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ReviewArticle

SMART GRID: AN OVERVIEW AND ITS IMPLEMENTATION STRATEGY IN INDIA

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ABSTRACT

Electricity is the major share of total global energy requirement, which is expected to be exponentially growing. As the demand grows steadily, not only will the supply become inadequate, it's transmission and distribution will become inefficient and wasteful. The existing grid infrastructure was not basically designed for today's pace of power transfer. It has not been updated and upgraded in accordance to the pace of increases in power and itsdelivery. As the power grid network is already a complex structure, the dynamics of this structure becomes more crucial due to overloading. Power quality in today's digital era is of outmost importance than it was before two decades. A small disturbance in power quality may lead to detrimental effects in production. Similarly there is considerable security risk in the design of grid with centralized generation plants serving end users over long distances. However penetration of distributed generations [DGs] presents new operational challenge. This leads to the concept of building stronger and smarter electrical energy infrastructure that is the Smart Grid. Defining a smart grid vision for India's power sector is a worthy challenge.

INTRODUCATION

Recently the role of electric power has been consistently and steadily growing up in multi directions. It has been recognized as an essence of social as well as economic prosperity of any nation all over the world. Similarly the life standard is evaluated on the basis of per capita consumption of electricity. However, about 1.4 billion people have still not an access to electricity, and another 1.2 billion have an inadequate access. (They face as an average 4hr outage or load shedding problems) (1). The share of electrical energy of the total energy requirement is expected to increase in coming decades as well. As the pace of utility structure expansion is not as fast as that of demand side, the power delivery system becomes too overloaded. The dynamics of the system becomes more important under such conditions. Specific attributes of Security, Quality, Reliability and Availability [SQRA] are needed to meet the requirements of today's growing digitalsociety (2). Smart grid technologies offer the solution to coup with these challenges in much reasonable manner.

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Smart Grid

Many opinions will come forward if asked utility professionals to define "Smart Grid". Similarly there will be a great deal of variations in suggestions if taken; what parameters are to be included in utility system and out of the system. It is an expansive view which is defined by its potentialities and functional characteristics rather than by the use of any specific technology. In (3.4) ABB says "Smart Grid is a self-monitoring system, based on industry-wide standards, providing a stable, secure, efficient and environmentally sustainable network. It must be able to detect and react automatically to disturbances and changes in supply and demand. It must establish balance maintaining the stability demanded by both end-users and government legislation" In (5) Amin says Smart Grid is a concept and a range of functionalities: It is structured to be inherently flexible, accommodating and adapting to a variety of energy production distributed sources. It is adaptive to new technologies. Similarly permits for charging energy consumers at variable rates, based upon supply and demand in the real time. This will incentivize consumers to shift their heavy loads (such as heavy duty appliances or processes that are less time sensitive) to off-peak hours of the day.

The Smart Grid cannot be reduced to a simple formula or template but is a vision like a blueprint. In its broadest view, it is an introduction of two-way communications and ubiquitous metering and measurement. It will enable much finer control of energy flows and the integration and efficient use of renewable forms of energy, energy efficiency methodologies and technologies, as well as many other advanced technologies, techniques and processes that wouldn't have been practicable until now. It will also enable the creation of more reliable, more robust and more secure electrical infrastructure. It will help to optimize the enormous investments required to build and operate the physical infrastructure required (6). Smart Grid has been defined in a fairly broader sense by different organizations as:

IEEE defines "Smart Grid as a vision for a digital upgrade of distribution and transmission grids both to optimize current operations and to open up new markets for alternative energy production"

Wikipedia presents "A Smart Grid delivers electricity from supplies to consumers using digital technology to save energy, reduce cost, and increase reliability"

GE states "The Smart Grid is in essence the marriage of information technology and process-automation technology with our existing electrical networks"

The Grid Wise Alliance defined Smart Grid as "a dynamic, simultaneous two-way communication system involving the entire grid that allows for greater choice by every user or stakeholder on the grid."

In short Smart Grid has many definitions but only one vision.

Features of Smart Grid

The functions and features of Smart Grid include: (7)

- Increased use of digital information and controls technology to improve security, quality, reliability [SQR] and overall efficiency of the electric grid.
- Dynamic optimization of grid operations and resources, with full cyber-security.
- Deployment and integration of distributed energy resources [DERs] including renewable resources, particularly wind and solar.
- Development and incorporation of demand response, demand side resources, and energy efficiency resources.
- Deployment of "smart" technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation.
- Integration of "smart" equipment and consumer devices.
- Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and DGs.
- Provision to consumers of timely information and control options.
- Development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.
- Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.

Drivers of Smart Grid in India (6)

Following parameters decide the adoption of Smart Grid in India:

Supply shortfalls: Peak Demand continues to outpace India's power supply. The industrialization and increasing propagation of house hold electricity consuming appliances are adding to power grid on transmission as well as distribution side. Official estimates of India's demand shortfall are 12% for total energy and 16% for peak demand. The total consumption is 3.4% of the total global requirement. Managing growth in power requirement and ensuring supply is a major driver for all programs of the Indian power sector.

Loss reduction: The gross technical and commercial losses in India are about 25 to 30 percent, and they may even be more than this estimate due to lack of transparencies and improper metering. Smart Grid will not only reduce the losses, it will make the substantial contribution as well as compensation.

Peak Load Management: The gap between demand and supply is huge, which indicates that the shortfall in peak load demand may persist for a long. This can be compensated through direct control or through two way communication strategy of Smart Grid.

Huge RES Potential: In order to have long term energy availability environment friendly Renewable Energy Sources (RES) should be accessible, and they can be technically penetrated in Smart Grid architecture India's supply shortfalls are expected to persist for many years. Government of India has supported the implementation of renewable energy. The main support was to wind power but Government aimed at achieving 20,000 MW of solar power by 2020. This is a driving factor towards smart grid. Similarly in south and west part of India huge wind potential is present which can be harnessed and penetrated in Smart Grid to enhance the SQRA factor.

Technological leapfrogging: Perhaps the most interesting driver for India is the potential to "leapfrog" means to advance into a new future for electricity, as it did with telecommunication.

Reduction in Greenhouse gases: Integrating more renewable energy sources, clean energy dream would be interpreted. Millions of metric ton greenhouse gas emission will be reduced due to penetrating distributed generations DGs into Smart Grid. India's commitment to a low-carbon economy can be enhanced through the modernization of grid structure.

Barriers to Smart Grid Implementation in India

The problems that India's Power Sector is facing are many and varied, and these problems are well known to policy makers, industry experts and general public as well. The average Transmission and Distribution losses are approximately 30%

of the total energy generated. This is the highest record among developing countries all over the world. This rate is variable in different states of India. In some states it is up to 60% of the generation. Similarly nontechnical losses such as theft, if considered the average loss may project to 50%. When non-technical losses such as energy theft are included in the total, average losses are as high as 50% (8). Lack of awareness is also a common factor in many areas of country especially in rural area. Consumer's level of understanding about how power is delivered to their homes is often low. The infrastructure is not an efficient to fulfil the requirements of smart grid. The most visible difference in today's and tomorrow's grid is the distribution network. In Smart Grid consumer's participation will be an active one through two way communication culture of Smart Grid. It will require privacy in maintaining consumer's record similarly their security. It requires high profile IT structure, which can fully automate the system. Capital investments for this regard will also be significant (10).

Initiatives Taken by Govt. of India

Despite of all these setbacks, power industry in India has some positive movements such as, Indian Smart Grid Task Force (iSGTF) a) to propagate the awareness about smart grid and to co-ordinate the stakeholders b) to research in allied technologies c) to work on standards and interoperability. The task group formed sub groups to monitor different activities like trials on recent technologies, collection of theft data, loss data and its analysis, analysis of reliability and quality of power, integration of distributed generations, cyber as well as physical attacks, analysis of standards etc. Indian Smart Grid Forum (iSGF) for implementing the technology and different policies. Bangalore Electricity Supply Company (BESCOM) is one of the India's leading DISCOM, which has been considered as the pioneer in distribution automation (9). North Delhi Power Limited (NDPL) in collaboration with Tata Power Limited experienced approximately 500 smart meters in civil lines and Shalimar bagh of New Delhi. These meters have the facility of showing peak load hours, thereby the consumer as well as utility can manage better schedule. The most important characteristic of these meters is that the metering function is under the control of utility nd the display is at consumer premises. This property controls the theft of power means the non-technical losses (11). MSEDCL in Maharashtra, MGVDCL in Gujarat, and APCPDCL in Andhraetc. are the initiatives in Smart Grid direction (9).

The steps for implementing Smart Grid in India include:

- A governing body (multi-disciplinary) consisting of various stakeholder representatives should be nominated by Govt of India for the exploration and implementation of Smart Grid in developed countries.
- A central Power Research Institute (CPRI) should be established which may coordinate various regional centres and agencies in this regard.
- The research and technical organizations like IITs, NITs, should be incorporated in this mission.
- Confirm target loss reduction curve for T & D losses DISCOM.
- Energy Conservation awareness among end users through the use of energy efficient devices and mechanisms should be propagated.
- CPRI may form subcommittee to implement the tasks. Regulatory committee will facilitate in cooperation in SG policy, SG standards, regulations and finance. The committee for Electric Vehicle (EV) will help to promote the fuel efficient electric vehicles.

Conclusion

Today's power grid is not as smart as to sustain the challenges of digital society. Many up gradations are needed in the mechanics of its structure to coup with the dynamics of today's power system. This condition may not persist as it is today, but it is expected to be more critical on tomorrow. That's why the enforcement of smart grid is profoundly needed in India, which is a worthy challenge. Considering the present power scenario, social, economical, and political circumstances, it can be concluded that the implementation of Smart Grid in India is not so easy and it can't be completed within a few years. Step by step execution with proper planning is required. It should be the integral part of national policy. The existing grid itself should be up graded at different levels in a gradual fashion. Different assets, Renewable Energy Sources, and technologies should be optimized prudently. Each activity of the Smart Grid Form should be well co-ordinated and monitored at different levels.

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