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Importance of Measurements in Smart Grid

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Abstract: - The need to get reliable supply, independence from fossil fuels, and capability to provide clean energy at a fixed and lower cost, the existing power grid structure is transforming into Smart Grid. The development of a smart energy distribution grid is a current goal of many nations. A Smart Grid should have new capabilities such as self-healing, high reliability, energy management, and real-time pricing. This new era of smart future grid will lead to major changes in existing technologies at generation, transmission and distribution levels. The incorporation of renewable energy resources and distribution generators in the existing grid will increase the complexity, optimization problems and instability of the system. This will lead to a paradigm shift in the instrumentation and control requirements for Smart Grids for high quality, stable and reliable electricity supply of power. The monitoring of the grid system state and stability relies on the availability of reliable measurement of data. In this paper the measurement areas that highlight new measurement challenges, development of the Smart Meters and the critical parameters of electric energy to be monitored for improving the reliability of power systems has been discussed.

Keywords: - Smart Grid, Measurements, Smart Metering, Advanced Metering Infrastructure(AMI),

I. INTRODUCTION

The need of transforming conventional grid to Smart Grid is getting attention worldwide. The present grid focuses on reliability and optimal operation of the system whereas in Smart Grid the quality, reliability, efficiency, optimal and environmental friendliness are the main concerns. This change will lead to advancement in technology and digitized automation of the entire system from generation to customer. The Smart Grid being bi-directional involve the customers actively and control their energy usage pattern. Customer can sell and buy energy in real time pricing and monitoring system. Moreover the integration of Distributed generators and Renewable energy resources makes the SG more volatile and complex. The desired features of Smart Grid such as real time pricing, self healing, self monitoring, energy efficiency, security and reliability need advancement in metering and monitoring system. AMI allow bidirectional communications between the Smart Meters and information system. AMI brings benefits to both utilities and to the customers. For exchange of data from one end to another and transmitting information, communication network will play as backbone for this system.

A. Smart Grid Architecture

The initial idea of Smart Grid started with Advanced Metering Infrastructure (AMI) with aim of improving demand side management and efficiency and constructing reliable grid protection against harmful destructions and natural disasters. A Smart Grid needs advanced monitoring and analysis that can prevent contingencies and prevent local disturbances by intelligent monitoring. The National Institute of Standard and Technology (NIST) has researched and developed a framework to achieve desired operation of Smart Grid systems and devices. According to NIST [1] the benefits and requirements of Smart Grid are following: -

i. Improving power reliability and quality.
ii. Optimizing facility utilization and averting construction of back-up (peak load) power plants.
iii. Enhancing capacity and efficiency of existing electric power networks.
iv. Improving resilience to disruption.
v. Enabling predictive maintenance and self-healing responses to system disturbances.
vi. Facilitating expanded deployment of renewable energy sources.
vii. Accommodating distributed power sources.
viii. Automating maintenance and operation.
ix. Reducing greenhouse gas emissions by enabling electric vehicles and new power sources.
x. Reducing oil consumption by reducing need for inefficient generation during peak usage periods.
xi. Presenting opportunities to improve grid security.
xii. Enabling transition to plug-in electric vehicles and new energy storage options.
xiii. Increasing consumer choice.

xiv. Enabling new products, services and markets.

IEEE P030 defines Smart Grid as System of Systems as it is composed of interleaved systems. The Smart Grid is considered to be composed of three main systems i.e. Smart Infrastructure System, Smart Management System and Smart Protection System [2]. The main systems and subsystems with their main functions are represented in Fig.1.

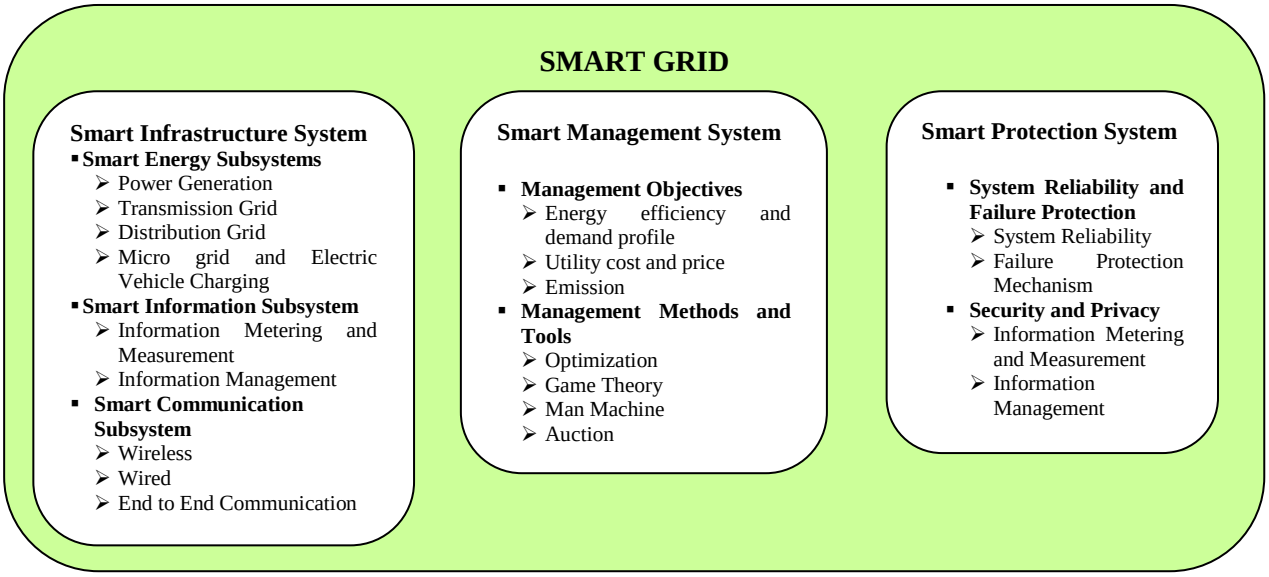

Fig.1: Smart Grid Architecture with its systems and subsystems

B. Applications of Smart Grid

The Smart Grid has to perform number of functions and applications such as:

i. Advanced Metering Infrastructure
ii. Power Network Monitoring
iii. Monitoring and Automation of substations at various levels
iv. Wide area Monitoring Measurement & coordination
v. Demand Response
vi. Communication with unified protocols
vii. Self diagnosis and Self healing
viii. SCADA (Supervisory Control and Data Acquisition) System

A Smart Grid can anticipate contingencies and prevent local disturbances by advanced and intelligent monitoring and analysis. The role of accurate measurements in Smart Grid is of utmost importance, as all the decisions related to generation and consumption of power by utility and customer, real and reactive power flows on lines, protection, stability etc. require sensors to provide the most accurate power measurements. The critical features of Smart Grid heavily depends measurement of electrical quantities in many nodes and they should meet the standards.[4]

II. IMPORTANCE OF ACCURATE MEASUREMENTS IN SMART GRID

The reliable operation of Smart Grid depends upon the accurate data collected by different measurement devices and effective design of AMI. The main measuring devices in Smart Grid are given below in Fig. 2.[4] The information exchange by Smart Meter from consumer end to utility gives information about all the activities being done at consume side and can be controlled. The Phase Measuring Units located at various levels and nodes of network measures flow of power at generation and transmission level. The Power Line Fault protection system demands accuracy in fault location and detection. The Partial Discharge Measurements give information about any insulation breakdown of cables or insulators. Availability of System depends upon strong correlation to use of suitable high performance measurement methods and instrument accuracy characteristics.

The successful implementation of Smart Grid requires the development of suitable measurement infrastructure whose optimal location will enhance observability and controllability of system. The role of accurate measurements within Smart Grid reduces uncertainty in system.[5]-[6]

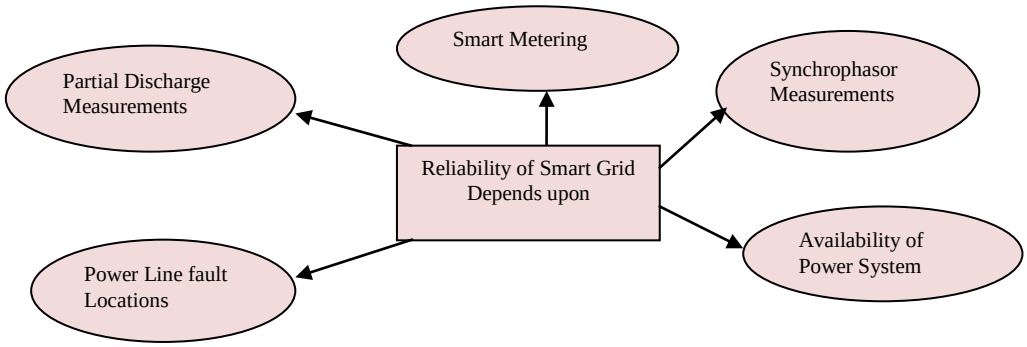

Fig.2 Block diagram showing measurement devices [4]

III. CONCLUSION

It is not that only skills and expertise strictly in power and energy is required but other fields such as instrumentation and measurements, information technology, communication, control and automation, education, and nanotechnology will be required to meet these goals. The role of meteorologist and measurement scientist is of extreme importance. The attention must be paid to optimal location of sensors and measuring instruments. The entire activity, control and functions of Smart Grid are dependent on accuracy of measurements hence attention should be given to solve new measurement challenges.

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