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Influence of Decentralization of the Smart Grid and Its Social & Economic Policy

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ABSTRACT: India is stubborn in meeting the fast-growing economy's electric power needs. The reorganization of the power industry merely adds to the many difficulties that power system engineers face. To deploy the Smart Grid (SG) at different levels in the Indian electricity systems, it is advised that a better automation mechanism be required. The idea of a "smart grid" seeks to improve the intelligence and effectiveness of grid operations. Operations on the smart grid are feasible with the correct deployment. It might provide new opportunities with substantial financial ramifications. This research may be found in a variety of Smart grid initiatives and its consequences for the expanding Indian power industry. This study suggests that the power flow controller for solar (PV), wind, and fuel cell generation systems be researched together. It is necessary for a conventional grid to be connected to solar, photovoltaic, fuel cell, three-phase inverter, battery units, wind energy, associated power electronics devices, and loads. This comprehensive model of photovoltaic and fuel cell connections to the smart grid starts with a PV source that is connected to a boost dc-dc converter, followed by a three phase inverter that supplies the smart grid with solar energy. A fuel cell is also connected to an inverter that supplies the smart grid with power. In order to adjust for voltage imbalances, harmonics, active power, and load voltage and current changes, this inverter is set up as a shunt active power filter (APF).

Keywords: Automation, Decentralized, Energy, Fuel, Smart Grid.

1. INTRODUCTION

From centralised to decentralised generation, the contemporary electric power industry is experiencing a tremendous shift. The usage of distributed generation has increased quickly as a consequence of this technological breakthrough, making energy promotion more enticing, competitive, and acceptable. Additionally, this technology has generated interest in research and growth among industrial countries all over the globe as a result of energy deregulation, environmental concerns, and government incentives. These problems have also prompted the creation of the Smart Grid platform to take the role of the traditional, packed, perpendicularly integrated electric power sector, which raises energy prices. Smart Grid is anticipated to provide a new platform for India's electricity sector in the future.

Due to the escalating nature of this issue, markets for distributed generation technologies including wind energy (WS), fuel cells (FC), photovoltaic (PV), and energy storage (ES) have developed quickly. We have created a simple model that incorporates sun, wind, and fuel cells. This model compares the voltage, current, and power factors of the three systems to decide which is the most reliable. When solar energy was more plentiful, we used this decentralised approach. We decentralise the system by using wind energy when the wind blows more often. The system requires a fuel cell in addition to computing the power factor and efficiency. It ultimately comes down to how distributed generating and distribution systems interact [1], [2].

Smart grid is the burgeoning business strategy in the electric utility industry. The Smart Grid debate is being driven by regulators, with the initial goal of reducing consumption via energy efficiency and demand response. To fulfil the rising demand, utilities must increase their producing capacity, which is against regulatory advice. Demand response, energy efficiency programmes, green electricity, nuclear power, oil, and gas are all beginning to be included into the generating plan (utility and the customer). By more effectively managing their present T&D asset, the utilities should be able to reduce their operational costs. Customers are being advised to accept the increased costs associated with demand response, pay the higher rates associated with it, or request that the plan reduce their consumption voluntarily via the use of new energy-efficient equipment. The smart grid is a great concept for managing energy and will improve power output in the future [2], [3].

1.1.   Smart Grid Characteristics

The National Technology Laboratory of the United States and the Smart Grid European Technology Platforms have identified seven essential characteristics of the smart grid. The Smart Grid provides a number of benefits for the electrical power industry's objectives [4], [5]. Figure 1 shows the several characteristics of Smart Grid.

Figure 1: Illustrates the characteristics of smart grid.

- *Safe and Dependable:*

When compared to the current electric grid, the smart grid is a safer and more reliable system with less losses.

- *Efficient and cost-effective:*

Through policy innovations, administration, and energy efficiency, as well as market contests, the smart grid may enhance the economic settlement. The power network is better supported in order to ensure that resource allocations are balanced. It reduces power loss and increases system efficiency by efficiently dealing with the energy market.

- *Environmentally friendly:*

This system is very clean and environmentally friendly, and it is in excellent working order. This method is also environmentally beneficial.

- *Enhancement:*

Smart grid is a very good price for the electrical energy that society provides. The goal of a smart grid is to maximize resource usage while lowering investment costs. It also lowers the expenses of operation and maintenance.

- *Self-healing: Self-healing is the ability to heal oneself.*

Self-healing is a key aspect of the smart grid. It is used to enhance the quality of services, increase dependability, and lower costs. It locates the problem.

- *Compatibility and Flexibility:*

A good combination of distributed generation and the power grid, as well as a correct, acceptable balance of renewable energy sources, may assist the smart grid. Furthermore, it may strengthen and enhance management operations in order to attain effective customer engagement skills. It's also compatible with the current grid.

- *Incorporated:*

It provides a unified platform and paradigm for use on the grid. It is possible to get high quality of combination and information exchanged with the power grid, as well as standard, normative, and refined infrastructure management. Many systems, such as solar energy, wind energy, and PV cells, are included in this system. It is more effective in terms of efficiency and cost.

1.2. Smart Grid Components

The Smart Grid is made up of many components. All of the components are linked and interconnected. To improve dependability, efficiency, and security, all components must be interconnected [6]–[8]. Figure 2 shows the components of smart grid.

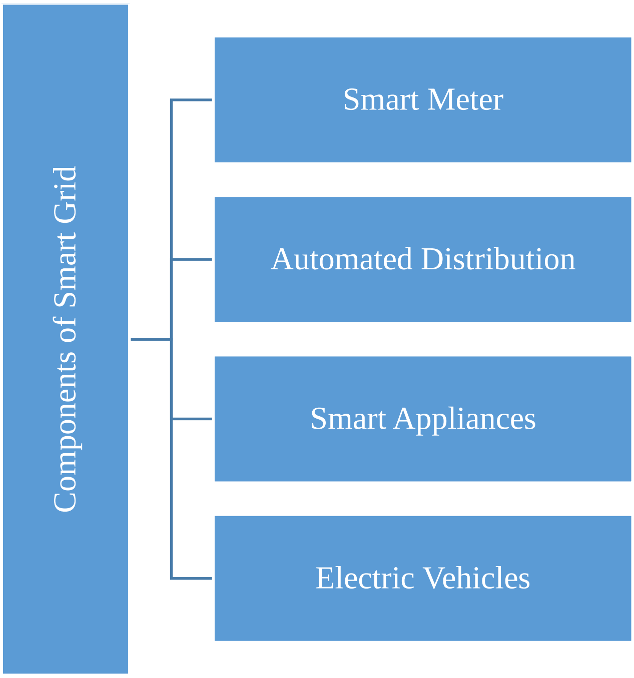

Figure 2: Illustrates the components of smart grid such as smart meter, automated distribution, smart appliances, and electric vehicle.

- *Smart-Meter:*

Its foundation is the Smart Grid. It is a tool that determines how much energy a person uses. It is made feasible for energy suppliers and customers to communicate. When there is a high demand, smart metres allow utilities to reach out to consumers through email or other means, allowing them to use less energy.

The following are the functionalities of a smart meter:

a. It calculates the quantity of active and reactive power used. A smart meter has a two-way metering capability as well as greater electrical energy storage.
b. It allowed bi-directional communication, allowing data to be sent and commands to be received, such as real-time power and software upgrades such as remote configuration.
c. Achieves intelligent overall load restriction in accordance with demand response requirements. When the electricity grid fails, the smart meter and smart interactive terminal will work together to provide a seamless transition to an isolated system.
d. It enabled multifunctional value-added services, such as reading smart gas meters, water meters, and other similar devices.

- *Automated Distribution:*

According to IEEE, a distributed automation (DA) solution permits an electric utility to remotely coordinate, monitor, and operate distributing components in real time from distant locations. Outdoor equipment, RTUs, information science, and automated make up the four core components. Changes in end-user customers' electricity use from their typical consumption patterns are defined by demand response management as "changes in electric usage in response to changes in the cost of energy over time, or to rationale payments intended to encourage the lesser electricity in use at periods of high reselling market rates, or when reliability is jeopardized ". For electrical utilities to increase their effectiveness and load curve smoothness, it is the most crucial element. The retailer and wholesale electricity markets both benefit from demand response. It refers to the process of dynamically and continuously balancing demand with supply-side resources in order to create a cost-effective energy system. It should include both a supply and demand mechanism that is responsive to a clear pricing structure [9], [10].

Demand management is a strategy for influencing consumers' capacity and desire to decrease their energy usage. It is a service function that fine-tunes customers' power consumption patterns based on utility energy production and distribution capabilities. DSM programs are utilities' monitoring, executing, and planning efforts aimed at encouraging customers to change their energy consumption levels and patterns. It is the result of combining a high-efficiency operating system with a decent operating system. It is the execution of policy and is used to maintain control.

1.3. Smart-Appliances:

The most important component of the smart grid is it. Very little energy is used. It greatly simplifies daily living. A transmission automation system may be built using smart substations, smart communication networks, and smart measurement, command, and control centres. The exciting transmission system and embedded career may improve power transfer in this situation. There will be different types of data present at each and every point in the system. It offers customers a respectable technique and produces superior outcomes. This model provides a wide range of data on various grids, which is useful for assessing energy management. Demand response management, electric storage, electric cars, smart metres, renewable energy sources, transmission automation, and other components of the smart grid. Existing systems will become more dynamic, reliable, and responsive as a result of smart appliances. Smart metering will aid in the identification of power theft and the online invoicing of electricity customers. In the next years, demand will rise.

- *Grid-to-Vehicle (G2V):*

Electric vehicles under the G2V system are originally powered by stored energy from an external power source, and therefore must be recharged once the batteries have been depleted. This technique is very easy to use. Optimizing the charging profile of electric vehicles is a method for reducing the effect of electric vehicles on the smart grid. We need to maintain demand's peak power as low as feasible, taking into consideration the additional power use from car charging. It is possible to do this by coordinating the charging processes of different electric vehicles so that they are not charged at the same time.

- *Vehicle-to-Grid (V2G):*

An innovative way of storing and providing electric power in V2G is provided by electric automobiles. A V2Generated electric vehicle that is connected to the grid and is parked sends a signal to the grid and gets power. Better batteries, hydropower, and other technologies all need electricity to be stored and distributed during times of peak demand for renewable energy. Renewable Energy Sources Significant amounts of renewable energy are used in the Smart Grid.

Wind energy, micro- and small-scale hydroelectricity, solar energy, and biogas are a few examples of renewable energy sources. While preserving the environment, it increases renewable energy's long-term worth. In the future, non-traditional and renewable energy sources will be increasingly prevalent since they are more environmentally friendly, practical, and economically feasible.

4. DISCUSSION

In the production, distribution, and use of energy, the modern electrical industry is experiencing a paradigm change. Decentralized energy resources, when introduced and integrated, have a beneficial effect on developing systems like micro grids and smart grids. Simultaneously, they shift demand's role in competitive energy markets from passive to active. The integration of distributed generation, scattered generation, energy storage, and demand resources into current centralised power networks is shown in this article. We come to the conclusion that the technical and economic analysis of centralised energy resources applies to decentralised energy resources as well, and that integrating the two resources enables energy diversification and ensures long-term power supply.

Electricity is a must-have item in today's society. As a result, the electric sector must guarantee that quality and consistency of supply are available at all times and at reasonable rates. Electricity supply reliability faces a number of difficulties:

- Demand is steadily rising, resulting in a drop in energy market activity.
- The depletion of fossil fuels, which drives up exploration costs and consumer prices.
- Large-scale power plants' technological obsolescence (implying high inefficiencies and high-cost replacements),
- reduced short-term returns on investments,
- Concerns about the environment, which add to the uncertainty and danger.
- Disruption of local and regional electrical networks by decentralized energy resources (DERs).

The conventional structure of electricity supply is jeopardized by these problems. They do, however, open up possibilities for addressing a larger issue on competitive energy markets: the existing electric supply system is no longer viable.

5. CONCLUSION

In this article, the workings of India's existing electricity system are studied. The smart grid system has been compared to the existing power grid, and the comparisons suggest that the smart grid system is superior. India should adopt the most modern methods for managing and operating the electricity system in light of the global breakthroughs in technology, such as Smart Grid. Smart grid technology integration will help the present power system manage and solve current issues in the Indian power industry. A development in electric power systems known as the "smart grid" aims to expand the spread of distributed generation using renewable energy sources while also enhancing safety, efficiency, and dependability. On the other hand, fast information gathering concerning equipment failures, natural disasters, and capacity limitations is very important for proactive and real-time issue diagnosis in the smart grid.

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