Advanced Research in Electrical and Electronic Engineering
Print ISSN: 2349-5804; Online ISSN: 2349-5812 Volume 2, Number 4 January-March (2015) pp. 368-371

http://www.krishisanskriti.org/areee.html

Smart Grid–Opportunities and Challenges

Jyotsna Singh[1] and Isha Bansal[2]

[1],2Department Of Electrical Engineering Vivekananda Institute Of Technology (East) Sector 36, NRI Road, Jagatpura, Jaipur
E-mail: [1]singh.jyotsna@vitej.ac.in, [2]bansal.isha@vitej.ac.in

Abstract— *Increasing complexity of power grids, growing demand, and requirement for greater grid reliability, security and efficiency as well as environmental and energy sustainability concerns continue to highlight the need for a quantum leap in harnessing communication and information technologies. This leap toward a "smarter" grid is now widely referred to as "smart grid". The paper provides a brief historical perspective of the decision-making that underlies existing, seemingly inflexible, grid structures. It emphasizes future needs for responsive grids, as a consequence of inevitable growth in renewable generation and newer types of loads such as plug-in electric vehicles. The paper considers the cyber-infrastructure requirements for supporting controllability of highly distributed generation and load resources.*

Keywords*: Power systems, Electricity grid, Cyber-physical systems, power system security, power system reliability, self-healing grid, IT infrastructure, architecture, distributed intelligence*

1. INTRODUCTION

The utility industry has been utilizing advances in communication and information technology over the years in order to improve efficiency, reliability, security and quality of service. Increasing complexity in managing the bulk power grid, growing concerns for environment, energy sustainability and independence, aging asset base, demand growth and quest for service quality continue to accentuate the need for a quantum leap in application of such technologies. The momentum for the "Smart Grid" vision has increased recently due to policy and regulatory initiatives [2]. These efforts can be categorized into the following trends:

- Reliability
- Renewable Resources
- Demand response
- Electric storage
- Electric transportation

Among these trends, system reliability has always been a major focus area for the design and operation of modern grids. The other trends involve distinct smart grid resource types with diverse impacts on reliability [3]. Renewable resources, while supplementing the generation capability of the grid and addressing some environmental concerns, aggravate the reliability due to their volatility. Demand response and electric storage resources are necessary for addressing economics of the grid and are perceived to support grid reliability through mitigating peak demand and load variability. Electric transportation resources are deemed helpful to meeting environmental targets and can be used to mitigate load variability.

2. CONCEPT OF SMART GRID

Since 1990's, with the increasing use of distributed generation power, more demands and requirements have been proposed for power grid intensity.

Consensus has been reached by experts and scholars from different countries that future power grid must be able to meet various requirements of energy generating and the demands of highly market-oriented power transaction so that the needs of the self-selection from customers can be satisfied individually. All of these will become the future development direction of Smart Grid.

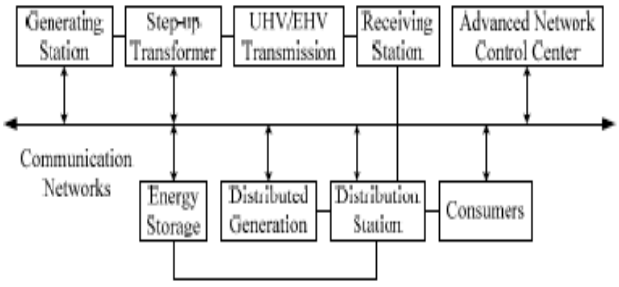

Fig. 1: Smart Grid Conceptual Diagram

In 2006, US IBM presented a "Smart Grid" solution [1]. This is a relatively complete concept for current Smart Grid which indicates its official birth. In comparison with traditional grid, Smart Grid includes integrated communication systems, advanced Sensing, metering, measurement infrastructure, complete decision support and human interfaces.

Such as the emergence of superconducting cables, it assures Obama's new government of United States has seen the daylights of the Smart Grid.Maintaining the Integrity of the Specifications. Europeans have more concerns about the

construction of renewable energy access, the impact on wildlife, as well as the actively research on real-time monitoring and remote controlling.

All is about to realize the "Plug & Play use" idea, ensuring a more friendly, flexible access and interaction with the user. In both Europe and United States [6], the most common direction for grid development is to seek new and renewable sources for energy generation.

3. SMART GRID IMPLEMENTATION CHALLENGES IN INDIA

The implementation of Smart Grid is not going to be an easy task as the Indian power sector poses a number of issues such as minimizing Transmission & Distribution losses [5], power theft, inadequate grid infrastructure, low metering efficiency and lack of awareness.

A. Power theft

Power theft has been one of the major issues in India. A few ways to help prevent the power theft are the use of overhead lines that are insulated and the Low Tension overhead wires used for distribution of power could be replaced with insulated cables in order to minimize the theft of energy through hooking. The conventional energy meters could be replaced with digital tamper proof meters and the use of prepaid card is yet another solution to eradicate theft of energy.

B. Inadequate Grid Infrastructure

For India to continue along its path of aggressive economic growth, it needs to build a modern, intelligent grid. It is only with a reliable, financially secure Smart Grid that India can provide a stable environment for investments in electric infrastructure - a prerequisite to fixing the fundamental problems with the grid.

C. Low Metering Efficiency

The commercial losses are mainly due to low metering efficiency, theft & pilferage. This may be eliminated by improving metering efficiency, proper energy accounting & auditing and improved billing & collection efficiency. Fixing of accountability of the personnel / feeder managers may help considerably in reduction of Aggregated Technical & Commercial loss.

D. Lack of Awareness

Consumers should be made aware about their energy consumption pattern at home, office etc. Utilities need to focus on the overall capabilities of Smart Grids rather than mere implementation of smart meters. Policy makers and regulators must be very clear about the future prospects of Smart Grids.

E. Financing Challenge

With timely and detailed information provided by Smart Grids, customers would be encouraged to avoid over use, adopt energy-efficient [4] building standards and invest continually in energy efficient appliances. The policy makers and regulators have to implement a robust incentive model frame work to attract more and more private investments keeping the rate of return, based on the output generated.

4. ROLE OF IEEE STANDARDS ASSOCIATION (IEEE-SA)

Through India Smart Grid Task Force, an initiative of Ministry of Power, India, IEEE-SA have been able to create an initial momentum in this area.

- The IEEE Standards Association (IEEE-SA), a globally recognized standards setting body within IEEE, today announced that it has become an associate member of the India Smart Grid Forum (ISGF) promoted by Ministry of Power, Govt. of India.
- The India Smart Grid Task Force is an inter ministerial group and serves as a government focal point for activities related to Smart Grid.
- IEEE-SA has been continually investing over the past two years in creating wider awareness of Smart Grid as a concept and also in bringing multiple stakeholders together to transfer best practices and knowledge from other Smart Grid markets worldwide.

5. MASSIVE POWER BLACKOUTS ANSWERS WHY SMART GRID IS THE NECESSITY FOR INDIA

NewYork Times reported

"This massive electric grid failure was an embarrassing reminder how intractable problems are still plauging India: Inadequate infrastructure, crippling power shortage, and according too many critics and yawning absence of governmental action and leadership."

Fig. 2: Areas affected by blackouts

Mr. Sam Pitroda, the chairman of India Smart Grid Task Force (ISGTF) said

"While it may be difficult to guarantee perfect power availability, in the current context, we can at least replace blackouts with brown-outs by providing a basic threshold of power to all households, with which to run at least a few key appliances." as reported by GovernanceNow.com.

6. SOME MAJOR STEPS TOWARDS SMART GRID IN INDIA

Microgrid In India And South Africa

Echelon, which is one of the leading Smart Grid technology company, has deployed two microgirds [7] one in India and another in South Africa. According to Echelon press release, "The model micro grid deployments are at Palm Meadows in Hyderabad, India and Clearwater Mall in Johannesburg, South Africa

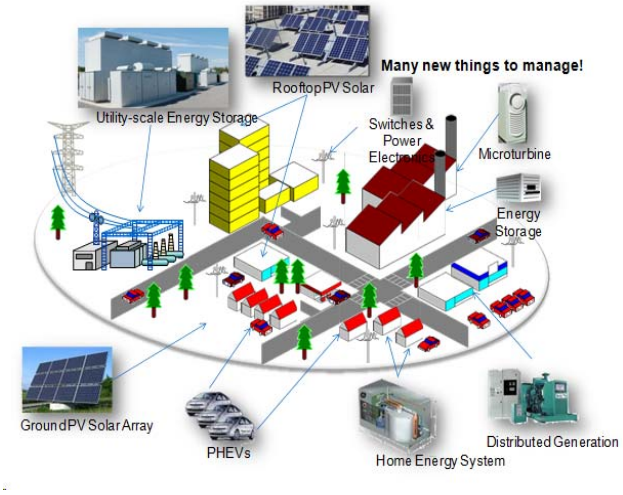

Fig. 3: Micro Grid Conceptual Diagram

Palm Meadows, India

The Palm Meadows community ties into the grid at a dedicated substation and sources energy in bulk from the utility. The community also runs diesel generators and will incorporate solar generation in the future. Residences within the community are equipped with Echelon smart meters that connect into data concentrators at distribution transformers and feed near real-time usage information to Echelon's Networked Energy Systems (NES) system software. Smart Grid Automation Firm ZIV Groups Acquired By Crompton Greaves

Crompton Greaves (CG), The Mumbai based company is India largest and world's 10th largest transmission and distribution equipment Maker Company. Since 2005, it has acquired 10 companies to expand its business and market and now operates in 21 countries.

- Crompton Greaves (CG) [1], the flagship company of Avantha Group, which is into business of power equipments and consumer durables, has acquired Spanish smart grid automation company ZIV Groups for $185 million (Rs. 1015 Crore).
- The Smart Grid market is set to reach €90 billion by 2020, which represent important market opportunity for emerging company like Compton Greaves which has global ambition to become leader in its segment.

"Green Energy Corridors" report

Powergrid evolved a comprehensive plan for integration of renewable capacity addition envisaged in the 12th plan as part of "Green Energy Corridors" report.

- About 43GW capacity is envisaged mainly through wind & solar in 12th plan in the eight (8) renewable rich states viz. Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Gujarat, Rajasthan, Himachal Pradesh and Jammu & Kashmir.

Report On Desert Power India 2050

Realizing need for large scale development of alternate energy sources like solar & wind, POWERGRID prepared study report on development of desert power utilizing waste land in India's desert regions of the states of Rajasthan (The Thar), Gujarat (Rann of Kutch), Himachal Pradesh (Lahul & Spiti valley) and Jammu & Kashmir (Ladakh), for up to 2050 time horizon.

7. CONCLUSION

Smart grid concepts are inextricably linked with enhancing the sensing, actuation and control structures within power systems. The primary benefit of developing such an extensive cyber-physical infrastructure is to significantly enhance the controllability and responsiveness of highly distributed resources within electrical power systems. It is of concern that advanced metering infrastructure (AMI) is currently being rolled out, with little regard for this ultimate use. Control structures that underpin grid responsiveness must be compatible with the legacy system, yet capable of fully utilizing highly distributed generation and load resources. Furthermore, load control must balance systems needs with end-user expectations. These various requirements can be achieved through the use hierarchical control structures. The future of smart grids will thus depend on the level of security that applications, devices and networking components incorporate rather than their efficiency, reliability or cost.

REFERENCES

[1] David G. Hart, " Using AMI to Realize the Smart Grid," in Proc. 2008 IEEE Power and Energy Society General Meeting - Conversion and Delivery of Electrical Energy in the 21st Century, pp. 1-2.
[2] S. Massoud Amin and B.F. Wollenberg, "Toward a Smart Grid: power delivery for the 21st century," IEEE Power and Energy Magazine, Vol. 3, No. 5 Sept.-Oct. 2005, pp. 34-41.
[3] D. Divan and H. Johal, "A Smarter Grid for Improving System Reliability and Asset Utilization," Power Electronics and Motion Control Conference, August, 2006.
[4] Massoud Amin S.; Wollenberg Bruce F., "Toward a Smart Grid," Power and Energy Magazine, IEEE, pp. 34-41, sep-oct, 2005.
[5] Richard E. Brown, " Impact of Smart Grid on distribution systemdesign," in Proc. 2008 IEEE Power and Energy Society General Meeting- Conversion and Delivery of Electrical Energy in the 21st Century, pp.1-4.
[6] European Commission, Directorate-General for Research, "Draft Strategic Deployment Document for Europe's Electricity Networks of the future", 2008
[7] Junqing Shuai, ג Aiming at the forefront and Establishing Smart Grid,ד State Grid, issue 2, pp.54-57, 2008.