ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 3, Issue 7, July 2016

Uninterrupted & Stable Power Supply by Smart Grid in India & World

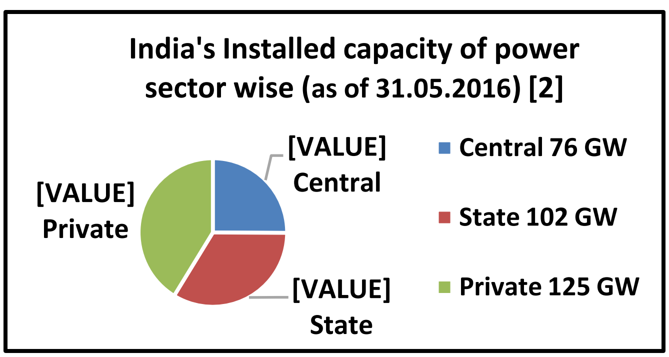
[1] Punit Mangal [2] Dr. Swati Vitkar
[1] Research scholar Computer Science, JJT University, Jhujunu(Raj)
[2] Assistant Professor SIES (Nerul) College of ASC, Navi Mumbai, Maharashtra
[1] punnumangal@yahoo.com [2] swativitkar@gmail.com

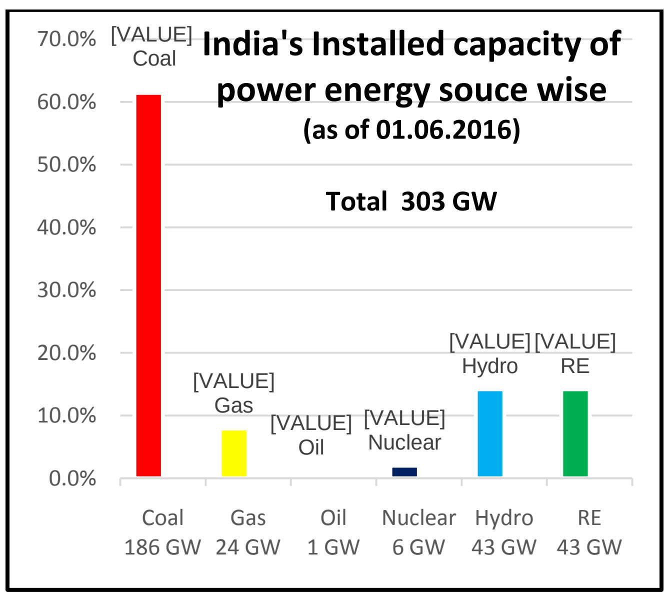
Abstract: **Status of a country is known by its per capita consumption of energy. With rapidly increasing demands of electricity, limited coal and fossil fuels and pollution by them, the importance of renewable energy is increasing. Different forms of renewable energy, being dependent on nature, keep on varying. Electrical storage is limited and very costly. Similarly, the demand of power is also fluctuating during different times of the day. To address the existing limitations, the solution lies in moving towards smart grid which allows smooth integration of renewable energy sources with the non-renewable energy sources. Smart grid can achieve desired results by use of intelligent controllers. The intelligent controller in a smart grid can be used for maintaining uninterrupted and stable power balancing the supply and demand.**

This paper provides an introduction to the present installed capacity of power sector wise & source wise for non-renewable and renewable energy, Renewable energy plans of India, a brief on India-One nation one grid, emerging synchrophasor technology and advantages of synchrophasor technology. The steps taken by India to proceed towards smart grid by synchrophaser technology using Phasor Measurement Units (PMU), Phasor Data Concentrator (PDC) and Wide Area Monitoring System (WAMS) network are explained. A brief on transmission & theft losses is given. It also explains the use of intelligent controller to minimise power theft and area identification of power theft. Expected changes likely to occur in few years are given which indicate we are proceeding towards one grid for whole world.

I. INTRODUCTION

Dr. Abdul Kalam emphasized the need to achieve 'energy independence' for SAARC countries by 2030. He said oil is being replaced with electricity and coal power with renewable energy sources. [1].Electricity can be managed efficiently bysmart grid where intelligent controllercan provide uninterrupted and stable power supply.





International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 3, Issue 7, July 2016

II. RENEWABLE ENERGY PLAN

Today Renewable energy installed capacity of India is 30% and Non-renewable is 70%. In Budget 2015, Indian Government has declared a massive renewable power production target of 175 GW by 2022 from present 36 GW out of which 100 GW is solar from present 4 GW. 60 GW of Solar energy is planned to be produced by power plants and 40 GW by roof top installations. This indicates the significant contribution of renewable energy in coming years, especially solar energy [3].

Centre has earmarked Rs 48,000 crore for development of 100 smart cities having smart grids along with many other smart facilities. Each smart city would get a central assistance of Rs 100 crore per year for five years [4].

Electricity is produced mainly by burning coal presently but one ton of coal burnt produces about 3 ton of CO_2 [5]. Thus, using coal for producing electricity increases emission of greenhouse gases. Hence, the use of renewable sources is increasing. Different forms of renewable energy, being dependent on nature, keep on varying [6]:

1. Solar energy – Availability in daytime only
2. Wind energy – Dependence on flow of wind
3. Bioenergy – Depend on biomass available
4. Geothermal energy -Dependence on thickness of earth crust
5. Hydropower – Variation in dam water level.
6. Ocean energy - Dependence on waves& occurrence of tides in oceans.

The demand of power is varying during different times of the day. Business buildings and government facilities consume electricity primarily during normal working hours. At homes and city lighting,it reaches a peak during evening to mid night, minimum early in the morning and moderate during rest of the day. It becomes difficult to manage the peak loads of electricity demand.

III. INDIA – ONE NATION ONE GRID

India was demarcated into five regions namely Northern, Eastern, Western, North Eastern and Southern region.India has achieved 'One Nation-One grid-One Frequency' on 31.12.2013 when Southern region was connected to central gridand all five regions are connected into a central grid [7].

The existing SCADA/EMS based grid operation has the capability to provide only steady state view of the power grid. PMU based technology with synchrophasor measurements over wide-area facilitate dynamic real time measurements and visualization of power system which are useful in monitoring safety and security of the grid as well as enabling control or corrective actions. Developments in WAMS and other technologies in the field of measurements, communication, control & automation, advanced meters, IT infrastructure, energy storage etc. have prominent role towards successful development of Smart Grid. The wide spread grid and increasing complexities in its operation requires wide area monitoring which may only be possible by using intelligent controllers working with PMU, PDC & WAMS based on application of emerging synchrophasor technology.

IV. SYNCHROPHASOR TECHNOLOGY

A phasor is a complex number that represents both the magnitude and phase angle of the sine waves found in AC system. Phasor measurements that occur at the same time are called "synchrophasors" and can be measured precisely by the Phasor Measurement Units (PMUs). PMU measurements are taken at high speed typically 25 or 50 samples per second – compared to one every 4 to 10 seconds using conventional technology. Each measurement is time-stamped according to a common time reference. Time stamping allows synchrophasors from different locations to be time-aligned i.e. synchronized which provides combined and comprehensive view of the entire grid. Another valuable use of synchrophasor data is the detection of equipment failure, most of which is not detectable by SCADA system. System stability assessment is being carried out using synchrophasor data especially capturing the intricacies of an interconnected system like low frequency oscillations due to generation control problem or other reasons. This shall be useful for post event analysis of any grid incidences.

A typical PMU installation as a part of wide area monitoring system (WAMS) network consists of PMUs dispersedly placed throughout the electricity grid at strategic locations in order to cover the diverse footprint of the grid. A Phasor Data Concentrator (PDC) at central location collects the information from PMUs and pass it to Master PDC or Super PDC after time aligning the same. PDC provides additional functions like quality checks on the Phasor data and inserts appropriate flags into the correlated data stream, checking disturbance flags and recording files of data for analysis, monitoring overall measurement system and providing display and record of performance, etc. PDCs are to be installedat various strategic grid locations and control centers.The WAMS network requires high bandwidth communication backbone for rapid data transfer matching the frequency of sampling of the PMU data. The components of intelligent controller are PMUs, PDCs, WAMS network, visualization aids, application and analysis modules, data archiving and storage etc.

The intelligent controller technology has three stages for implementingsynchrophasor technology. The initial stage is to collect and archive Phasor data. In second stage, the data is used to calculate grid conditions and make suggestions to grid operator to keep grid stable and reliable. The third and final stage is to do all of the above automatically without human intervention.

V. ADVANTAGES OF SYNCHROPHASORS

Synchrophasor has many advantages over SCADA system, which are as under.

1. ***Exact information of less than a second:*** PMU provides information about part of a second. For example, at an instance in USA, lightning initiated an event where 100 Hz breaker tripped, causing a fault to remain for two seconds. As a result, the 230 kv to 100 kv transformer at the station tripped by overload and back up protection was engaged. The PMU accurately recorded the magnitude & time duration of the fault making the analysis to diagnose and correct the problem timelier and efficient.
2. ***Detect fault undetected by SCADA*:** An automatic voltage regulator at a power plant malfunctioned as a result of low voltage transformer fault. Plant engineers needed to know the duration of the voltage drop but supervisory control and data acquisition (SCADA) was unable to observe the fault. Using synchrophasor, engineers determined that the voltage on the 230 kv bus momentarily dipped to 150.6 k, which is well outside the tolerance of the control system.
3. ***Increased system reliability*:** PMU data contribute to improving reliability. It helps in restoring critical tie line. The shortened outage reduces the power system's vulnerability to a potential subsequent contingency, i.e., another line trip.
4. ***Increased system efficiency:*** PMU data contribute to improving asset utilization and power system efficiency. An example is BPA's using PMU data at USA to calibrate the 1,100 MW Columbia Nuclear Generating Station model without taking the unit off line. This saved an estimated $1-7 Lakhs.
5. ***Increased event analysis:*** PMU data contribute to improving event analysis. An example is ISO-NE's using synchrophasor-based event analysis software to automatically collect and analyze PMU data from across New England. The reduced cycle time enables engineers to identify and analyze two or three events per week – up from two events per year.[8]

VI. STEPS TAKEN FOR SMART GRID

Installation of four PMUs and one PDC in Phase I was completed at Northern Regional Load Dispatch Centre (NRLDC) in May-2010 and four PMUs have been installed in Phase II. The Phase III planning included installation of another eighteen PMUs, one PDC and one historian at the NRLDC. PMUs are installed in other regions also.[9] Presently 56 PMUs and 6 PDCs are working in India.Fullimplementation of WAMS technology would require installation of about 1500 PMUs and about 60 PDCs. The State Load Dispatch Centre may have Master PDCs and every region may have a Super PDC with 2 main and backup PDCs working in hierarchy at NLDC, Delhi for real time dynamic state monitoring The Ministry of Power, GoI launched a Smart Grid Vision and Roadmap for India in Sep 2013 that envisages transformation of the entire Indian power system to smart grids by 2027.[10]

VII. TRANSMISSION & THEFT LOSSES

Central Electricity Authority of India (CEA) has reported following data as on 31.05.2016:
Monitored Capacity of power = 260 GW

Planned Maintenance of power = (-) 7 GW
Forced outage of power = (-) 66 GW
Other reasons of power = (-) 10 GW

Capacity of power on line = 177 GW

Actual power from 1.4.16 to 31.5.16 = 199 GU.[11]

1 Unit = 3.6 x 10^6 J Days in Apr & May =61

177 GW = 177 x 10^9W = 177 x 10^9J/Sec

$$= \frac{177 \times 10^9 \times 60 \times 60 \times 24 \times 61}{3.6 \times 10^6 \times 10^9} = 259 \text{ GU}$$

So, Transmission & theft losses in Apr & May-16 are 60 GU out of 259 GU i.e. 23% as calculated above.

The intelligent controller will be connected with smart meters of every consumer and measure total power consumed. It would also be connected with smart meter measuring power produced. Thus, it would calculate daily the difference between power produced and consumed and display the total transmission losses daily. Increased losses abruptly will be indicative of power theft. In a similar fashion, use of intelligent controller can be extended further to provide area wise transmission losses. Hence, when power theft is detected, immediately it will also be known that in which area it has happened. In this way, intelligent controller will identify the area in which power theft has taken place.

VIII. CHANGES LIKELY IN FEW YEARS

Following changes are likely to occur in few years:

1. The fuel vehicles on road will be replaced by electrical vehicles. The electrical cars are claiming 0.55 Rs/Km (2 seater) to 0.70 Rs/Km (14 seater) [12]. Even if they have not considered battery replacement cost, still no doubt, they are very cheap & pollution free also. Even hybrid cars and solar cars are being launched. [13] Electric vehicle charging facilities will be constructed in all parking lots, institutional buildings, apartment blocks, etc. with quick/fast charging facilities in fuel stations and strategic locations on highways. New electric cars to be launched in 2016 are likely to be five seaters, speed more than 100 km/hr, running for more than 120 km with battery fully charged, charging in 5 hr by 230 V supply and 15 min by supply of 440 V.

2. The use of power by renewable resources like solar energy, wind energy, biomass etc. will increase significantly. Smart grids allows integration of renewable and non-renewable energy resources. Both energy sources will be connected with each other and smart grids will be implemented in India.

   Smart grid is a modernized intelligent electrical network with two-way flow of energy in distribution networks and real-time information flow between power producers, grid operators and consumers.

3. The current meters will be replaced with smart meters.

4. The concept of distributed generation will be implemented, in which the energy will be produced from millions of houses.

5. It is likely that variable freight rate for power during day & night will be implemented in India in upcoming time as in some other countries or as happens in internet.

6. Many countries of world will be connected with each other for import and export of power.Some neighbor countries of India has been connected with each other for import and export of power.

IX. CONCLUSION

The consumption of energy is increasing and to meet the demand, production of renewable energy is increasing. The existing energy system have limitations of pollution & high cost of oil with non-renewable energy sources. Renewable energy sources have limitations of costly storage i.e. battery cost but they are pollution free and have no input material cost. The solution lies in increasing renewable energy generation and moving towards smart grid which allows smooth integration of renewable energy sources with the non-renewable energy sources. Smart grid can achieve desired results by use of intelligent controllers. The intelligent controller in a smart grid aims to balance the supply and demand of power and provide uninterrupted stable power supply at optimum cost. It can be used to monitor transmission losses on daily basis and thus can be used to control power thefts and find the area in which power theft is taking place. The five regions of India are connected on 31.12.2013 and India has become one nation one grid. India is now moving towards smart grid by synchrophaser technology using PMUs, PDCs and WAMS network. The synchrophasor technology has many advantages over SCADA system as it records 25 readings of power with magnitude and phase angle with time stamping on them providing real time health picture of grid.The intelligent controllerwill be used here in smart grid for doing all of the above actions automatically without human intervention.

REFERENCES

[1] SAARC Energy Independence by 2030 to create livable Planet Earth – Dr. Abdul Kalam

[2] Ministry of Power, Government of India [available] at: http://powermin.nic.in

[3] The Economic Times [available] at: http:// articles.economictimes.indiatimes.com

[4] The Financial Express [available] at: http://www.financialexpress.com

[5] U.S. Energy Information Administration [available] at: http://www.eia.gov/coal

[6] Report on Renewable Energy Resources and Climate Change Mitigation, 2012

[7] Evolution of national grid [available] at http://www.powergridindia.com

[8] Advancement of synchrophasor technology report – Mar 2016 by US department of energy.

[9] Electric Power Components and Systems [available] at http://www.tandfonline.com

[10] Draft National Electricity Plan 2012 [available] at http://www.cea.nic.in/reports

[11] Central Electricity Authority, Ministry of Power, GoI, Daily reports & Executive summary.

[12] Cheap electric cars in India [available] at http://www.autoindiaforum.com.

[13] Top-5-hybrid-electric-cars-in-india [available] at http://auto.ndtv.com/news