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An Examination of the Smart Grid Power System Network

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Abstract

This essay provides a quick overview of the "smart grid," a recent revolution in grid technology. Energy autonomy results from the development of smart grids, and steady expansion of the economy. With this technology, Dr. A.P.J. Abdul Kalam's vision of "Energy forever and energy for all" would undoubtedly come true. The three levels that make up a smart grid are (a) the power and energy layer, (b) the communication layer, and (c) the IT/computer layer. It offers both communication with customers and the bidirectional flow of energy. Another name for it is "Auto Healing System." It provides improved energy use along with high grid system efficiency. By using the idea of an interconnected power system, it improves the system's overall integrity and security.

Keywords: Smart Grid, SCADA, ICT, FACTS, and smart meters.

I. INTRODUCTION

Due to rising power demands to anticipate shifting industry needs, there is a shortage of power generation in the current electrical grid system era. Right now, The moment has come to transition from the traditional power system to the new, future power system that artificial intelligence (ICT, or information technology) will bring about. This approach can control the transmission losses and increase efficacy. It has been somewhat equated with the prior power scarcity. This approach will use the most recent Smart Grid Technologies to improve the grid system's efficiency. Applying the energy requirements in a methodical manner requires the allocation of energy among the various zones to be done through strategic power management. In light of this, the Although SCADA and other tracking systems are in use, a smart grid can advance the power system by meeting energy needs in accordance with zone regulations and ensuring that energy is accessible from various sources without human intervention. This will allow for a prompt, efficient, and well-organized distribution system of energy requirements. The distribution system's "digital upgrade" is the smart grid. It is a long-distance transmission "system of systems." IEEE–2020 Copyright © ISBN: 978-1-7281-8908-Six lines to reduce the losses and optimize the on going operations. The idea of a smart grid will lower the high cost of electricity at Accessible new technologies like more numerous and perceptive SCADA sensors safeguard two-way communication and integrated data Opportunities that did not exist even ten years ago have now become possible thanks to management and clever autonomous controllers. Although there are many definitions of the smart grid that are proposed based on specific applications or local needs, it is explained in this work that the smart grid is not limited to specific applications based on personal preferences, but rather is a modification of the conventional grid system and a process of finding weaknesses in our system that we can work to improve. The block diagram of a Smart Grid system with several cutting-edge technologies to help its end users is shown in Figure 1.

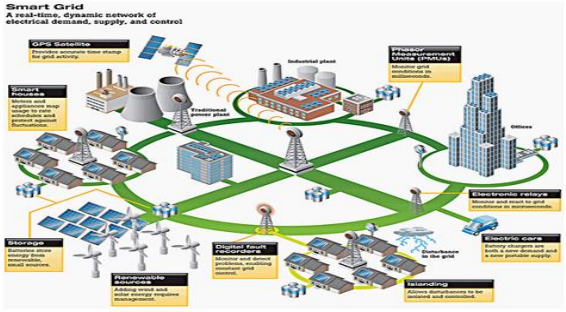

Fig. 1: SMART GRID Block Diagram Representation

II. Smart Grid

A century ago, the traditional energy networks were created, where the ideas of power generation, The lack of high-level automation and communication inputs made transmission, distribution, and consumption relatively simple. Next is the traditional grid, which is the current grid system and has a one-way energy flow (from energy generation to energy consumption). It is challenging to create a grid using a conventional network that satisfies every need for the average fluctuation in electricity consumption across time. For the "Future Grid," an upgrade of the conventional system is necessary. This can be achieved by changing the conventional system and adding new components, such as fault detectors, two-way communication networks, and sensors for voltage and current. Therefore, in addition to communication data and control power networks, it will be conceivable for future grids to provide the idea of bi-directional energy flow. Figure 2 and Table 1 provides a good understanding of the concepts around smart grid by comparing it to the traditional grid.

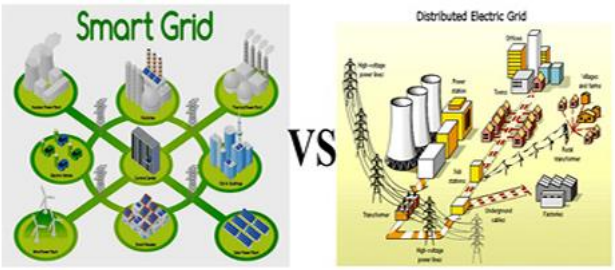

Fig. 2: Smart Grid vs. Traditional Grid

Figure 2 illustrates how power is supplied in a traditional grid using conventional methods, such as adhering to the same generation-transmission arrangement. distribution, after which this used various methods (such as subterranean cables) to disperse electricity provided to various consumption points, such as factories, villages, offices, and houses.On the other hand, a smart grid uses automation systems, information technology, smart meters, and controllers to create an integrated electricity system that is more cost-effective, efficient, and builds consumer confidence. The Control Center is the single location where the whole power system is controlled.

Table 1: Traditional Grid vs. Smart Grid

Sr.No.	Characteristics	Traditional Grid	Smart Grid
1	Technology	Electromechanical: The realm of electromechanical energy infrastructure was formerly utilized. This displays, Electrical power was used to operate mechanical devices. This technology lacks suitable internal regulation and communication channels.	Online: A smart grid is made up of digital technology that allows for the both remote control and self-control.
2	Distribution	One-Way Distribution: Historically, power was distributed in just one route, that is, from Main network of distribution to grid.	Two-Way Distribution: In this scenario, the smart grid-integrated technology makes it easier for power to be distributed via the primary power plant and it also becomes bilaterally with the assistance of a backup supplier to restore electricity to the main plant. It is possible to feed electrical energy back into the grid by integrating PV-based solar panels or any other secondary energy source. With this strategy, renewable energy is encouraged.
3	Generation	Centralized: In traditional grid the electrical power was centrally generated. This persists a disadvantage of not able to associate other energy sources alternatively with the supply system as and when required.	Distributed: Power distribution in this system is made possible by a number of plants and substations, which aid in load balancing, lower peak time overshoots, and a significant decrease in the frequency of power outages.
4	Sensors	Few Sensors: The power cables in this system prevent us from having more than one sensor. Consequently, it becomes challenging to pinpoint the precise source of the problem. and can get the desired results with lengthy pauses.	Sensors everywhere: The smart grid system's power lines are equipped with a number of sensors that assist in pinpointing the precise location of a defect so that electricity can be diverted to the required location. As a result, downtime allows for system protection without significantly impacting the healthy parts.
5	Tracking	Manual: Historically, energy distribution monitoring was carried out by hand due to certain drawbacks with the earlier grid arrangement.	Self: One feature of the smart grid is the ability for digitally controlled self-monitoring of the distribution of energy. This facilitates outages and load balancing. diagnose and control the distribution system as a whole without using any outside resources.

6	Refurbishment	Manual: The conventional method of fixing problems. This system makes use of movement on a physical level. of specialists to identify the problem's location and fix it. The procedure takes a long time as a result.	Self-Healing: Sensors are capable of identifying issues on their own by self-diagnosing and making repairs. If the framework is destroyed in any way, this The system offers a way of alerting the control room technicians so they may take prompt action to make the necessary repairs.
7	Equipment	Error & Absence: The old grid is increasingly vulnerable to malfunctions over time. Any infrastructure malfunction, leads to blackouts, a serious situation where there is no power remaining at the point of consumption.	Adaptive & Islanding: Anywhere there is a problem, the smart grid system can take over the power flow. This aids in keeping that from going dark. specific location.
8	Control	Limited: It becomes challenging to control the full energy source in the traditional method because it is manual. degree. Once power is delivered, different authorities cannot regulate how it is distributed.	Common: The Smart Grid system, which incorporates all technological breakthroughs, maintains strict control over the flow of power from the initial stage of transmission to the last stage of distribution to the customer end with the aid of sophisticated sensors and additional actively operated equipment.
9	Customer Choices	Fewer: Customers could not have a variety of options under the old power grid arrangement for obtaining power. It was constrained and did not adequately sustain client happiness.	Many: Smart grid technology has given the option of sharing. It has collaboration of various companies, energy resources with advanced control techniques to provide more alternative options to energy recipients up to their satisfaction level.

III. The Smart Grid's Future Scope

The smart grid's revolutionary features will usher in a new era in electricity systems as well as in economic expansion. The following are some of the essential conditions that bring about this change in the power system's current state:

- The integration of renewable energy resources into smart grids addresses global climate change.
- It makes it possible for customers to become involved and improve energy saving.
- To address system safety, permit the use of cyber secure communication systems as well.
- Enables improved use of the current system to address sustainability over the long run.
- It makes optimal energy flow possible, which lowers energy costs and losses.
- By integrating the electric cars, this will lessen reliance on fossil fuels.
- Reduces the overall cost of energy by providing improved energy distribution management and effective energy storage.
- By combining the system's communication and control access, it fosters interoperability and increases operational flexibility.

Thus, as a result of the smart grid system revolution, smart meters have gained prominence. With the use of smart meters and their technologies, such as SCADA, real-time consumption can be easily detected, which is undoubtedly very advantageous for customers.

Conclusion

The smart grid has the ability to benefit the nation and the electricity system in the age of automation. It enhances the economy, dependability, efficiency, and electrical infrastructure. Distributed system that respects the environment. Without a doubt, the smart grid represents the generation, transmission, and distribution of power to happy customers in the future. Although there may be some variations as renewable energy sources become more prevalent, the future power system network will operate quite well generally. The self-healing feature of the IT-based electric power system boosts grid security. Thus, we can realize Kalam Sir's vision of "Energy forever and energy for all" in this way.

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