EMERGING TECHNOLOGY- SMART GRID

Swati Sharma (Research Scholar), Dr. S.S. Mehta,
Devendra Nagal (Research Scholar), M.K. Bhaskar
Department of Electrical Engineering ,
Jai Narain Vyas University
MBM Engineering College,
Jodhpur-342001 , Rajasthan, India
er.swati.sharma15@gmail.com , ssmehta_58@rediffmail.com,
devendra.nagal@gmail.com, mkb31@rediffmail.com

Guneet Singh Mehta
Indian Institute of Technology
Jodhpur-342001 , Rajasthan, India
mehta_guneet@iitj.ac.in
Harleen Mehta
Christ University,
Bangalore , India
mehta.harleen@gmail.com

***Abstract*— Smart grids are a key suite of technologies to deal with pressing current and future needs in the electricity sector and to enable the effective adoption of low - carbon energy technologies such as variable renewable energies and electric vehicles. The Smart Grid is a vision of a better electricity delivery infrastructure. Smart Grid implementations dramatically increase the quantity, quality, and use of data available from advanced sensing, computing, and communications hardware and software. As a result, they help utilities address two of today's most important business drivers: environmental concerns and power delivery constraints and disturbances.**

Keywords- smart grid,

I. INTRODUCTION

The Smart Grid is a vision of a better electricity delivery infrastructure. Smart Grid implementations dramatically increase the quantity, quality, and use of data available from advanced sensing, computing, and communications hardware and software. As a result, they help utilities address two of todays most important business drivers: environmental concerns and power delivery constraints and disturbances. The Smart Grid is a vision of a better electricity delivery infrastructure. Smart Grid implementations dramatically increase the quantity, quality, and use of data available from advanced sensing, computing, and communications hardware and software. As a result, they help utilities address two of todays most important business drivers: environmental concerns and power delivery constraints and disturbances.

The Smart Grid is a vision of a better electricity delivery infrastructure. Smart Grid implementations dramatically increase the quantity, quality, and use of data available from advanced sensing, computing, and communications hardware and software. As a result, they help utilities address two of today's most important business drivers: environmental concerns and power delivery constraints and disturbances.

The research community has a critical role to play: without research there is no innovation and without innovation there is no development. Cooperation among universities and research centers, utilities, manufacturers, regulators and legislators must be fostered, not only for the successful development of new technologies but also to overcome non-technical barriers.

Significant technology and business changes lie ahead and equipment manufacturers will be key players in developing innovative solutions and in achieving their effective deployment by working with the grid companies. As with grid companies, technology providers will have important investment decisions to make. A shared vision will be critical to ensuring sound strategic developments that provide open access, long-term value and integration with existing infrastructure. Innovation will be needed in relation to networks, demand, and for generation, both distributed and centralized, as grid system operational characteristics change.

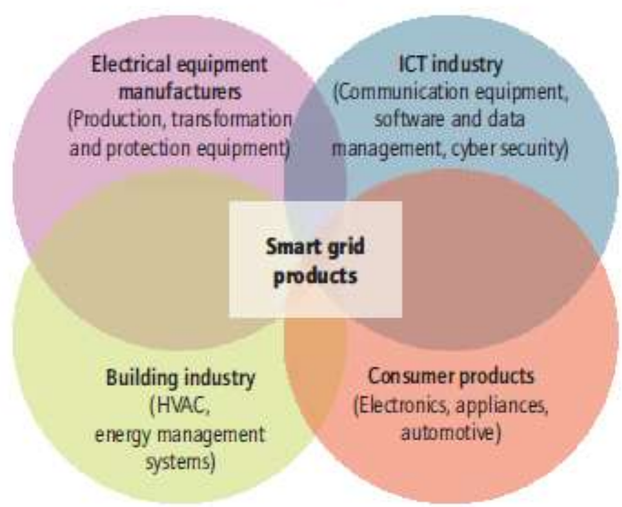

Fig.1. Smart grid product providers

New businesses will be provided with the choice between own (on-site) generation, including sales of surplus to the grid, and the purchase of electricity from supplier companies. They will have the opportunity to offer demand side response products and services to the grid. In the case of electricity-intensive industries, their decisions will be influenced by market price changes. Thus businesses will be seeking a wider range of solutions than is currently available. Co-ordination between actors is essential in maintaining a secure supply, an efficient network operation and a transparent market. Common technical rules and tools need to be adopted by the different players regarding data exchange, modelling grids, ancillary services and their users. They must also share a vision of electrical system performance.

Throughout the world efforts to shift to a low-carbon society are beginning in hopes of reducing output of greenhouse gases. Electric power is a particularly important area where work is actively underway to switch to renewable forms of energy, such as solar or wind that do not consume fossil fuels when generating electricity. However, the amount of power that can be produced by renewable energy sources is affected substantially by weather conditions, so there is concern that the stability of the electrical grid could be jeopardized as the scale of their use expands. In addition, demand for power is expected to increase rapidly, due in part to the future adoption of plug-in hybrid vehicles and electric vehicles. This raises the possibility that the power system as a whole may be unable to cope with future demand. Against this background, the "smart grid" concept has emerged as a way to maintain the stability of the power grid while enabling effective utilization of power.

II. CHARACTERISTICS OF SMART GRIDS

1. Enables informed participation by customers :

Consumers help balance supply and demand and ensure reliability by modifying the way they use and purchase electricity. These modifications come as a result of consumers having choices that motivate different purchasing patterns and behaviour. These choices involve new technologies, new information about their electricity use and new forms of electricity pricing and incentives.

2. Accommodates all generation and storage options:

A smart grid accommodates not only large, centralised power plants, but also the growing array of customer-sited distributed energy resources. Integration of these resources – including renewables, small-scale combined heat and power, and energy storage – will increase rapidly all along the value chain, from suppliers to marketers to customers.

3. Enables new products, services and markets:

Correctly designed and operated markets efficiently create an opportunity for consumers to choose among competing services. Some of the independent grid variables that must be explicitly managed are energy, capacity, location, time, rate of change and quality. Markets can play a major role in the management of these variables. Regulators, owners/operators and consumers need the flexibility to modify the rules of business to suit operating and market conditions.

4. **Provides the power quality for the range of needs:**

Not all commercial enterprises, and certainly not all residential customers, need the same quality of power. A smart grid supplies varying grades (and prices) of power. The cost of premium power-quality features can be included in the electrical service contract. Advanced control methods monitor essential components, enabling rapid diagnosis and solutions to events that impact power quality, such as lightning, switching surges, line faults and harmonic sources.

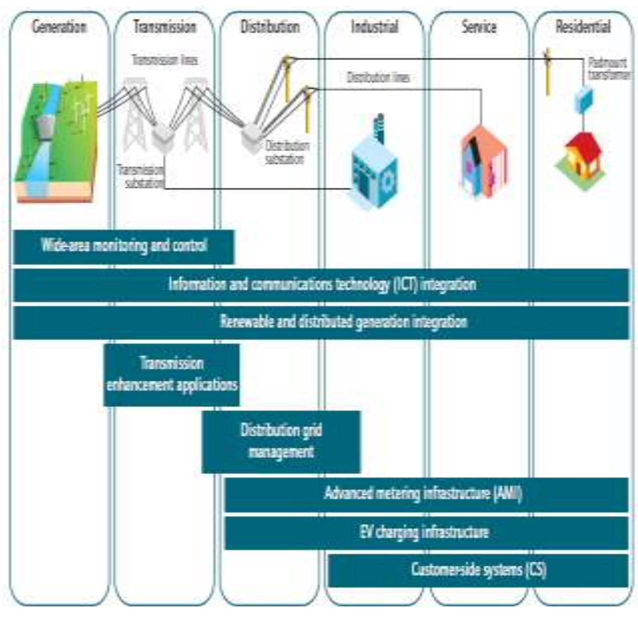

Fig. 2 Smart grid technology areas

5. Optimises asset utilisation and operating efficiency:

A smart grid applies the latest technologies to optimise the use of its assets. For example, optimised capacity can be attainable with dynamic ratings, which allow assets to be used at greater loads by continuously sensing and rating their capacities. Maintenance efficiency can be optimised with condition-based maintenance, which signals the need for equipment maintenance at precisely the right time. System-control devices can be adjusted to reduce losses and eliminate congestion. Operating efficiency increases when selecting the least-cost energy-delivery system available through these types of system-control devices.

6. ***Provides resiliency to disturbances, attacks and natural disasters:***

Resiliency refers to the ability of a system to react to unexpected events by isolating problematic elements while the rest of the system is restored to normal operation. These self-healing actions result in reduced interruption of service to consumers and help service providers better manage the delivery infrastructure.

III. BUILDING BLOCKS OF SMART GRID

The building blocks needed to implement the various capabilities. Implementation of a smart grid will require investments and changes in tangible infrastructure complemented by investments and changes in soft infrastructure. A detailed understanding of the benefits and challenges for both of these categories is required when assessing the business case for the various capabilities of the Smart grid.

A) Hard Infrastructure

Key investments and changes in tangible infrastructure to deliver smart grid capabilities are the following:

i) Smart meters /advanced metering infrastructure (AMI)

Smart meters and the information backhaul systems required to support them are probably the best known, and also likely the most expensive, building block supporting a smart grid. Fully enabled smart meters can communicate in real-time between users and energy suppliers about energy use and prices, coordinate household consumption based on these signals and customer preferences and facilitate measurement and customized pricing.

Power companies have been moving forward with adoption of electronic meters and automated meter reading (AMR) as ways to reduce the personnel costs associated with meter reading (manual checking of the gauges of electric meters to determine power use) and to combat tampering by means of magnets and the like. By adopting electronic power meters the power companies are able to collect a variety of types of data on power usage, allowing them to provide more fine-grained service. For example, by offering pricing plans that make it cheaper to consume power during times of day when usage is lowest overall, they provide consumers a way to save on their power bills (by using electricity when it is cheapest) and reduce the load on the grid during peak times. Now power companies are going further by introducing Advanced Metering Infrastructure (AMI). AMI is defined as a comprehensive power control system that, in addition to automated meter reading and improved service for consumers, includes capabilities such as operation and maintenance of power equipment over a wide area, support for recovery from natural disasters (such as lightning strikes), and sale of power from solar cells (sale of electricity to the power company). The electric meters with the advanced functions needed to make AMI a reality are known as "smart meters." Smart meters can measure power usage almost in real time, and by establishing communication links with the power company via a wide area network (WAN) it is possible to implement capabilities such as bidirectional power control and bill payment by means of prepaid cards.

ii) Network devices and* Increasing Importance of Communication and Network *communication

Grid enhancements will be required to integrate additional renewable and distributed generation into the grid. These enhancements will include enhancement of monitoring systems—more locations, with better visualisations and improved simulations, as well as improved data processing across the entire grid. They will also include advanced voltage control, increased fault detection, digitization, and (automatic) system protection practices. These improvements have the potential to limit losses, optimize integration of distributed resources and electric vehicles and enhance the resilience of the system.

A smart grid uses communication technology and IT to link all components of the power grid, including generating stations, distribution facilities, transformers, businesses, and households. It is a system intended to enable the stable supply and efficient usage of electrical power. The latest technology is used to give "intelligent" functions to the entire power distribution grid, making it a "smart" grid capable of reducing emissions of greenhouse gases and boosting energy efficiency. The idea of the smart grid is not merely to bring innovations to the power distribution system. Its scope of application is broad and multi-branched, and it is hoped that the adoption of smart grids will give rise to a variety of new services and industries. Businesses related to smart grids that are considered to have high growth potential include the following.

1. New systems for storing and managing energy
2. Sales and billing systems for solar energy, etc.

3. "Visualization" of power usage and automated meter reading using smart meters

4. Household appliance control (demand response, demand side management, etc.)

5. Security (anti-theft) and fire alarm systems, etc.

The foundation of a smart grid is a communication infrastructure, and the role of this infrastructure is expanding to cover the entire power grid. Key applications for communication technology in smart grids include enabling efficient operation of solar cells, etc., detection of faults in grid transformers, management of power peaks, monitoring of power consumption in businesses and homes, control of equipment that uses electric power, and communication between different pieces of equipment. The communication format can be selected to match the application, with possibilities including wired communication, wireless communication, and power line communication. Wireless communication simplifies installation because no wiring is required, and there are a variety of wireless technologies now available with transmission capabilities ranging from near field to long distance.

iii) Distributed energy storage

Distributed energy storage has the potential to optimize the stability of the power supply resulting in reduced grid losses, reduced power outages and improved power quality. Local storage will also enable increased penetration of renewable resources and ensure their integration will not reduce the stability and reliability of energy supply. The main obstacle for employing additional "exible storage solutions" such as batteries, or pumped storage, is their relatively high cost. Plug-in electric vehicles could provide distributed storage, but signal Cant penetration is still many years out and it is not yet clear how substantial the storage contribution from electric vehicles will prove to be.

iv) Household appliances

To get the full value from the smart grid, customers will require appliances to communicate with a home area network (HAN) that will optimize electricity use depending on market signals (and within limits set by the customers). The magnitude of the replacements is required—a change that will be dispersed across millions of households—poses some clear challenges at the interplay of technology, standardization among suppliers, and customer behavior.

B) Soft Infrastructure

Soft infrastructure required includes the following issues:

i. Cyber Security

Cyber security becomes a priority concern as additional technologies connect to grid systems and provide more real-time data as well as two-way communications. The need exists to assess risks and vulnerabilities all along the communications chain from data sources to consumers, much of which is outside ISO control. There is little doubt that situations will emerge that require new security controls and monitoring to ensure that grid monitoring, operations and control systems are not compromised. A number of national forums are addressing security concerns. One is the National Institute of Standards and Technology that recently released *NISTIR 7628, Guidelines for Smart Grid Cyber Security*. This is a three-part document covering smart grid from a high-level functional requirements standpoint. Among the challenges associated with cyber security is tailoring policies for power system monitoring and control applications, which are complex and industry and application specific. Implementing, maintaining, monitoring and improving information security so it is consistent with the organizational requirements and process are also issues to address.

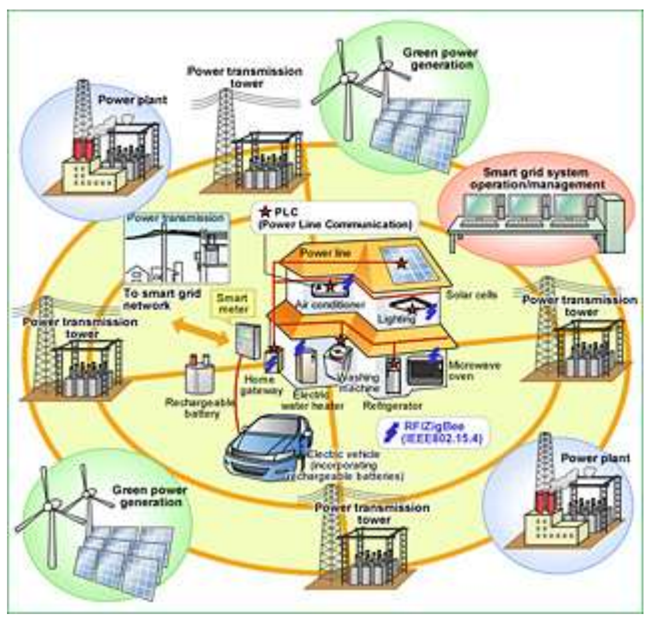

fig.3 Overview of Smartgrid

ii. Customer engagement

There is a general lack of public awareness of the smart grid and a lot of confusion in sorting through the various claims and definitions that are being advanced to explain it. It will be important for customers to have a much better understanding of the benefits of smart grids if they are to be introduced effectively and sustainable. Since the high cost of smart grid implementation will, directly or indirectly, be shared by customers, if they are not convinced by claims regarding current and future benefit, they are likely to resist and challenge those costs over time.

iii. Changes in customer behavior

Complicating this need for customer buy-in is the fact that the value of the smart grid system is intrinsically tied to their willingness to use the tools made available to them to manage their electricity use. It is important to note that households already have an array of options for reducing energy use and saving money that go untapped (e.g., isolation of heating and cooling, better insulation, lighting changes). Thus history shows that even where energy savings have a short-term financial pay-off; it may not be enough to convince the customer to act. Customer education will likely need to be combined with regulatory incentives and disincentives before full participation can be realized.

IV. FUTURE SCOPE

Future models for the electricity grids have to meet the changes in technology, in the values in society, in the environment and in commerce. Thus security, safety, environment, power quality and cost of supply are all being examined in new ways and energy efficiency in the system is taken ever more seriously for a variety of reasons. New technologies should also demonstrate reliability, sustainability and cost effectiveness in response to changing requirements in a liberalized market Environment

Many factors will shape future electricity networks and the actions and decisions taken today will influence longer-term outcomes. It is therefore important to recognize that a flexible approach and regular interaction with stakeholders is required to respond to future challenges and opportunities. Future work should adopt a techno-economic system approach. This calls for the development of:

- distribution grids accessible to distributed generation and renewable energy sources, either self-dispatched or dispatched by local distribution system operators;
- distribution grids enabling local energy demand management to interact with end users through smart metering systems;
- distribution grids that facilitate dynamic control techniques and high levels of power security, quality, reliability and availability;
- transmission grids with minimum negative side-effects on the environment and the society;
- secure transmission grids that can comply with different forms of generation including large and small, controllable and non-controllable, variable and intermittent sources;
- transmission grids that can accommodate central and non-central, multi-product markets.

V. CONCLUSION

Electricity is consumed by a range of customers, including industrial, service/commercial and residential. In industrial and sometimes the commercial sectors, customer knowledge of energy management is high and technologies to enable demand response or energy efficiency are well known, mature and driven by cost savings.

REFERENCES

[1]Heinen Steve, Elzinga David,Kim Seul-Ki and Ikeda Yuichi, "*Impact of Smart Grid Technologies on Peak Load to 2050*", International Energy Agency, 2011.

[2] Houseman Doug and Shargal Meir, "*Smart Grid: Leveraging Technology to Transform T&D Operating Models*", Capgemini, 2007.

[3] Pratt RG, Kintner-Meyer MCW, Balducci PJ, Sanquist TF, Gerkensmeyer C, Schneider KP, Katipamula S, Secrest TJ, "*The Smart Grid: An Estimation of the Energy and CO2 Benefits*", U.S. Department of Energy under Contract DE-AC05-76RL01830, January 2010.

[4] Metke Anthony R. and Ekl Randy L., "Security Technology for Smart Grid Networks", IEEE TRANSACTIONS ON SMART GRID, Vol. 1, NO. 1, June 2010.

[5]Report to NIST on Smart Grid Interoperability Standards Roadmap EPRI, Jun. 17, 2009 [Online]. Available:http://www.nist.gov/smartgrid/InterimSmartGridRoadmapNISTRestructure.pdf