Issues in Implementing Smart Grid in Power Systems

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Abstract- In this paper an attempt has been made to analyze the key challenges in implementing the Smart Grid concept in India. In most of the advanced countries Utilities have made major achievements in terms of productivity, reliability, and efficiency through the use of Smart Grid technology. Indian utilities are still lagging far behind when compared to other countries. Today their main focus is on providing energy at reasonable price but soon the day will come when the utilities will be focusing on encompassing sustainable use and environmental improvement into their agendas.

Keywords: - concept, India, Smart, Grid, energy, key

I. INTRODUCTION

The Smart Grid is aide of a better electricity delivery infrastructure. Smart Grid implementations will certainly increase the quantity, quality, and use of information available from advanced sensing, computing, and communications hardware and software. As a result, they help utilities address two of the main issues in today's world:

- Environmental concerns.
- Power delivery limitations and disturbances.

Effective use of Smart Grid technologies helps utilities in:

- Improved grid usage.
- Improves grid efficiency and security.
- Better match of demand with supply of energy and grid congestion.
- Enable distributed generation.
- Allow customers to manage their consumption level and to take benefit of pricing and supply options.
- Cater the environmental issues.

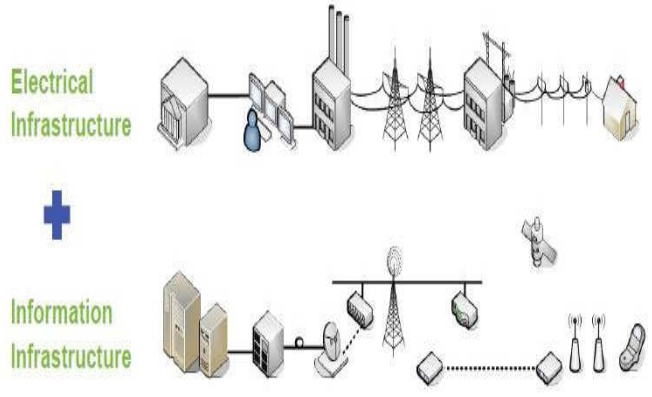

Figure 1: Smart Grid

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II. Goals and Objectives of Smart Grid

Efficient and reliable transmission and distribution of electricity is a fundamental requirement for providing societies and economies with essential energy resources. The utilities in the industrialized countries are today in a period of change and agitation. On one hand, large parts of the power grid infrastructure are reaching their designed end of life time, since a large portion of the equipment was installed in the 1960s. On the other hand, there is a strong political and regulatory push for more competition and lower energy prices, more energy efficiency and an increased use of renewable energy like solar, wind, biomasses and water.

In industrialized countries, the load demand has decreased or remained constant in the previous decade, whereas developing countries have shown a rapidly increasing load demand. Aging equipment, dispersed generation as well as load increase might lead to highly utilized equipment during peak load conditions. If the upgrade of the power grid should be reduced to a minimum, new ways of operating power systems need to be found and established.

In many countries, regulators and liberalization are forcing utilities to reduce costs for the transmission and distribution of electrical energy. Therefore, new methods (mainly based on the efforts of modern information and communication techniques) to operate power systems are required to guarantee a sustainable, secure and competitive energy supply.

The general goals of Smart Grid are to ensure a transparent, sustainable and environmental-friendly system operation that is **cost and energy efficient, secure and safe**. Objectives of developing the Smart Grid are quite different from country to country for their various demands and start points. However, the common objectives of a Smart Grid are clear and listed below:

- ***Robustness*:** The Smart Grid shall improve resilience to disruption to provide continuous and stable electricity flows, avoiding wide-area breakout accidents. It shall guarantee the normal and secure run of the electricity grid even under the instance of emergency issues, such as natural disasters, extreme weather and man-made breakage, and provides self-healing abilities;
- ***Secured operation*:** The Smart Grid shall enhance communication networks and information security of the electricity grid;
- ***Compatibility*:** The Smart Grid shall support the integration of renewable electricity such as solar and wind, has the capacity of distributed generation access and micro-grids, improve demand response functions, implement the effective two-way communication with

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consumers and satisfy various electricity demands of consumers;

- ***Economical energy usage*:** The Smart Grid shall have the capacity of more effective electricity markets and electricity trades, implement optimized configuration of resources, increase efficiency of the electricity grid, and reduce electricity grid wastage;
- ***Integrated system*:** The Smart Grid shall highly integrate and share information and data of an electricity grid, utilize the uniform platform and model to provide standardized and refined management;
- ***Optimization*:** The Smart Grid shall optimize assets, reduce costs and operate efficiently;
- *Green energy*: The Smart Grid shall solve problems of energy security, energy saving, carbon dioxide emission and etc.

III. Characteristics of Smart Grid

Smart Grid has the following fundamental characteristics:

- Use of information, computing, networking technologies to support the envisioned Smart Grid services: energy distribution management, energy trading, grid monitoring and management, distributed renewable energy integration, electric vehicles charging, distributed energy storage, and smart metering infrastructure;
- The Smart Grid services involve many parties across many domains, in particular active participation of customers is essential;
- Smart Grid requires new capabilities in each functional plane to achieve its goal of energy efficiency, reliability, and automation, such as new algorithms in the Services/Applications plane, security and QoS-awared two-way communications in the Communication plane, two-way transmission capability, storage techniques, and new intelligent sensors/controllers in the Energy plane;
- In order to support these services, the ICT systems must
    - provide wide range of applications such as home, building, and factory energy management systems, on demand meter readings, demand and response systems, electrical grid status monitoring, fault detection, isolation, and recovery;
    - manage wide variety of devices such as intelligent sensors, smart meters, smart appliances, and electric vehicles;
- The network infrastructure must provide reliable two-way communication and support various class of QoS, such as real-time and non-real-time, and different bandwidths and latency, loss, and security requirements;
- To ensure the interoperability of applications and devices, interoperable standards are required for communications, information representations and exchanges;
- Security of services, applications, devices in all domains, including the networks are of paramount importance to the stability and integrity of the Smart Grid.

IV. Issues in Smart Grid

Smart Grid Technology should consider building greater efficiency into the energy system which would result in reduction of losses, peak load demand and thereby decreasing generation as well as consumption of energy. New regulatory framework which incentivizes utilities for reducing the technical losses would help utilities to perform more efficiently. The Various Issues in Implementing Smart Grid in Power Systems are as follows:

IV.1 Policy and regulation

The current policy and regulatory frameworks were typically designed to deal with the existing networks and utilities. To some extent the existing model has encouraged competition in generation and supply of power but is unable to promote clean energy supplies. With the move towards smart grids, the prevailing policy and regulatory frameworks must evolve in order to encourage incentives for investment. The new frameworks will need to match the interests of the consumers with the utilities and suppliers to ensure that the societal goals are achieved at the lowest cost to the consumers.

Generally, governments set policy whereas regulators monitor the implementation in order to protect the consumers and seeks to avoid market exploitation. Over the last two decades, the trend of liberalized market structure in various parts of the world has focused the attention of policy-makers on empowering competition and consumer choice. The regulatory models have evolved to become more and more effective to avoid market abuse and to regulate the rates of return.

Moving forward, the regulatory model will have to adopt the policy which focuses much on long term carbon reduction and security of supply in the defined outcomes and they need to rebalance the regulatory incentives to encourage privately financed utilities to invest at rates of return that are commensurate to the risk. This may mean creating frameworks that allow risk to be shared between customers and shareholders, so that risks and rewards are balanced providing least aggregate cost to the customer.

IV.2 Business Scenario

The majority of examples results in negative business cases, undermined by two fundamental challenges:

- **High capital and operating costs** – Capital and operating costs include large fixed costs linked to the chronic communications network. Hardware costs do not cause in significant growths in economies of scale and software integration possess a significant delivery and integration risks.
- **Benefits are constrained by the regulatory framework** – When calculating the benefits, organizations tend to be conservative in what they can gather as cash benefits to the shareholders. For example, in many cases, line losses are considered to be put on to the customer and as a result any drop in losses would have no net impact on the utility shareholder. The smart grid benefits case may begin on a positive note but, as misaligned policy and regulatory incentives are factored in, the investment becomes less attractive. Therefore regulators are required to place such policies

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and regulations in place which could provide benefits both to the utilities and the consumers. Therefore the first factor to be considered is to provide incentives to the utilities in order to remove inefficiencies from the system. They should be aptly remunerated for the line losses on their networks.

On the budget side of the calculation, there is no avoiding the fact that smart technologies are expensive to implement, and at the present level it is right to factor inthe risk associated with delivery. But the policy makers and regulators can mitigate that risk by seeking economies of scale and implementing advanced digital technologies.

IV.3 Technology maturity and delivery risk

Technology is one of the essential constituents of Smart Grid which include a broad range of hardware, software, and communication technologies. In some cases, the technology is well developed; however, in many areas the technologies are still at a very initial stage of development and are yet to be developed to a significant level. As the technologies advances, it will reduce the delivery risk; but till then risk factor have to be included in the business situation.

On the hardware side, speedy evolution of technology is seen from vendors all over the world. Many recently evolved companies have become more skeptical to the communications solutions and have focused on operating within a suite of hardware and software solutions. Moreover the policy makers, regulators, and utilities look upon well-established hardware providers for Smart Grid implementation. And this trend is expected to continue with increasing competition from Asian manufacturers and, as a consequence, standards will naturally form and equipment costs will drop as economies of scale arises and competition increases.

IV.4 Lack of awareness

Consumer's level of understanding about how power is delivered to their homes is often low. So before going forward and implementing Smart Grid concepts, they should be made aware about what Smart Grids are? How Smart Grids can contribute to low carbon economy? What benefits they can drive from Smart Grids? Therefore:

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

IV.5 Access to affordable capital

Funds are one of the major roadblocks in implementation of Smart Grid. Policy makers and regulators have to make more conducive rules and regulations in order to attract more and more private players. Furthermore the risk associated with Smart Grid is more; but in long run it is expected that risk-return profile will be closer to the current situation as new policy framework will be in place and risk will be optimally shared across the value chain.

In addition to this, the hardware manufacturers are expected to invest more and more on mass production and R&D activities so that technology obsolescence risk can be minimized and access to the capital required for this transition is at reasonable cost.

IV.6 Skills and knowledge

As the utilities will move towards Smart Grid, there will be a demand for a new skill sets to bridge the gap and to have to develop new skills in analytics, data management and decision support. To address this issue, a cadre of engineers and managers will need to be trained to manage the transition. This transition will require investment of both time and money from both government and private players to support education programs that will help in building managers and engineers for tomorrow. To bring such a change utilities have to think hard about how they can manage the transition in order to avoid over burdening of staff with change.

IV.7 Cyber security and data privacy

With the transition from analogous to digital electricity infrastructure comes the challenge of communication security and data management; as digital networks are more prone to malicious attacks from software hackers, security becomes the key issue to be addressed. In addition to this; concerns on invasion of privacy and security of personal consumption data arises. The data collected from the consumption information could provide a significant insight of consumer's behavior and preferences. This valuable information could be abused if correct protocols and security measures are not adhered to. If above two issues are not addressed in a transparent manner, it may create a negative impact on customer's perception and will prove to be a barrier for adoption.

V. Conclusion

Smart Grids will play a vital role to help utilities in accomplishing this mission. So, the utilities will need to invest heavily in new hardware, software, business process development, and staff training. Further there would be high investment in home area networks and smart appliances by the customers. Achieving the broader view of Smart Grid will require complex task prioritization and right set of policies and regulations to be in place.

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