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An Overview of Smart Grid Technologies

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Abstract: The traditional electricity grid is currently transforming into a smart grid. The smart grid complements the traditional Power grid with information and communication technologies (ICT). This integration allows the Electricity suppliers and consumers improve the efficiency and availability of the electricity grid constant monitoring, control and management of customer needs. An intelligent network is a huge and complex network it is made up of millions of interconnected devices and entities. This article briefly discusses the evolution of smart grid development. The smart grid is important because it will lead us to energy independence and environmentally friendly economic growth.

Keywords: Smart Grid, FACTS, ICT, Smart Homes.

I. INTRODUCTION

Today, due to the increased demand for energy to meet industrial needs, attempts have been made to alleviate the shortcomings in electricity generation by developing connected systems to the national grid, in which all sources of national electricity generation are connected, between supply and demand national grid and energy management is implemented on the basis of the zonal requirement. A "power grid" is not a unit, but a collection of several networks and several power generation companies with several operators who use different levels of communication and coordination, most of which are controlled manually.

With this concept, the previous lack of performance has been taken up to a certain extent and can control transmission losses and improve the efficiency of the transport to a certain extent. This is in contrast to an efficiency of 60% for networks that are based on the latest technology and can represent the solution to the above problem: SMARD GRID TECHNOLOGIES.

In order to systematically implement the energy requirements of the various zones, a strategic energy distribution program is inevitable. While SCADA and other continuous monitoring systems are in vogue, fast, effective and efficient distribution of energy demand requires an intelligent system that can take into account the needs of the zones and the availability of energy from various sources in areas without people. Interference. Smart networks improve connectivity, automation and coordination between providers, consumers and networks that perform long-distance transport or local sales activities.

A smart grid is an umbrella term for the modernization of transmission and distribution networks. The smart grid concept is that of a "digital upgrade" of distribution and long-distance transport networks in order to optimize ongoing operations, reduce losses and open up new markets for energy generation. The advantages of such a modernized power grid include the ability to reduce energy consumption by consumers during peak hours, which is known as demand management. enable connection to the energy network of decentralized production (with photovoltaic modules, small wind turbines, micro-hydropower plants or even combined thermal energy generators in buildings); Integration of the network energy storage system for load balancing with distributed generation; and eliminate errors like generalized cascade errors from the power grid. The increased efficiency and reliability of the smart grid should save consumers money and help reduce carbon dioxide emissions. Governments are increasingly focusing on energy security. Investing in the smart grid could reduce dependence on non-domestic energy sources. This could also make the network more resilient to military or terrorist attacks, be it through physical or digital means. The smart grid is known by other names, including "Smart Electric Grid", "Smart Power Grid", "Intelligrid" and "Future Grid". [1].

II. SMART GRID

A smart grid is an electricity grid capable of intelligently integrating the actions of all users connected to it: generators, consumers and those who do both to efficiently provide a sustainable, economical and safe energy supply [2]. A smart grid uses innovative products and services, as well as intelligent monitoring, control, communication and self-repair technologies to:

• facilitate the connection and operation of generators of all sizes and technologies;
• Enable consumers to play a role in optimizing system operations;
• provide consumers with better information and a better choice of what is offered;

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• Significantly reduce the environmental impact of the entire power supply system;
• offer a higher level of reliability and security of supply.

A. Aims of the Smart Grids - The Vision
• Provide a user-centric approach and allow new services to enter the market;
• Make innovation an economic engine for renewing electricity networks;
• Maintain security of supply, ensure integration and interoperability;
• Provide access to a liberalized market and promote competition;
• enable the decentralized production and use of renewable energy sources;
• Ensure the best possible use of centralized production;
• Take due account of the effects of environmental restrictions;
• Enable participation on the demand side (DSR, DSM).
• Provide information on political and regulatory aspects;
• Take into account social aspects [2].

B. Pathways to a Smart Grid
Movement from static infrastructure to a flexible power grid with enhanced observability, controllability and process efficiency [3],

C. Components of Smart Grid [4]
The basic components of Smart Grid are as shown in Figure 1.

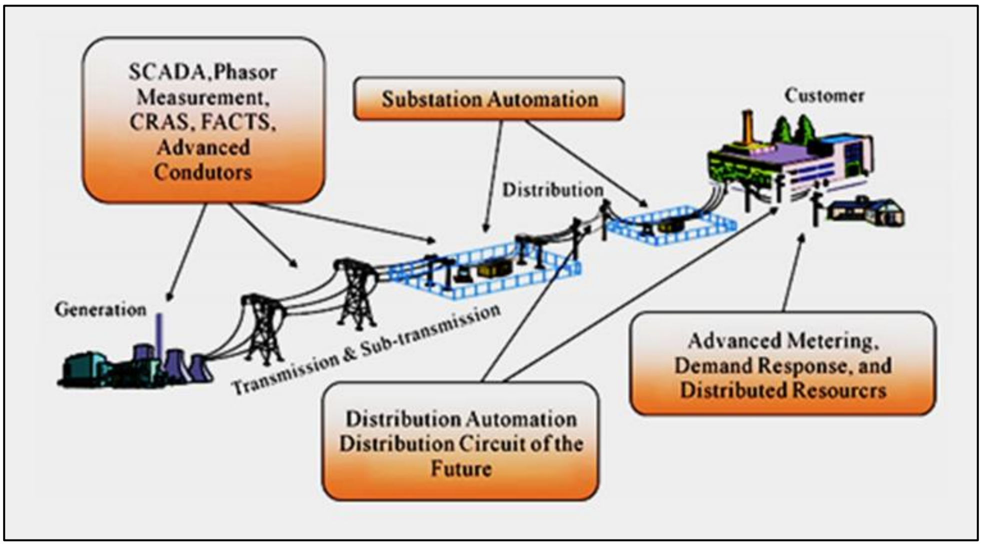

Figure 1. Components of smart grid

D. The Key Challenges for Smart Grids
• Strengthening the network: ensuring sufficient transport capacity to network energy resources, especially renewable resources;
• Offshore relocation: developing the most efficient connections for offshore wind farms and other marine technologies;
• Developing decentralized architectures that allow small power systems to work in harmony with the entire system;
• Communication: providing the communication infrastructure to enable potentially millions of parties to operate and trade in the internal market;
• Active demand side: Allow all consumers, with or without their own generation, to play an active role in how the system works.
• Intermittent Generation Integration: Find the best ways to integrate intermittent generation, including residential micro-generation.
• Greater intelligence in terms of production, demand and especially the network;
• Prepare for electric vehicles: If smart grids are to meet the needs of all consumers, electric vehicles will be given special attention due to their highly distributed and mobile nature and possible massive use in the coming years, which would be a major challenge for future electricity grid - it works [2].

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E. A Model Set Up [4]

A model set up of Smart Grid including smart generation, smart transmission, smart storage, smart sensors to isolate the fault is given in Figure 2.

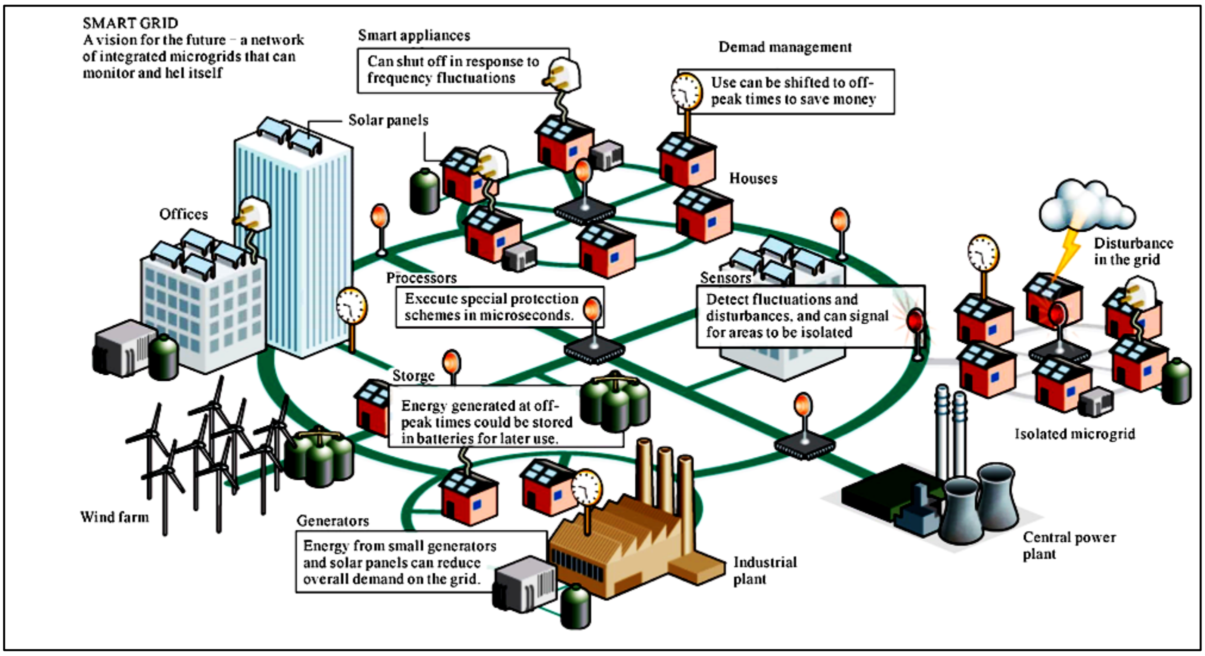

Figure 2. A model set up of smart grid network

III. ACTION PLANS

For the vision of smart grids to become a reality, an action plan is needed to optimally address the many facets of technical, regulatory, environmental and cultural problems. This will enable a consistent delivery of R&D results integrated into existing infrastructure and technology, providing initial benefits while maintaining steady progress and advancement towards key objectives [2].

A. Optimizing Grid Operation and Use

In order to meet the ever-increasing demands for energy exchange and security of supply, existing transport and distribution networks require better integration and coordination. In order to control the flow of electricity across national borders, it is necessary to use advanced applications and tools already available today to control the complex interaction between operational safety and commerce and to actively prevent and eliminate disturbances.

Key elements and priority components

• WAM (Wide Area Monitoring) and WAC (Wide Area Control) systems with regulation of static VAR compensators, possibly closed circuit, to maximize the use of the available transmission capacity while reducing the likelihood of interference;
• Distributed state estimators for large synchronous areas with real-time safety assessment of the electrical system and optimized distribution with dynamic constraints;
• Training of the network operator's staff on traditional topics (e.g. control of the electricity network) and emerging topics (e.g. electricity market and regulation);
• Coordinated ancillary services, including the integration of balancing markets and the coordination of reserves across all grids / control areas - The integration of balancing markets is of particular importance for both greater security of the electricity system and better market liquidity.
• Stationary and dynamic (transient) simulators with modelling of renewable energy sources and non-linear devices;
• Coordinated operation of power flow control systems (FACTS, phase shifters, etc.) with automatic countermeasures / system defences.
• These applications now exist as components, but if not recommended, few will be made available in the near future. More work is urgently needed to understand how these solutions can be implemented and validated in closed-loop operations.
• Regulatory issues related to defined objectives should be taken into account to ensure that innovative technological solutions are properly promoted and implemented.

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B. Optimizing Grid Infrastructure

New and efficient resource management solutions are needed for transmission and distribution networks, as well as coordinated and consistent planning of the network infrastructure. Instead of being clearly deterministic, coordinated planning should be scenario-based and include the necessary elements of risk management to address the growing volatility and uncertainty of the location and size of production, as well as the increase in intermittent production.

Key elements and priority components

• The expansion of networks (especially traffic) with new infrastructures (e.g. HVDC) depends on the approval procedures being accelerated and made more efficient than they are today.
• New overhead line configurations are needed to increase capacity and reduce electromagnetic fields.
• Refurbishment / implementation of existing power lines using innovative grid resources, including superconductor technology;
• New methods of asset management and planning of the transmission and distribution network;
• Development of systems and components to keep energy quality at an acceptable level, while promoting the integration of new types of generators.

C. Integrating Large Scale Intermittent Generation

Large-scale forms of production, for example. Wind farms and future (concentrated) solar thermal generation require grids to enable efficient harvesting of the electricity produced and to allow system balancing, whether through energy storage, conventional generation or participation of the request [5]. Offshore wind energy requires marine electricity acquisition networks and the strengthening of onshore networks. This priority therefore also concerns the promotion and promotion of a large-scale integration of renewable energy sources so as to meet grid security requirements while taking into account economic efficiency.

Key elements and priority components

• Technically viable and profitable solutions for offshore wind energy collection networks;
• The grid connection of offshore grids must take into account security and quality of supply, economic efficiency and ecological sustainability.
• The strengthening of the transnational and cross-border network should be considered. The current lengthy authorization procedures should be shortened.
• Solutions should be developed to allow efficient and safe operation of the system of future networks with high intermittent production, high mass production and / or difficult distribution.

D. Information and Communication Technology

It is about defining the tasks and implementing the necessary standards for ICT solutions (information and communication technologies) in future smart grids. The use of ICT is a prerequisite for the exchange of data between different market participants in the electricity supply chain and for the safe, inexpensive and environmentally friendly operation of intelligent networks [6].
Today ICT are applied at the transmission and sub-transmission levels and terminate at the busbar level of the sub-transmission (110 kV) / medium voltage substations. Several standard protocols are used at different voltage levels and for different types of devices. In general, the medium and low voltage levels are characterized by a limited TIC for economic reasons. Open and standardized information models and communication services are required for the entire data exchange within the entire power supply chain and the power supply system.
Various ICT technologies should be explored and tested in the field in order to introduce ICT into the distribution layer by building on the existing communication infrastructure (radio, power line, copper or fiber optic) in a cost-effective manner. The challenge is to coordinate all of these databases via an overlapping data warehouse based on the Common Information Model (CIM). The data warehouse concept is linked to all other databases and thus guarantees the required data consistency.

Key elements and priority components

• Simple, robust, secure and flexible communication infrastructure to enable monitoring, administration, control and dispatch processes at all levels up to sales and customers.
• In order to ensure a coherent management of the database, common information and data models must be defined for all components of the information at all levels of the power supply system and the supply chain.
• Effective ICT solutions are essential for maintaining security of supply and for effective interaction between market participants.
• A truly competitive situation for all types of products based on multi-vendor strategies can only be achieved with well-defined and standardized ICT solutions.

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E. Active Distribution Networks

Transmission grids have always played a balancing and administrative role in the energy supply chain, while distribution grids have been designed to be passive ("fit and forget") in operation. The challenge now is to provide many services that can be found in transmission grids, such as B. the management of electricity flows and constraints, emergency analysis and balancing in distribution grids [7]. This is necessary not only due to the increasing use of decentralized electricity generation, but also due to the new smart construction technology in residential and commercial premises, the need to use local electricity generation to support the local electricity grid during periods of load on the main network. electricity grid and for the future use of electric vehicles.
Distribution networks must be able to react in real time to the complex interactions of all these challenges or to adapt to them and provide the various actors with improved information to allow real-time exchange of the various services offered.

Key elements and priority components
• An active network requires efficient and consistent visibility of the various devices connected to it in order to allow a timely decision-making process and a timely flow of information.
• Centralized manual control must be replaced by a distributed control architecture that is coordinated and integrated into existing control methods in order to harness the intelligence that will improve the networks of the future.
• Compatibility of all functions and devices must be ensured even during the transition from currently active sales networks to future ones.
• In addition to online control and administration, the active sales network will introduce new functionalities made possible by new tools and solutions based on dynamic and diversified optimization [8]. The modelling of the necessary planning and operational uncertainties is based on:
• Standardization of data models and communication protocols to ensure minimum overhead and minimum capacity for expansion and adaptation to future requirements;
• Communication systems capable of meeting the capacity, reliability and cost requirements caused by the new functions.

F. New Market Places, Users and Energy Efficiency

Reducing the differences between transmission and distribution in areas such as ancillary services, grid connection and access, but also quality and security of supply, is one of the most important features of the set of smart grid concept. At the same time, such "democratization" and "decentralization" requires increased and strengthened control and administration. This is not only necessary for the network to function securely. Adequate control and management solutions are also required to successfully and efficiently use a number of new and emerging concepts, such as: B. virtual power plants and energy management concepts for end users.
In order to meet the future needs of customers, a number of new market players will develop. Besides transparent and non-discriminatory access and connection to the grid for all grid users (generation and demand), this supply priority also relies on the technologies needed in the so-called "last mile" of smart grids.
The needs, interests and benefits of customers are clearly at the heart of this distribution priority. In addition, white goods in homes will contribute to the efficiency of power grids in the future, but only if there is coordinated activity between the grid, the smart meter, the user and the producer of the goods. For such developments to take place, there must be sources of income.

Key elements and priority components
• Innovative customer interface devices as intelligent two-way communicators between customers and the market.
• In order to give the customer, the possibility of choosing his energy supply, it is necessary to develop solutions to increase and optimize the information on the energy consumption and to improve the interaction between the customers and the market operators.
• These devices must be able to provide the relevant energy information stored in digital or electronic meters to stimulate awareness and create new virtuous behaviours in terms of energy saving, thus increasing the energy efficiency of end users.
• These devices can also act as "energy data providers" for all smart devices installed in the house to enable load management services.
• Intelligent Smart Home Controller which provides behavioural information to raise awareness of energy consumption and encourage efforts to achieve real energy savings / savings.
• Promoting the active role of customers requires advanced ICT tools that manage the complexity of multiple inputs, take consistent and intelligent action, and enable simple and flexible interaction between customers and the system.
• The Smart Home Controller should be the control point and counterpart to smart meters. They will work closely together to share data.

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• The active role of customers will focus on defining the rules and priorities for energy consumption in terms of availability and costs during day-to-day operation, information and communication.

IV. CONCLUSION

This paper covered the development of the Smart Power Grid system. Traditional power systems are moving to digitally enabled smart grids, which will improve Communication, improved efficiency, increased reliability and reduced costs of electrical services. The mass of the smart grid and advanced communication capabilities make it more vulnerable to cyber-Attacks. It is still in its infancy. The entire electricity community is currently engaged in understanding and developing a smart grid that is no longer a problem of the future. This introductory document is a small but very important step towards the ultimate goal of creating a "national network".

REFERENCES

[1]. M. Weedall, “BPA Smart Grid Overview,” Energy and Communications, Washington House Technology, January 22, 2000.
[2]. European Technology Platform, “SMART GRIDS”— Strategic Deployment Document for Europe’s Electricity Networks of the Future, September 2008.
[3]. U. Niehage, “Pathways to a Smart Grid,” Power Transmission and Distribution, Siemens, 8 November 2007.
[4]. S. Rahman, “The Smart Grid and Its Impact on the Integration of Distributed Energy Resources,” Southeast University, Nanjing, 2 April 2009.
[5]. P. F. Ruiz, “Towards Smart Power Networks,” Lessons Learned from European Research FP5 Projects—European Commission in 2005, 2005.
[6]. IBM, “Smart Grid Overview—IBM,” International Exhibition and Conference—Gridtech 2009, New Delhi, January 29-30, 2009.
[7]. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis,” 3rd Edition, McGraw Hill, New York, 2006.
[8]. D. P. Kothari and I. J. Nagrath, “Power System Engineering,” 2nd Edition, Tata McGraw Hill, New Delhi, 2007.
[9]. T. Vijayapriya, D.P. Kothari, “Smart Grid: An Overview,” Smart Grid and Renewable Energy, 2011

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