Smart Grid: The Future Belongs

Abhilash Dhatrak[1], Niraj Dandge [2], Prof.Mrs. S.R. Gawande[3]
Department of Electrical Engineering, K. D. K College Of Engineering, Nagpur, India

Email: [1]abhilashadhatrak@gmail.com, [2]nirajdandge32@gmail.com.

***Abstract* — The purpose of this paper is to explain the importance of Smart Grid. The paper throws the light on various problems and challenges related to electricity grids that are faced in all over the world and the solution to manage those problems by adopting the vision of a "Smart Grid." A smart grid is a developed grid system that manages electricity demand in a sustainable, reliable and economic manner, built on advanced infrastructure and tuned to facilitate the integration of all involved. Specifically, a "smart" grid must be capable of providing power from multiple and widely distributed sources, e.g., from wind turbines, concentrating solar power systems, photovoltaic panels and perhaps even plug-in hybrid electric vehicles. Moreover, since all renewable energy sources invented so far vary greatly with time, a smart grid must be capable of flexibly storing electric power for later use, e.g., in batteries, flywheels or super-capacitors or again even in plug-in hybrid electric vehicles. Last but not least, to improve power reliability a smart grid must make use of new and highly sophisticated adaptive generation and distribution control algorithms.**

Index Terms – Smart Grid, Real Time.

I. INTRODUCTION

Electricity is actually an energy currency. Power collected from a various sources, such as burning fuel, falling water, wind and solar is used to create electricity for delivery to customers. Electricity is the most versatile and widely used form of energy and global demand is growing continuously. Electricity has proven to be efficient and convenient means of delivering energy to customers. Electricity is delivered at the speed of light and is consumed the instant it is created. There is no means to store electricity without converting it to another form of energy. As a result, the demand for power, driven by customers, must match the supply of power from the available sources (e.g. generators and energy storage devices) at all times.

Generation of electrical energy, however, is currently the largest single source of carbon dioxide emissions, making a significant contribution to climate change. To mitigate the consequences of climate change, the current electrical system needs to undergo significant changes. The electrical power system was built up over more than 100 years. It is now one of the most effective components of the infrastructure on which modern society depends. It delivers electrical energy to industry, commercial and residential consumers, meeting ever-growing demand. Most of today's generation capacity relies on fossil fuels and contributes significantly to the increase of carbon dioxide in the world's atmosphere, with negative consequences for the climate and society in general. To satisfy both the increasing demand for power and the need to reduce carbon dioxide emissions, we need an electric system that can handle these challenges in a sustainable, reliable and economic way.

Smart grids will provide more electricity to meet rising demand, increase reliability and quality of power supplies, increase energy efficiency, be able to integrate low carbon energy sources into power networks. Smart grids possess demand response capacity to help balance electrical consumption with supply, as well as the potential to integrate new technologies to enable energy storage devices and the large-scale use of electric vehicles. Electrical systems will undergo a major evolution, improving reliability and reducing electrical losses, capital expenditures and maintenance costs.

A smarter grid will provide greater control over energy costs and a more reliable energy supply for consumers. Environmental benefits of a smarter grid include integration of more renewable power sources, reduced peak demand, and reduced CO2 emissions and other pollutants.

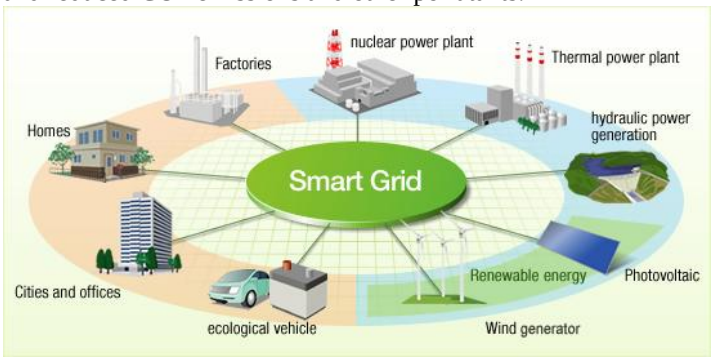

Fig1. Smart Grid Concept

For providing the quality and simplicity for customers the utility industry is currently facing three main challenges in the design and operation of the power grid of tomorrow.

Meeting the Demand:

Utilities have taken responsibility to meet the demand of customers with little or no advance notice.

Reliability:

The grid is designed for reliability. Even at the annual peak load, a contingency loss of generation or a single transmission element will not cause serious losses for customers.

Quality:

Even if the continuously varying load, Power system frequency and voltages should maintained within acceptable limits. These standards have become a part of the daily life for users, most of whom have little idea of the challenges they create.

II. What Is Smart Grid

The Smart Grid is ultimately about using megabytes of data to move megawatts of electricity more efficiently and affordably.

A smart grid is an electrical grid with automation, communication and IT systems that can monitor power flows from points of generation to points of consumption (even down to the appliances level) and control the power flow or curtail the load to match generation in real time or near realtime. The increased visibility, predictability, and even control of generation and demand bring flexibility to both generation and consumption and enable the utility to better integrate intermittent renewable generation and also reduce costs of peak power. If the traditional grid was made secure only through over-engineering, a smart grid is cost-effective, nimble, responsive, and better engineered for reliability and self-healing operations.

There are different views to make a Smart Grid. In some cases, attaching smart meters to houses is enough; in other cases, it's the radical redesign of a region's power grid that allows consumers to control their fridges and air conditioning units from anywhere in the world via the internet, responding to price changes and the availability of power. The Smart Grid project is that they turn the electric power system from a one-way delivery system into a network based on a two-way communications channel between producers and consumers.

This new layer of communication makes the electric power system more intelligent and easier to balance. Instead of generators simply producing electrical energy and the consumer using that energy in a one-way transaction, the Smart Grid allows for the consumer to communicate with the system and plan usage based on price and/or availability. It can also allow consumers to respond to requests from Independent system operators (ISOs)/Regional Transmission Organization (RTOs).

Connecting to the Smart Grid gives the operators of industrial, commercial and municipal buildings, as well as homeowners, an opportunity to take part in the greening of the grid and in building more efficient power systems in their regions. The Smart Grid is providing a new set of technology-based tools that allow the grid to be fully optimized, using both loads and generators to achieve the best and most efficient means of operation while still fulfilling the primary obligations of loads.

Different jurisdictions are advancing the use of Smart Grid technologies at different speeds, with some regions conducting dramatic regional overhauls while others remain tentative.

On the demand side, the Smart Grid is made up of smart meters and process measurement tools, and on the supply side, there are upgraded transformers, transmitters and plants. Together, these tools give users information to help them make intelligent decisions about usage and move information from the consumer to the provider, allowing the ISOs/RTOs to manage distribution in a more sophisticated manner.

III. Smart Grid Components

While still new enough to lack a universally agreed upon definition, some typical components of a smart grid include:

A. Intelligent appliances

Intelligent appliances capable of deciding when to consume power based on pre-set customer preferences. This can go a long way toward reducing peak loads which has a major impact on electricity generation costs - alleviating the need for new power plants and cutting down on damaging greenhouse emissions. Early tests with smart grids have shown that consumers can save up to 25% on their energy usage by simply providing them with information on that usage and the tools to manage it.

B. Smart power meters

Smart power meters featuring two-way communications between consumers and power providers to automate billing data collection, detect outages and dispatch repair crews to the correct location faster.

C. Smart substations

Smart substations that include monitoring and control of critical and non-critical operational data such as power factor performance, breaker, transformer and battery status, security, etc.

D. Smart distribution

Smart distribution that is self-healing, self-balancing and self-optimizing including superconducting cables for long distance transmission, and automated monitoring and analysis tools capable of detecting or even predicting cable and failures based on real-time data about weather, outage history, etc.

E. Smart generation capable

Smart generation capable of "learning" the unique behavior of power generation resources to optimize energy production, and to automatically maintain voltage, frequency and power factor standards based on feedback from multiple points in the grid.

F. Universal access

Universal access to affordable, low-carbon electrical power generation (e.g., wind turbines, concentrating solar power systems, photovoltaic panels) and storage (e.g., in batteries, flywheels or super-capacitors or in plug-in hybrid electric vehicles).

IV. Smart Grid Benefits

A. Create a clean environment

Reduce carbon emissions and improve energy efficiency through reduction in losses and by integrating renewable generation.

B. Increase efficiency and reliability

By flattening the consumption profile, the system can run much more efficiently and can respond more intelligently, with the potential, as previously mentioned, of running at 80% capacity instead of 50%.

C. Increased consumer participation

The Smart Grid has the ability to change the way consumers use electricity by showing them exactly how much electricity is being used and how much it costs throughout each day. This helps consumers save money and more intelligently control their usage.

D. Support intelligent loads

The development of intelligent loads, whether appliances in the home or larger loads in industrial settings, will be encouraged through the expansion and adoption of the Smart Grid. These loads will be able to sense fluctuations and automatically respond to grid emergencies in real-time. They will also give consumers more control over how they use electricity.

E. Connect private renewable generation

The bi-directional nature of the Smart Grid allows consumers to connect their own private generation, such as solar panels, to the grid. This adds flexibility and reduces greenhouse gases while putting less stress on the system and reducing losses.

F. Self-Healing

A smart grid automatically detects and responds to routine problems and quickly recovers if they occur, minimizing downtime and financial loss.

G. Motivates and Includes the Consumer

A smart grid gives all consumers - industrial, commercial, and residential - visibility into real-time pricing, and affords them the opportunity to choose the volume of consumption and price that best suits their needs.

H. Resists Attack

A smart grid has security built-in from the ground up.

I. Provides Power Quality for 21st Century Needs

A smart grid provides power free of sags, spikes, disturbances and interruptions. It is suitable for use by the data centres, computers, electronics and robotic manufacturing that will power our future economy.

J. Accommodates

All Generation and Storage Options A smart grid enables "plug-and-play" interconnection to multiple and distributed sources of power and storage (e.g., wind, solar, battery storage, etc.)

K. Optimizes Assets and Operates Efficiently

A smart grid enables us to build less new infrastructure, transmit more power through existing systems, and thereby spend less to operate and maintain the grid.

V. Smart Grid Vision For India

Transform the Indian power sector into a secure, adaptive, sustainable and digitally enabled ecosystem that provides reliable and quality energy for all with active participation of stakeholders

India's demand for power is increasing at an annual rate of 8-10%. In October 2008, the "Smart Grids India" conference was held to discuss the infrastructure requirements to "modernize the grid" and to turn a "dumb grid" into a "smart grid". Indian utilities are challenged to achieve the ambitious target set by the power ministry.

India is also home to one of the weakest electric grids in the world. India's transmission and distribution losses are among the highest in the world, averaging 26% of total electricity production, with some states as high as 62%. When non-technical losses such as energy theft are included in the total, average losses are as high as 50%. This creates a powerful incentive for introducing smart grid components, and the meter market in India is estimated at 100 million nodes!

The transmission and distribution losses are still very high in the Indian power system and distribution network (aggregate technical & commercial, or AT&C) loss reduction continues to be the top priority of both utilities and government. Smart grid solutions will help monitor, measure and even control power flows in real time that can help identify losses and thereby appropriate technical and managerial actions can be taken to arrest the losses.

In July, 2008, Rabirashmi Abasan in Kolkata (greater Calcutta area) became the first housing project in India where residents have the option of generating power in

rooftop solar photovoltaic panels, and selling it to the power grid utility. From now on, their electricity bills will reflect the difference between the energy consumed from the utility and how much they send to the grid.

CONCLUSION

As the Smart Grid continues to developed, builds on its growing reputation as a cost-effective way for industrial users to manage energy usage and costs, buy-in from both residential and industrial consumers will become simpler.

Connecting requires the simple installation of meters to monitor equipment more closely. By monitoring the equipment, smarter decisions regarding usage can be made. The next step, connecting a network of loads to a regional electricity system operator, allows companies to respond to the needs of the grid and start offering Grid Balance. This creates a new revenue stream for companies with connected loads.

Though the days of full integration are still many years away, the future is now, and companies that embrace innovation today and connect first will stay ahead of the game.

REFERENCES

[1]. Gurlin Singh Lamba Landis +Gyr/software engineer "Smart Grid and Development Prospects In the Asia-Pacific Region" 2010-11 CSI Journals.

[2]. Bichlien Hoang "Smart Grids" Published On the IEEE Emerging Technology portal ,2006-2012.

[3]. ENBALA Power Network "Smart Grid :The Future of the Electric Power System"2011.

[4]. Silver Spring Network "Smart Energy Future"2012 2nd edition.

[5]. ISGTF "Smart Grid Vision and Roadmap for India"Aug 12,2013.