

Smart Grid: The Future Grid of India

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1. Abstract:- A smart grid is basically defined as an electrical grid which includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy sources and energy efficient resources. It also includes aspects like electronic power conditioning and control of the production and distribution of electricity. It deals with the application of digital processing and communications to the power grid, making data and power flow bidirectional. India being the world's sixth largest energy consumer and one of the emerging nations in the field of development, needs to shift its gears from conventional grid system to a revolutionary smart grid. Although the entire system needs to be changed but initially the three key technological components of Smart Grid must be upgraded, this includes: Distribution Automation (DA), Personal Energy Management (PEM), Advanced Metering Infrastructure (AMI). Focusing on the role of the above three key components, this paper exhibits the factors that are pulling and pushing the utilities to change the way they operate conventionally in order to improve the current services. The paper also focuses on the requirement to make the electricity grid "Smart" and revolutionizing the electric power networks. This implementation would certainly prove to be a boon to the development of the nation and its citizens.

Keywords: Smart Grid, Distribution Automation (DA), Personal Energy Management (PEM), Advanced Metering Infrastructure (AMI).

2. INTRODUCTION

The significant increase in the retail prices of electricity is experienced in India. This has resulted for the interest in Advanced Metering Infrastructure i.e. AMI by utilities which involves demand response programs through which the customers can lower their monthly electricity bills. Outage problems are especially encountered when the demand is high. The population in countries like India is large and so is the demand for electricity. These are some reasons for which utilities are now actively considering the AMI investments. The utilities have many ongoing pilot programs to consider the effectiveness of new pricing structures enabled by AMI. AMI involves many features/ways to manage the peak loads like:

1. Demand Metering: It is a billing method in which the customer is charged for the normal energy usage plus an additional charge for the peak usage.
2. Time of Use Metering: In this billing method the utility varies the price of electricity during twenty four hours a

day depending on peak demand. The other major benefits of AMI are:

- Automated Meter Reading
- Remote Customer Disconnect
- Outage Management
- Call centre Integration
- Theft Detection
- Distribution Automation

The internal factors induce the utilities to change the way they operate in order to improve current services. The factors include:

- Reliability
- System efficiency
- Safety
- Security
- Supply and demand balance

The external demand drivers for the utilities to offer new services include:

- Demand-side management
- Customer service quality
- Environmental factors
- Distributed generation
- Need for energy storage

3. ADOPTION OF SMART GRID VISION

Classically metering was all about commercial processes that included meter reading, billing and bill clearing. Utility networks were "one way" networks in terms of automation and feedback.

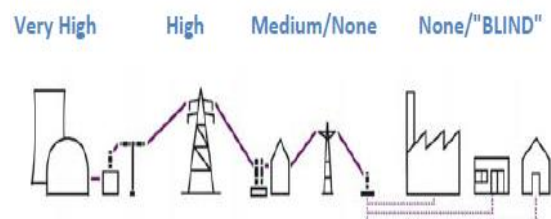


Figure 1 Automation/Real Time Feedback

We are in transition phase today. The major challenges in this field are:

- Quality, security and reliability of supply
- Cross-border power trading and grid services
- Ambitious energy policies and environmental goals
- Real time and variable pricing
- Growing expectations from consumers

As power failures are frequent in India, Nepal, China and neighbouring regions, there's been an urgent need to renovate the country's power network. Since 2005 the research projects and government policies are focusing on smart grid and next generation electric networks. The above discussed challenges can only be met if we move towards the future vision of electricity system and make our electricity network "smart". It will enable utilities to provide user specified quality, security and reliability of supply. Harmonized legal frameworks facilitating cross-border trading of power, extensive small and distributed generation close to end customers etc., all can be achieved. But all this is very far until and unless we move our approach towards smart grid.

"A smart grid is an electricity network that can intelligently integrate the actions of all users connected to it –generators, consumers and those that do both in order to efficiently deliver sustainable, economic and secure electricity supplies." Smart grid refers to next generation electric power network that makes use of IT and other high technologies so as to operate intelligently. Compared to telecom industry the power sector has not developed remarkably in terms of innovative technologies. But if we see the scenario of telecom industry, earlier say 8-10 years back the telecom industry was not developed as it is today. The mobile phones were just used as a means of wireless communication i.e. just for outgoing and incoming calls. But now the remarkable revolution has been observed in this industry from past 5-8 years wherein now this industry with the use of latest IT and other innovative technologies offer thousands of services to its end users. Now it's the turn of power sector, as, smart grid by revolutionizing the electric power networks and being almost as powerful as the Internet, is attracting attention among various industries.

Smart grid is a system that enables two-way communications between consumers and electric power companies. The must requirement for smart grid is the intelligent meter i.e. the smart meter which is installed on the consumer side. We can have "smart metering" without the "smart grid"...but the "smart grid" is built on "smart metering." The basic drivers for smart grid are:

- Energy Efficiency
- Demand-Response
- Integrated Multi-Energy resources
- Revenue Protection
- Customer Satisfaction

Smart grid is a one system for Advanced Metering Infrastructure (AMI), Distribution Automation (DA) and Personal Energy Management (PEM). It is a secure, scalable, interoperable, intelligent and proven system with the path to future enabling applications for smart grid today. In a smart grid system, consumer's information is received by the electric power company in order to provide the most efficient electric network operations. This paper focuses on explanation of smart grid with the short description on AMI and DA followed by the description on PEM which is yet to be achieved and is the major part for smart grid initiative along with the solution as to how PEM can be integrated with smart grid.

3.1 ADVANCED METERING INFRASTRUCTURE (AMI)

AMI is architecture for automated, two-way communication between a utility's smart meter with an IP address and a utility's head end systems. The goal of an AMI is to provide utility companies with real-time data about power consumption and allow customers to make informed choices about energy usage based on the price at the time of use. AMI differs from traditional Automated Meter Reading (AMR). It involves the intelligent use of demand-response system where the end customers are aware of the pricing rates of electricity when the demand is high or low and the customers can use their electric appliances accordingly.

Distribution Automation System provides tools for the distribution network's security and economical operation. It guarantees power quality, increases working efficiency and provides series of solutions for the distribution automation system. The system serves purpose of grid monitoring, control, failure management, power balance and charge management. It improves reliability with real-time monitoring and intelligent control. This system is basically head-end network management software. It provides network speed enhancements. Improving efficiency and reliability of a distribution network is a critical goal for many utilities. Two-way communications with the protection and control devices on the distribution portion of the smart grid is fundamental to achieving those energy efficiency and reliability goals. Distribution Automation (DA) devices themselves are evolving to be more robust and reliable, offer higher computing power, and act as a source of planning data. Today utilities focus on improving energy efficiency and power reliability, matching these improvements with real-time communications is a key. Understanding the status of devices like: switches and reclosures, capacitor banks, voltage regulators and transformers in real time enables much faster outage detection /notification and improves fault location and isolation. It also increases energy efficiency through better voltage control and improved asset management. It is believed that DA is the secret to make the smart grid pay for itself.

3.2 PERSONAL ENERGY MANAGEMENT (PEM)

PEM is a critical component of the smart grid. It opens the door for energy consumers to become directly involved in monitoring and controlling energy use. It provides utilities with the tools to more uniformly control peak load, and ultimately support new sources of generation and new uses of electricity. Personal energy management is the future of energy efficiency. This is one of the aspects of the smart grid that has only recently begun to emerge: using Home Area Network to engage the energy consumer more directly in the energy management process. Today's advanced metering technology provides a ready communication gateway into the residence or business that didn't exist before. A smart distribution grid requires the means to remotely, securely and automatically capture information, monitor performance, and execute commands that enable efficient and reliable power delivery. Personal

Energy Management takes this concept directly to the consumer with a variety of applications for reducing peak load, monitoring alternative generation, managing recharging of plug-in hybrid vehicles and prepayment of electric service. The Smart Grid solution for home automation utilizes the advanced digital meter with secure ZigBee communications to support a variety of personal energy management features, including:

- **Variable pricing:**-In-home display is used to notify consumers about peak pricing and time-of-use rates. In addition, consumers are able to monitor and track kWh (real energy usage) consumption over time. Alerts can warn customers of unexpected or high consumption, leading to better efficiency and reduced costs.
- **Load management:**-This two-way, verifiable load control for appliances provides reliable information and control for load reduction programs.
- **Programmable HVAC controls:** - The programmable,communicating thermostats provide another option for control of air conditioners and heating systems during peak periods.
- **Distributed generation:**
Integrated communications provide opportunities to track net generation from site-generated or stored power back to the utility's distribution system during optimal times.

In Home Area Network, each meter has a separate radio for home communication. ZigBee which is a low power wireless communication technology provides an affordable and standards based approach to home automation, which allows for robust, but simple and cost effective solutions to be developed that can provide increased convenience, efficiency and safety for the average home owner. The home automation profile supports a variety of devices for the home including lighting, heating and cooling, and even window blind control. ZigBee technology and the home automation profile provide interoperability from different vendors that allow a greater range of control and integration of different devices in the home. The ZigBee technology also supports commercial controls for lighting, HVAC, water heating and distributed generation.

4. CONCLUSION

With increase in the demand of electricity in the various areas or regions in the nation there is an urgent requirement of implementation of the principles of smart grid.

The smart grid aims at improving the involvement of client in the power delivery mechanism. The general consensus that existing electricity grids in India are not sufficient in terms of capacity, efficiency, reliability, security, and environmental impact to supply the electrical power needs of modern societies. Therefore the need of the hour for revolutionizing society of India is to adopt Smart Grid vision. This would certainly make the path of development for our country.

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