems become easier to diagnose and solutions can therefore be implemented faster, improving customer service.
- Smart Grids can collect much more data than the manual energy meter reading system. This permits the use of data analysis techniques and the preparation of highly realistic consumption forecasts as many more variables are taken into account. Utilities can then better tailor their production to consumption (balances) and reduce energy surpluses.
- All the benefits above involve reducing consumption, which entails a reduction in CO₂ emissions. We can thus say that Smart Grids lead to a more sustainable future. All this will directly contribute to the future integration of electric vehicle charging systems on the mains. The deployment of renewable energy systems is also made easier as utilities gain greater control of their grids.

VII. DISADVANTAGES

- The biggest concern is Security in a smart grid system. Grid system uses some smart meters, which are automated and provides communication between power provider and customer. Here some type of the smart meters can be easily hacked and they may control the power supply of a single building or an entire neighbourhood.
- Cellular network providers do not provide guaranteed service in abnormal situations such as wind storm, heavy rain & lightning conditions.
- During crisis circumstances, organize clog or execution are huge difficulties in shrewd framework.
- It is costly to introduce brilliant meter contrast with customary old power meter.

IX. APPLICATIONS

- **Monitoring of Distribution Grids**—one of the primary goals is to increase the transparency of distribution grid operation, i.e. increase the monitoring capabilities. Transportation of monitoring data is one of the core functions of smart grid ICT.
- **Ancillary services from network participants on the distribution level** – The term ancillary service relates to services that are provided by power network participants (typically large power plants) that are required to ensure the safe and reliable operation of the system. Frequency control, reactive power control or voltage control are examples of ancillary services.
- **Advanced control of distribution grids** -Communication and control in these approaches is a core smart grid application. Line-based techniques or alternative continuous techniques are used to change the voltage on a selected network segment. While hardware components are available as products today level, and more control algorithms are still subject to research.
- **Plug-In Electric Vehicles**- plug-in electric vehicles are now being rolled out to consumers throughout the United states. The smart grid will have the infrastructure needed to enable the efficient use of this new generation of PEVs. PEVs can drastically reduce our dependence on oil, and they emits no oil, and they emit no air pollutants when running in all electric modes.

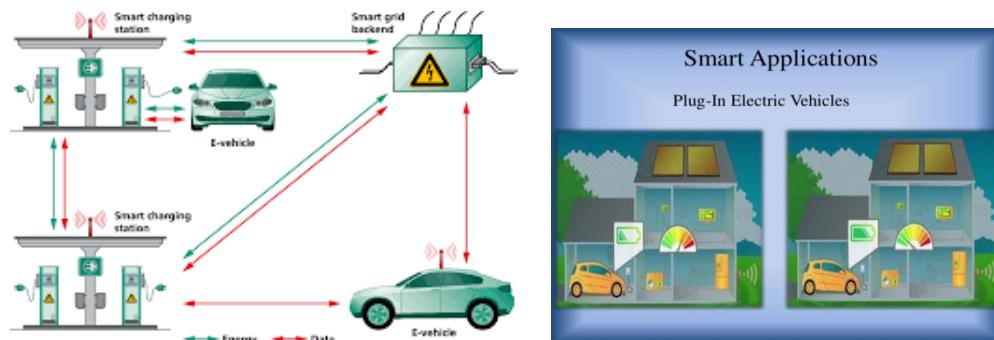


Figure No.4 Application of Smart grid plug-in electric vehicles

X. CONCLUSION

In this paper, there was presented different aspects related to electrical smart grid i.e need of smart grid, components used in smart grid, comparison with traditional grid on the basis of various factor.

It's smarter for you the more you know about your electricity consumption, the more control you have over your usage and your bills. When it comes to manage electricity, knowledge really is a power,

It's smarter for planet the technology will provide daily estimation of greenhouse gases associated with electrical usage. At the same time the technology will improve and provide how renewable energy sources are integrated with electrical.

It's smarter for us all smart meters and smart grid can make your electricity supply more reliable, with fewer and shorter outages. We need to start planning for the future today, by building smarter grid and giving people smarter ways to control their energy consumption.

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