Application Development of Smart Grid System

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Abstract- The power grid is the name given to the infrastructure that is used to supply energy. This infrastructure includes power plants, transmission lines, and distribution networks. One of the most impressive achievements in engineering is the construction of the electrical grid in its current state. The infrastructure of the grid has been extremely important in ensuring that people have access to electric electricity in a dependable and cost-effective manner. Before we can even get started on modernizing the grid we use today, we need to have a crystal clear picture of the power system that will be necessary in the future. By having this understanding, we will be able to generate the alignment that is required to drive enthusiasm, investment, and progress toward the Smart Grid for the 21st century. In order to build a flourishing society in the future, the Smart Grid will be an essential enabler. The provision of adequate sources of energy has emerged as one of the most pressing problems confronting humanity in the 21st century. The demand for energy has skyrocketed in every section of the nation as a direct result of increasing populations, an increase in the number of residences and enterprises, and an increase in the number of various new appliances. Utilities all over the world are racking their brains to find a solution that would bring their networks into the 21st century and the digital era. The creation of a "smart grid" is the common name given to the process that aims to increase the intelligence of the electricity system. The business world views the transition to a smart grid as an opportunity to improve both the delivery and use of electrical power. The 'State of the Art' of the Smart Grid, together with its vision, application, and control, are all introduced in this paper. This paper also discusses the benefits, opportunities for growth, and challenges presented by smart grids. A case study of the implementation of smart grid technologies is also presented and analyzed in this paper. The study is based on recent references and technical reports produced by government, research, and academic agencies.

keywords: Smart, Grid, System

INTRODUCTION

The process of rapidly upgrading the United States' electrical wire system infrastructure is being referred to as the "smart grid," and the term "smart grid" has been chosen to denote this process. since of this, after the upgraded system has been completely created, it will be referred to as a "smart" system since it will make it viable to link across grids using qualities that are not now accessible. This process is being defined by the term "smart grid." A "smart grid" is nothing more than an advanced electrical distribution system that incorporates the capability to balance electrical demands that are created from a broad range of alternative energy generating sources, which are often intermittent in nature. This ability to balance electrical needs is what gives the "smart grid" its name. The term "smart grid" is used to describe this kind of technology in various contexts. The capacity to store electrical energy is essential to the operation of the so-called "smart grid," which makes it possible for the supply of electricity to keep up with the demand from end users. This is an essential part of what we refer to as the "smart grid." Adaptable, with lower dependent on operators, particularly in terms of its capacity to promptly react to changing conditions, the Smart Grid is characterized by the following characteristics: Predictive in the sense that operational data may be exploited to enhance equipment maintenance methods, and even in the sense that prospective outages might be spotted before they even take place in the first place. Completely integrated in terms of the responsibilities of operational control and real-time communications Interactional between several markets and the customers of each specific marketplace, Designed to provide the highest possible levels of reliability, availability, economic performance, and resource use efficiency while it was being developed. insulated not only from the destructive effects of humanity but also of the natural disasters that might befall it [3]. Power grids of today are designed to provide assistance to large power producing units, which, in turn, are responsible for delivering electricity to customers located in far-flung locations via a transmission and distribution network that is primarily unidirectional. This process is known as the "feedback loop." This cycle will continue until the customer has been supplied with electricity. But the grid of the future will have to be a two-way system by necessity, where electricity is generated by a myriad of tiny, scattered sources in addition to large plants, and then flows via a grid that is based on a network rather than a hierarchical structure [3]. This will be necessary due to the fact that the grid of the future will need to be able to accommodate a wider variety of power generation methods. This will be essential due to the fact that the electrical grid of the future will need to be able to support a diverse range of different kinds of energy sources. This modification, which can be seen illustrated in the schematic that can be seen below in Fig.1 [3], has been implemented. The hierarchical power structure that is still in use today is depicted in the first picture, which gives a depiction of the system. This structure is quite similar to an organizational chart in the sense that it placed big generators at the top of the hierarchy and huge consumers at the very bottom of the hierarchy. The fully operational smart grid is depicted by the second diagram, which features a network topology that is representative of the smart grid. It is demonstrated that the smart grid is running normally in every respect.

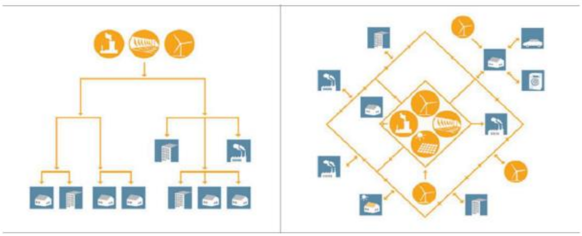

Fig.1: The transition from the current power system, shown on the left, to the realized smart grid [3].

In addition to the administration of electrical power, the management of information and control are at the core of the idea that underpins smart grids. Broadband over Power Lines, often referred to as BPL, is a technique that superimposes information on top of electrical power and is used to transfer a major percentage of data across power lines. This technology, which is also commonly known as BPL, is also referred to as BPL. With this knowledge, it will be feasible to reroute electricity away from trouble regions until the issue can be fixed and to adjust power levels so that they are in keeping with the amount of demand that is being placed on the system. Smart grids have the capability of satisfying the requirements of both the consumers of electrical power and the providers of that electricity. Customers might potentially be charged higher rates during periods of heavy consumption and lower rates during times of low demand if wind and solar electricity were to be introduced to the grid. This would make it possible for customers to benefit from both types of energy. Smart grids are able to adjust for lower output from solar cells on cloudy days as well as from wind turbines on still days, in addition to meeting the growing demands that are caused by air conditioners when the temperature rises. Smart grids have the capability to swiftly respond to both natural disasters (also known as "Disaster Avoidance") and terrorist attacks by rerouting around problems or completely shutting down the network, respectively. This capacity is referred to as "Disaster Avoidance." They are also responsible for controlling rolling brown outs in order to save electricity at periods when demand is higher than output. This is done for the purpose of preventing power outages.

SMART GRID DRIVERS

The many distinct factors that are presently driving the development of the smart grid are as influential as they are diverse. These forces come from a variety of different areas. In many regions of the world, people are becoming more concerned about the state of the environment, which is one element that is driving the development of renewable energy sources on a far larger scale than in the past. The widespread use of renewable energy sources, such as wind, solar, and others, which provide energy in an intermittent manner, poses problems for operational efficiency. These problems may be mitigated, however, by optimizing how these sources are used. In order for such technologies to reach their full potential, it will subsequently become necessary to have a grid that is capable of handling a generation mix that incorporates a high percentage of renewable energy sources [6]. This will be the case because such a grid will become necessary.

STATUS OF SMART GRID

The term "smart grid" is more of a catch-all phrase that refers to a collection of different technologies; yet, the benefits of making it a reality transcend far beyond the power system that is used to quantify it. The transition from the grid that we are accustomed to today to the grid of the future will be as momentous as all of the breakthroughs that have been achieved in power systems over the period of the previous hundred years, but it will take place in a portion of the time that it took for those advancements to take place. It will be necessary for there to be a new level of collaboration between the numerous actors in the sector, the advocacy organizations, the general public, and most importantly the regulatory authorities that have such direct power over the course that the process will take. Those individuals and organizations that have a vested interest in the smart grid will, in the long run, be the ones to benefit from its successful implementation [3]. Up until this point, the concept of intelligently integrating photovoltaic (PV) systems that are connected to the grid has been largely overlooked. This is in part due to the availability of subsidies. Photovoltaics, often known as PV for short, have been the most quickly developing source of energy in recent years because to the subsidies offered by a number of governmental incentive programs. PV is an abbreviation for photovoltaics. As direct financial incentives and other types of subsidies for photovoltaic (PV) systems are likely to be gradually phased away [4, the design of future photovoltaic (PV) systems will need to incorporate a critical component that is going to become a vital component: a smarter grid interface.

SMART GRID TECHNOLOGY

It is not possible for renewable energy systems (RES) to immediately replace the technologies that are employed in the electricity networks that are currently in existence. These later technologies are much too well established to be abandoned, while the more recent ones have not yet reached a point where they are adequately developed to provide the entire need for energy. As a consequence of this, it makes perfect sense to gradually incorporate renewable energy sources into the grids that are already in existence and to make modifications to the system over the course of time [5].

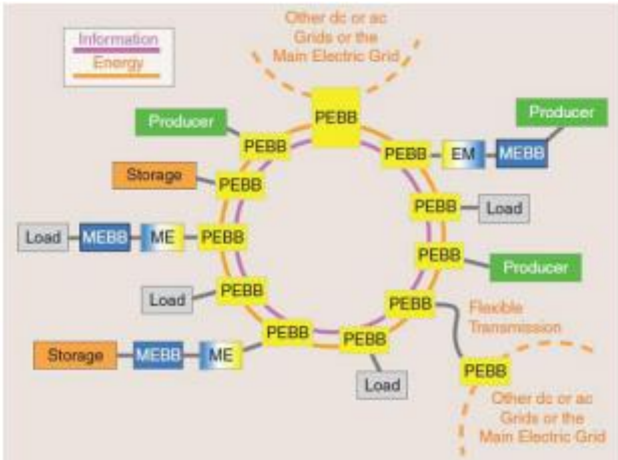

Fig. 2: Nodes for the intelligent conversion of energy [1]

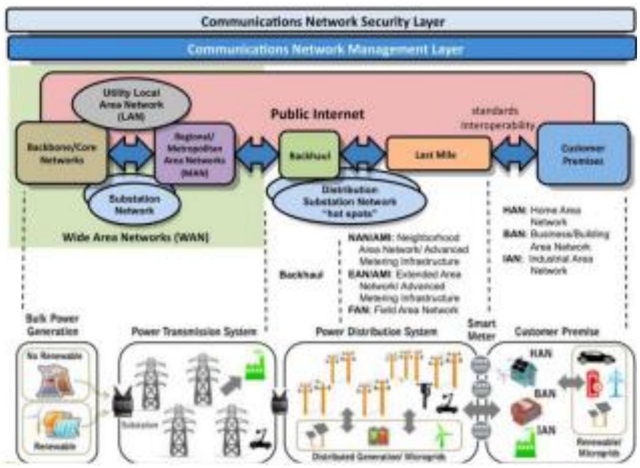

Fig.3: A Fraught Situation for the Deployment of Smart Grid Technology [6]

In this diagram, a smart grid is represented by two concentric rings. The movement of information over various communication networks is modelled by the inner circle, while the flow of energy is modelled by the outer circle. Managing the flow of energy in active networks that incorporate distributed power generation has been tackled from a number of different approaches up until this point in time. One of the most appealing concepts is the utilization of energy hubs for the administration of many forms of energy carriers (for example, electricity, natural gas, and district heating). Inside of each hub is a device known as an energy converter, and its primary function is to change some of the flow of energy into a different sort of power. Figure 2 represents one possible outcome for the power grid of the future, which is based on smart-grid technology and contains power electronic building blocks (PEBBs) and other components. This outcome is envisioned to be similar to what is shown in the figure. When the technology for smart grids has progressed to the point where intelligent meters can manage residential appliances, customers will be able to apply more cost-effective methods to minimize their power bills during periods of high electricity costs. This will allow consumers to save more money overall. The installation of intelligent power grids will become feasible as a result of this. As a result, shifting peak load is feasible, and it is anticipated that the system will evolve to become economically beneficial, intelligent, and beneficial to the environment [1].

SMART GRID PLATFORM

One approach to think about the smart grid is as a massive cyber-physical system that significantly enhances the controllability and responsiveness of very scattered resources and assets that are contained within electric power networks. This method of thinking about the smart grid is one way to think about how the smart grid works. The generation of electricity from renewable sources will play an increasingly major part in the overall production of electric energy in the years to come. Innovative approaches to the operation and administration of power networks will need to be developed in order to accommodate the integration of resources that are both highly variable and geographically scattered. In a similar vein, new types of loads, like as plug-in electric cars and the vehicle-to-grid capabilities that comes along with them, will bring both challenges and opportunities [5]. Plug-in electric vehicles are just one example.

The following is a synopsis of the advantages offered by smart grids, as presented on the technical platform for smart grids developed by the EU. They [5]:

1. Improve the ease with which generators of various sizes and types may be connected and operated .
2. Give customers the opportunity to participate in the process of improving the efficiency of the system .
3. Make more information and alternatives available to customers so they may make an informed choice about their supply .
4. Make significant strides toward mitigating the overall environmental effect of the power distribution network .
5. Maintain or even increase the high standards of system dependability, quality, and security that are already in place
6. Ensure a steady supply of services, as well as maintain and enhance those already in place, and encourage market integration .

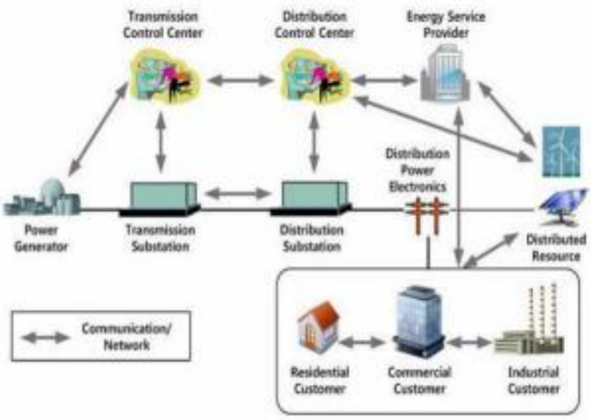

Fig.4: Every section of the Grid has its own control center [1]

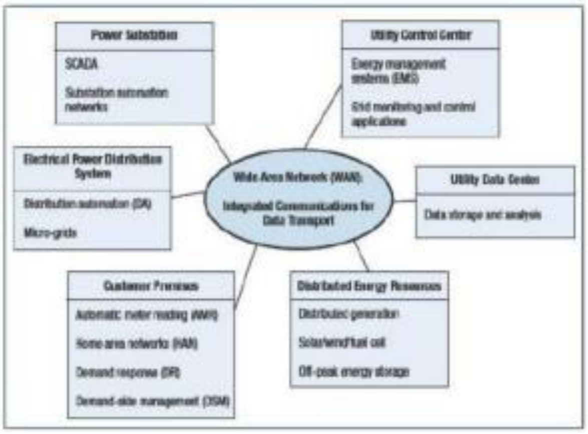

Fig. 5: A unified communication and information system [1]

There is a rising understanding of the fact that a new perspective on energy, one that goes beyond oil, coal, and other fossil fuels, will lead to decentralized components of the power grid [1]. This realization comes as a result of the fact that there is a growing awareness of the fact that there are decentralized components of the power grid. When compared to the centralized generating and structured system that was in place in the past, this will be a big shift.

SMART GRID TECHNOLOGY AND APPLICATION

The concepts that are driving the smart grid initiative encompass a wide range of different kinds of technology and areas of application. In the next section, we will discuss a few that are now in use, but before we do so, it is necessary to point out that at this early stage in the development of smart grids, the function of control, particularly sophisticated control, is constrained [6]:

1. The Advanced Metering Infrastructure, more commonly referred to as AMI, is a concept for communicating in both directions between meters and utilities. It has been decided that the deployment of two of the AMI's fundamental components will take place. Automatic meter reading (AMR) systems give a beginning step toward decreasing the expenditures of data collection through the exploitation of real-time metering information. This is the first step toward the overall goal of reducing those expenses. When compared to techniques of manually reading meters, this is a huge benefit. Second, meter data management, sometimes referred to as MDM, provides a centralized point of integration for all of the various forms of meter data. MDM is commonly abbreviated as "MDM." It makes it feasible to exploit such data in order to automate business activities in real time. Additionally, it makes it possible to exchange such data with essential business and operational applications in order to boost overall enterprise efficiency and to give support for decision making throughout the whole company.
2. The software that makes up the distribution management system (DMS) generates a mathematical model of the electric distribution network. This model is used to anticipate the consequences of a variety of factors, including power outages, transmission, generation, fluctuations in voltage and frequency, and more. It highlights how current assets may be utilized more efficiently, enables peak shaving through demand response (DR), and enhances network dependability, all of which contribute to a decrease in the amount of capital investment that is necessary. DR stands for demand response.
3. The technology known as geographic information system (GIS) was developed specifically for the utility industry in order to model, plan, and manage their essential infrastructure. This was done in order to save money. A graphical representation of the infrastructure may be obtained through the use of GIS by merging data from utilities with geographical maps. This approach makes it possible to cut costs via more straightforward planning and contributes to the overall simplification of the process.

i. Because power outages can be resolved more quickly with the help of outage management systems (OMSs), expenses associated with power outages may be better managed.
ii. Intelligent electronics devices, also known as IEDs, are high-tech, application-enabled gadgets that are deployed in the field and have the ability to process, calculate, and communicate relevant data to a higher level. IEDs are able to gather data from the network as well as the customers' facilities (behind the meter), and they can allow for the reconfiguration of the network either locally or on order from the control center .
iii. Wide-area measurement systems, also known as WAMS, are able to collect precise and synchronized data from many large-scale power grids. WAMS are made up of phasor measurement units (PMUs), which are responsible for providing accurate data that has been time-stamped, as well as phasor data concentrators, which are responsible for aggregating the data and performing event recording.
iv. Energy management systems (EMSs) installed on client premises have the ability to regulate usage, as well as onsite generation and storage, and maybe even the charging of electric vehicles. EMSs are now utilized in big commercial and industrial buildings, and it is anticipated that their widespread implementation will coincide with the introduction of smart grids .
v. Implementations of smart grids are happening at a quick pace, and there are various projects now under way all over the world. Projects such as Elektra distribution management system (DMS) increase the quality of service by incorporating next-generation devices to manage and control information (SCADA), DMS to plan and optimize distribution system operations, and Arc FM/Responder to improve the reaction times for outages [6] .

CONCLUSION

Because of the many benefits that may be gained from using smart grids, their rate of acceptance has skyrocketed in recent years. Smart Grids are the most comprehensive technology that has been developed in recent years. It is comprised of a number of components, and the transition to a fully operational smart grid provides a plethora of advantages in the context of a partnership that is typically advantageous for both parties: grid operators are going to witness a considerable improvement in their monitoring and control capabilities, which will, in turn, allow them to give a larger degree of system dependability despite the ever-increasing demand. Grid Operators are going to be able to provide a greater degree of system dependability because of this. Utilities will experience a reduction in the amount of money they lose due to distribution, a deferral in the expenditures they make for building, and a reduction in the amount of money they spend on maintenance. Consumers will enjoy the benefits of a more reliable grid while also gaining greater control over their ability to manage their energy costs, which may include the ability to generate their own power. It will be helpful for the environment if peak demand is reduced, renewable energy sources are expanded, and a commensurate reduction in emissions of CO_2 and other toxins, such as mercury, also takes place. The distribution made possible by a "smart grid" has the potential to reduce carbon dioxide emissions by 13–25 percent, the amount of electrical energy consumed by 5–10 percent, and the cost of power-related interruptions to enterprises by 87 percent. Trial experiments have shown that energy management systems that are enabled by smart networks have the capacity to reduce total electricity usage by 10–15% and up to 43% of necessary peak demands. These reductions were achieved through the implementation of smart grids.

REFERENCES

[1] Mohhammad Zahran, "Smart Grid Technology, Vision Management and Control" WSEAS TRANSACTIONS on SYSTEMS, Volume 12, Issue 1, January 2013.

[2] http://www.ehow.com/facts_5974930_ smartgrid- definition.html.

[3] ABB, "When Grid gets smart-ABB vision for the power system in the future", www.abb.com, ABB Inc., USCS 1411, 2008.

[4] Azzopardi et.al, "Smart Integration of Future Grid-Connected PV Systems", IEEE, 2009.

[5] Marco Liserre, Thilo Sauter, and John Y. Hung, "Future Energy Systems", IEEE Industrial Electronics Magazine, March 2010

[6] T.Samad and A.M. Annaswamy, "The Impact of control technology- Control for renewable energy and Smart Grid" www.ieeecss.org. (eds), 2011.

[7] Maryam Sadeghi, Magid Gholami, "Advanced Control Methodology for Intelligent Universal Transformers based on Fuzzy Logic Controllers", Recent Researches In Communications, Electrical & Computer Engineering, 10th WSEAS International Conference On Applications Of Computer Engineering (Ace '11), Playa Meloneras, Gran Canarias, Canary Islands, Spain, March 24-26, 2011.

[8] R. Al-Khannak, B. Bitzer, "Grid Computing Technology Enhances Electrical Power Systems Implementations" 3rd IASME/WSEAS Int. Conf. on Energy & Environment, University of Cambridge, UK, February 23-25, 2008,

[9] R. Al-Khannak, L. Ye, "Integrating Grid Computing Technology for Developing Power Systems Reliability and Efficiency", 12th WSEAS International Conference on SYSTEMS, Heraklion, Greece, July 22-24, 2008

[10] Mohamed Zahran, Yousry Atia and Ahmed AbulMagd, "A Developed SCADA for Remote PV Systems", Engineering Research Journal, Minoufiya University, Vol. 32, Issue No. 4, July 2011