Different Aspects of Smart Grid: An Overview

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Abstract Smart grid involves the application of computer, transmission line, and networks into an inactive power distribution system. It is used to improve the maintenance, operations, and technologies of the smart grid, so that the component of the power grid can easily interchange data. However, concerns associated with communication and management must be addressed before full benefits of the smart grid can be accomplished. In this paper, all aspects that are relevant to smart grid communication and information technologies, and also its challenges, have been discussed.

Keywords Smart grid · Network · Transmission line · Topology
Energy

1 Introduction

Power grid refers that distribute electricity from the power plant to the users. It contains power plant, transformer, transmission line, substations and distribution line, distribution transformer, etc. Power grid was made in the 1890s and upgraded day by day as technology enhanced each decade. At present, electric grid consists of beyond 9,200 power generating units which can generate over 1 million megawatts of power, which is linked to above 300,000 miles of transmission line. Further, a new kind of electric grid is required, which is made from the lowermost to manage the groundswell of computerized and digital equipment and technology that depend on it, also which can systematize and accomplish the rising difficulty and requirements of electricity in the twenty-first century. In other words, we can say to make a grid smart, a digital technology is used. This technology permits the two-way communication between the services and its customers. Smart grid

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V. Nath and J. K. Mandal (eds.), *Nanoelectronics, Circuits and Communication Systems*, Lecture Notes in Electrical Engineering 511,
https://doi.org/10.1007/978-981-13-0776-8_41

includes controls, computers, automation, new technologies, and equipment which all are working together. These technologies respond digitally to electrical grid. Through this reliability, efficiency, sustainability of the generation and economics, transmission, and supply of electrical power can be improved. The explanation of the smart grid is not essentially unique, as its visualization to the investors and the technological complications can be different [1]. The US Department of Energy (DOE) has suggested the definition of smart grid as "Smart Grid is an automated broadly distributed energy delivery network". It will be categorized by a bidirectional flow of electricity and information. Also, it will be capable of monitoring everything from power plants to customer preferences to individual appliances. The benefits of distributed computing and communications incorporate into the grid to deliver real-time information and allow the near-instantaneous balance of supply and demand at the device level [2].

Normally, smart grid is the combination of a traditional distribution network and a two-way communication network for sensing, monitoring, and spreading of information on energy consumptions. A smart grid communication architecture is shown in Fig. 1. A typical smart grid consists of several power generating entities and power consuming entities, all connected through a network. The generators feed the energy into the grid and further consumers draw energy from the grid.

The Smart Grid benefits include as follows:

(a) More effective transmission of electric power.
(b) Restoration of electricity will be faster after power disturbances.
(c) By reducing higher demand will also help lesser electricity rates.
(d) By this large-scale renewable energy systems will be increased.
(e) Customer-owner power generation systems will be improved.
(f) Costs of operations and management services will be reduced.
(g) Improved security.

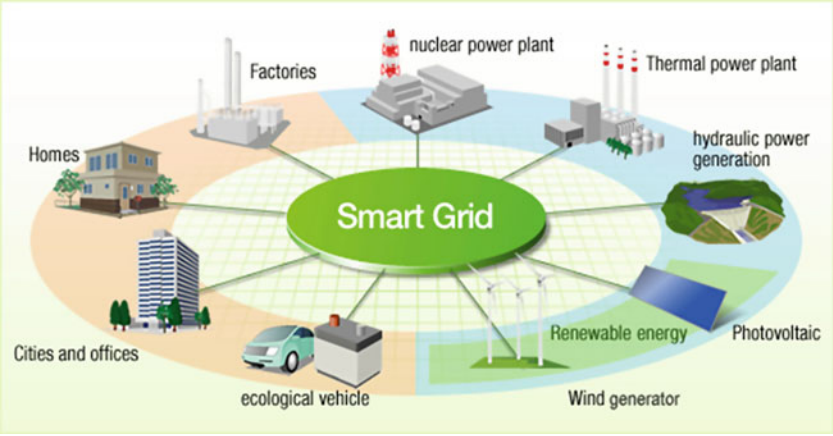

Fig. 1 A smart grid communication architecture

Smart Grid will enhance resiliency to our electric power system and prepared it for to address emergencies such as earthquakes, large solar flares, severe storms, and terrorist attacks. When instruments fail or outages occur, smart grid will permit for automatic rerouting because of its two-way communicating capacity. Through this outage, their effects will be minimized.

2 Smart Grid Features

The smart grid signifies the full set of current. It proposed responses to the challenges of electric power supply. There are many competing classifications and no agreement on a universal definition because of the different ranges of factors. However, possible classification is given here:

2.1 Reliability

By using technologies such as state approximation [3], the smart grid will improve the error detection and also allow the network to be self-curing without interference of operators. Through this reliable distribution of electric power will be ensured. Also, exposure to natural disasters will be reduced. By the economic effect of upgraded version of grid resilience, reliability becomes the subject of a number of studies. Also, by using a US DOE-funded methodology, it can be calculated by using only one calculation tool.

2.2 Efficiency

By the utilization of smart grid technology, overall enhancement of the efficiency of energy substructure can be predicted. Like in energy demand management, e.g., air conditioners will be turnoff, when short-term changes occur in the price of electricity, through VAR optimization technique (VVO) voltage on transmission lines are reduced and so is eliminating truck-rolls for meter reading. Redundancy of overall effect in transmission line and distribution line will be less. Also, using greater number of generators leads to lesser electricity prices.

2.3 Network Topology

Flexible transmission and distribution setup in next generation will capable to deal with probable bidirectional energy drifts. Also it permittes fair distribution of power generated from photovoltaic panels, from the fuel cells uses, wind turbines, from the electric cars batteries, pumped hydroelectric power, and from other sources. Traditional networks were operating on unidirectional flow of electric power. But it is consuming if local sub-net will generate more amount of power. And the inverse movement can increase reliability and security issues [4]. Aims of the smart grid are to manage these circumstances [5].

2.4 Load Matching/Load Balancing

Electric grid load can be changed expressively. The overall load is not only unstable but also varies solwly which makes total amount of load dependent upon the summation of several individual selections of the users. Traditionally, certain additional generators are added on a dissipative mode to give response to a quickly changed power consumption. To reduce the load temporarily or continuously, a smart grid can give the warning to all different television sets or another customer [6]. By the use of precise calculation techniques, it would be possible to calculate how many standby generators are required to be used and to obtain a certain failure rate. In customary grid at the cost of more standby generator, only the failure rate can be decreased. In smart grid, the problem will be reduced by the load reduction in small portion of the clients.

2.5 Sustainability

Smart Grid allows more saturation of extremely variable renewable energy resources such as wind power and solar power due to its enhanced flexibility, even though without adding of energy storage. For several distributed feed-in points, modern network setup is not made to allow it. And if some feed-in is allowed, transmission-level setup cannot accommodate it at the local (distribution) level. Because of gusty or cloudy weather, quick fluctuations in distributed generation occurred. This becomes challenging to electric engineers who have to make sure the steady power level by fluctuating the more controllable generators output, such as hydroelectric generators and gas turbine. For this reason, smart grid technology is an essential condition for a very large quantity of renewable electric power on the grid.

3 Challenges in Smart Grid

Smart grid involves substantial challenges because major changes occurred in it. From the DOE's National Energy Technology Laboratory report, modern grid has the following major barriers to attaining smart grids [7]:

- **Commercial Resources**

The commercial instance for a self-healing grid is good, especially if it contains social benefits. Before authorizing major investments, regulators will require general proof based heavily on social benefits.

- **Government Sustenance**

Without the help of government, the industry may not have the financial capability to fund new. Even though some utility industry has capital-intensive, with $800 billion in resources, but it has suffered from hard times in the marketplace. Also, some utilities have reduced its financial ratings.

- **Compatible Equipment**

New smart grid technologies cannot fit with older equipment. So it must be replaced. Because of this, a problem exists for services and controllers since keeping equipment beyond its devalued life minimizes the cost to users. Early retirement of apparatus can become an issue.

- **Speed of Technology Improvement**

It was predicted 50 years ago that the basement fuel cell, the solar shingle, and the chimney wind generator as an integral part of the home of the future. This retiring historical progress will need to increase the speed.

- **Regulation and Policy**

A regular parochial view of new construction projects is taken by utility commission. The state financing on the project may not always be the one who benefits the most from it. Smart grid investment is encouraged so that the attractive return is held. To invest in a new technology utilities will remain reluctant.

- **Cooperation**

To implement the smart grid concept, it is become challenging for 3,000 different utilities to cooperate while installing.

4 Conclusion

The smart grid is a completely automatic energy transmission network. It has the ability to guarantee two-way information and power flows between generation plants, final users, and applications among others. In this paper, some features of the smart grid have been discussed that include reliability, efficiency, network topology, load matching/load balancing, and sustainability. The development of smart grid will mean an extreme transformation in electric power administration and its uses. So, several technical challenges and issues associated with effective and safe communication and information processing must be resolved before realizing the vision of a smart power grid.

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