Managing Energy Demand of Renewable Energy Sources by using Smart Grid Technology

P. Jagannadh, J. Vijay Chandra, B. Sesha Sai, B. Sateesh Babu

Abstract*— Day by day the non-renewable sources of power are getting depleted. Due to higher demands of energy the necessity of such sources is becoming more important in the field of electrical power according to the estimates of power sector the usage of renewable component has increased by 9% w.r.t to 2013. Even though non-renewable sources capacity increasing day by day the complexity of the power system network increasing which result in mismatch between voltage and power in electrical network. By using smart grid technology, we can minimize the unequal effect of voltage and power in the domain of renewable energy source. Smart grid technology uses digital transformation of electrical parameter to central coordination center at high sample rate, which uses effective and reliable operation in managing energy demand of renewable energy sources

***Keywords*—Information and communication technology, smart grid, power system network, Energy Management, phasor measurement unit.**

I. INTRODUCTION

In present day scenario both world & India is witnessing high electricity demand according to international energy agency every year electricity demand in world increasing 2.6% [1] and in India electricity demand is increasing 4% this year [2]. Due to this demand research is being done form 1891's on renewable energy sources as they are gift by nature which will not deploy by using [3]. From that decade onwards use of renewable energy is also increasing. Due to this high demand power system network is becoming more complexity there by system losses its stability nature. In order to retain the trustworthy network. The stability of the network should be increased there by reducing the losses and disturbances. The stability of a power system is the term used for power system network. In given initial conditions, the power system network is to again come to normal equilibrium state when after subjected to disturbance. A variable system is bounded so that system integrity is preserved. Due to the increase in the complexity of the power system various types of faults occur in the system. The power system network has so many faults like power station faults, transmission line faults, substation faults, & short circuit faults and by main line over loading. The main problem is to control the energy demand. Research is going on how to manage the energy demand. In this paper, one of the ongoing research on managing energy demand i.e. smart grid technology is described with the challenge it is facing [4].

II. RENEWABLE ENERGY AT GLANCE

A renewable resource is a resource that can be used multiple times and naturally replaced. The Govt of India has a separate ministry(MNRE) for the new and renewable energies with over all aim of developing and deploying such energies for complementing the national needs. Allied departments are:

1. Additional Sources of Energy (CASE) in 1981.
2. Non-Conventional Energy Sources department (DNES) in 1982.
3. Non-Conventional Energy Sources ministry (MNES) in 1992.
4. Non-Conventional Energy Sources (MNES) ministry renamed as Ministry of New and Renewable Energy (MNRE) in 2006.

The trend of latest renewable energies has become increasingly important now a days with growing concern for the country's energy security. Electricity self-sufficiency has been identified as the main driver of latest renewable energies in the country following the two oil shocks of the 1970s. The sudden increase in the oil price, the uncertainties related to its supply and the negative impact the balance of payments situation led to the creation of the Additional Energy Sources commission of the Dept. of Science and Tech in 1981. Policy formulation and implementation, cover new and renewable energy development programs, in addition to the coordination and intensification of R & D sector. Later a separate department name as DNES was created in 1982 including CASE under the ministry of energy. Ten years later this merged into ministry of unconventional sources which was renamed as MNRE [5]. It is known that the Indian economy gets energy inputs from traditional sources like coal, hydroelectricity and nuclear energy. Presently the installed capacities are 70% for thermal The commercial inputs of Indian 16% hydroelectric, 2% for nuclear and 12% for renewable. Keeping long term effects in mind fossils fuels should be used to minimum level where as use of renewable energy sources must be maximized keeping losses in consideration.

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Some of the renewable energy sources capacity in India:

Solar thermal power and PV power:

In solar power generation and per watt installation India stands at top position, as on date 31-dec-2018. According to the report given by bridge to India(BTI) India is having a solar capacity installation of 28GW; in that 17.65 GW is under implementation.

Hydro power:

In hydro power, India has a high potential which is at rank of sixth in the world. As on date 27-jan-2019, India is having an installation capacity of 45,400 MW which is 16.36% of the total generation of electricity in India. In addition to this India has a small hydro power capacity of nearly 4000MW.

Wind energy:

As per the estimation of wind energy resources, India has an installed capacity of 35GW which stands at fourth position world. The future estimation is set at 60,000 MW by 2022. As per the initial assessments the prospect of wind energy for Indian coast of 7600KM is good because of high and stable wind speeds.

Biomass Energy:

Energy from biomass can be used in the most efficient way to generate electricity. By the use of combined cycle system of power generation and co-generation heat is generated. In India, there are 288 biomass projects and total installed capacity as on date 2016 is 5940.57 MW. Power generation by waste to energy and waste to power is with a capacity of 275.24 MW have been installed in the country to supply the grid with electricity. In sugar factories, total electricity generation by use of bagasse is nearly 1600MW and it may be raised to nearly 10,000 MW by 2022.

Wave energy:

India has a long coast line of 7600km which gives a high amount of electrical energy through waves. Indian coast is having capacity of 6-15MW/m; sea coast has a capacity of 40-60MW installation.

Tidal Wave Energy:

India has an estimated 8000 MW of tidal power. Despite the huge potential, tidal power extraction has not progressed. An agreement is signed for the implementation of first small tidal Project which is having a capacity of 3.75 MW in West Bengal.

Ocean Thermal Energy Conversion (OTEC):

Over all capacity of such conversion for the whole country has been projected as 1,80,000 MW. This is equivalent to forty percent the sum of total parasite damage.

Energy form Geo thermal:

As per the planning figure, the country needs nearly ten thousand MW in geothermal sector. The MNRE has, of late, proposed a new policy to utilize this sector by generating one thousand megawatts in the first phase before 2022.

Overall electricity demand in our nation is estimated to exceed more than 9.5 lakh MW by 2030. The energy resources from the above forms could fulfill national energy needs. If the energy from non-renewable sources such as coal, natural gas and oil are not used, it will be possible to generate the electricity from renewable sources i.e. seventy percent by next 10 years. A high amount energy can be available from renewable sources according to production target of the year 2022: solar energy about one lakh MW, followed by sixty thousand power from wind, ten thousand MW energy from biomass and five thousand from small hydropower project. From long coast line, we are generating maximum energy from geo thermal sector, which fulfills the energy needs in the future.

III. SMART GRID TECHNOLOGY

The above technology refers to future generation power grids, with multidirectional energy and information flows to set a broad distributed network. By the use of intelligent network, an energy system becomes intelligent when detecting, controlling, applying along with communicating intelligence. With an ideal system, the above technology is highly reliable, since they allow more functions which can be optimized with the integration with the use of mass generation and transmission. The future grid will keep the environment free from contamination. It will be cost effective and reliable being free from all types of dangers.

3.1 Making the smart grid:

Smart grid is a two-way communication. Due to digital technology which permits bi-directional interaction between utility and customers as well as the detection on that lines of transmission, the network becomes smart. Similar to the internet this intelligent network can comprise controls computers and automation. In such cases, this technokgies work with electrical network which responds digitally to the varying demands of electricity.

3.2 Work of smart grid:

The function of the smart grid is to offer higher reliability and efficiency for the transition period it is required to have testing, technical progress, consumer education and projective projects exchange of development. The chief advantages of smart grid are:

(i)Speedier maintained in restoring electricity and preventing electrical disturbances.

(ii) Minimum operating and management costs for the consumers. Reduced operating and management costs

(iii) More efficient electricity transmission.

(iv) More effective integration of large renewable systems.

(v) Benefits the customer owner of power stations.

(vi) Stealing of electricity can be decreases.

3.3 Origin of smart grid:

Although the electrical grid started in 1886 great Barrington Massachusetts. Smart grid technology started after 2003 north eastern blackout in united states. The definition of Smart Grid is attributed to energy independence and security act of 2007 approved by US congress.

IV. SMART GRID TECHNOLOGY IN INDIA

India is a country in which demand for the electricity is increasing day by day therefore smart grid technology will become one hand in power sector. India also seen several black outs throughout the years from this Indian power sector is well depend on smart grid technology for the well reliable operation of distribution. As per the ministry of energy the network and distribution losses are in the highest in the world. 26% not include non-technical losses such as theft. If These losses are included the figure goes up to 50%. Some technical errors of Indian power grid are 1) poor planning of distribution network 2) over loading 3) lack of reactive power support and improper regular services such as bill collection and counting. On 27-Mar-2015 the national smart grid mission was initiated after black outs took place in 2012.As of now there are 14 smart grid pilot projects implemented by state owned distribution facilities [10]

Bangalore electricity supply company limited, Bangalore, Karnataka	USD 100 Million smart grid pilot project
North Delhi power limited.	Collaboration with G.E for smart grid
IIT K & IIT M	Collaboration with IBM for Smart grid research.
Management development institute , Gurgaon Haryana	Smart grid education program at the school of energy management

Table 1: efforts of smart grid in India

V. POWER SYSTEM SCENARIO

The statistical data of energy consumption says that the world is producing and using 5.67* 1020 joule of energy in 2013.This is equivalent to 18 terawatt hour which is same as 5 billon barrel of oil per year or 1 billon tone of coal per year [11]

5.1 Power sector in India:

The install capacity of power is around 350 thousand Megawatt [12]; Electricity act 2003 came into operation from 15-06-2003 with the objective of introducing competition, providing power for all and protecting consumer interests. This act provides the national electricity policy. In India due to heavy industrialization and introduction of power consuming technologies control of power has become two edge knife. From 20th century onwards several technologies are come on to use for control the losses in the power sector. one such method is smart grid technology introduced in India in 2015.

VI. SMART GRID AT THE GLANCE

A smart grid network essentially has overlaying mechanism for power systems having information system. It is an improvement over the conventional grid. It transforms the traditional unidirectional power to an intelligent system of bi-directional exchange of electrical energy. The network includes sensors, smart meters and automatic fied devices for predicting, adapting and reconfiguring with reliability and efficiency

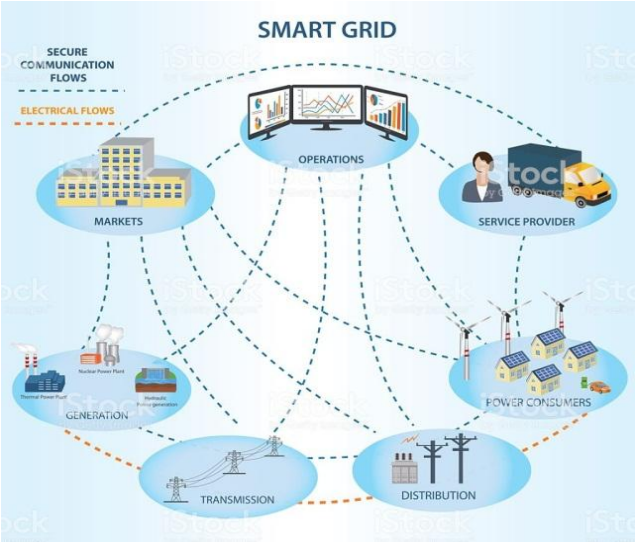

Fig:1 conceptual view of smart grid

From the fig 1, all the platforms like generation, transmission, distribution, power consumers, and markets are connected to service provider. This service provider will take care of the power system. If any mismatch between the electrical parameters occur, then this do the correction.

Instead of using normal grid, use of smart grid will has so many advantages.

BEFORE SMART GRID	AFTER SMART GRID
one way information is possible	Two way information is possible
Electricity generation is centralized	Electricity generation is distributed
Only limited sensors are in use.	Sensors which are in advanced technology are in use.
If any fault occurs manual healing is done	If any fault occurs in a system Self-healing is done
Failure & Black Outs are common	Adaptive islanding method which reduces the failure and black outs
For consumer the tariff choices are few	For consumer the tariff choices are many
Electro Mechanical	Digital

Table 2. comparison of system before and after smart grid

VII. MANAGING ENERGY DEMAND

Normally Demand side response or Demand side management called as Managing energy demand. Energy demand managing is one of the important criteria for reliable usage of energy. Without the concept of Managing energy demand a power distributor or a consumer was not able to know how to use the electricity efficiently. In this case the energy demand on the consumer side is made by various techniques such as tariff methods and economic

Energy management on demand side implies that the consumer should use less energy in the peak hours [6] The role of renewable energy sources becomes significant due to increase in demand In this paper the management of such sources is done by smart grid.

VIII. ENERGY MANAGEMENT THROUGH SMART GRID

The period of changing smart grid from one state condition to another is proved by the need to satisfy the day by day increasing consumption of electricity and to ensure a secure and sustainable supply of the electricity system. The best approach for the smart system is to develop the grid in combination of all energy sources(renewable) which are available at an area so that as smart grid technology can use digital technology. Therefore, the integrated values of all generation is sent to the central coordination center with very high sampling speed so as to rectify the mismatch data in the process and to correct unequal effects of voltage and power in the system. In addition to this smart grid technology development on the generation area, management of energy, algorithms approaches, optimization techniques on the load side are needed to improve the power system for satisfying future requirements [7]. Centralized optimization, autonomous & cooperative are still regarded as an essential approach of energy management of smart system and smart distribution system and demand side. In this aspect, smart grid concept mainly focuses about how one can utilize the integration of wind power and solar power with the combination of loads with demand response.

IX. SMART GRID APPROACH TO HOME APPLIANCES

Smart grid develops a new system which includes the consumer's appliances, managing energy devices, digital equipment, and end side users in order to attain energy management at higher level [7]. In house, appliances are connected with energy management devices which are controlled by end-users and these are over communication network to better monitor energy consumption and production.

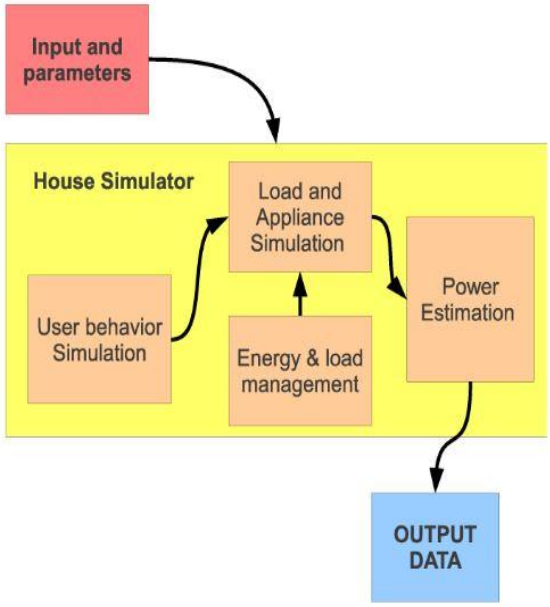

Fig 2: House simulator for energy management

The above figure shows that all the load and simulation is connected through energy management simulator. The basic point for smart grid development at present is real time communication, because it will allow the end users to have electricity rates at real time conditions and it will also allow incentive signals, so that they have a choice either to consume energy or give the energy to the grid. The above method allows every house with the end users to have a real source of energy production and also have a real time energy savings.

Cost benefit analysis:

By the help of cost benefit analysis, we have

(i)Consumption of electric energy in home appliances will reduce.

(ii) At the grid level, losses of electrical energy will be reduced.

(iii) Environmental impact, due to the reduction of the electric energy demand, which can be result in reduction of the CO2 emissions, as well as with the reduction of the local impact on air pollution, public health and biotic community (emissions of particles, SO2, NOX, CO, etc.).

X. RENEWABLE ENERGY APPLICATION WITH ENERGY DEMAND RESULTS

In Electric power industry managing the emission control is an important task, which shows an adverse effect on environmental protection. Hence research mythologies have optimized emission reduction, [9] with a 3-step control strategy to reduce the emission control and thereby increase the carbon dioxide emission, along with increase in renewable energy sources.

Following case is has been done by this laboratory of palermo, which implemented a complete energy management system of a connected house. This is coupled by means of an ICT tool in a combined PV and ST system under DoS actions

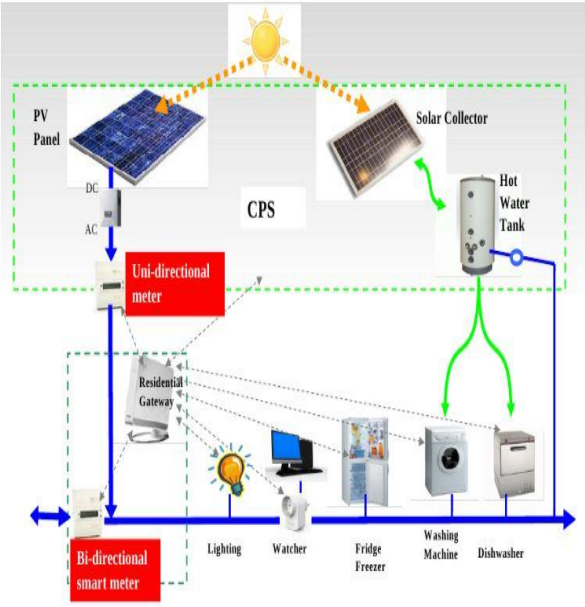

Fig 3: CPS Architecture of a home

XI. CONCLUSION:

From this paper we can give a conclusion that by using smart grid technology one can use the reliable power of renewable energy sources without uneven match between voltage and power. By this technology energy demand is managed so that energy used in reliable condition. And in this paper power sector in India and smart grid installation in India is presented.

XII. FUTURE SCOPE

Smart grid technology is further used in self-healing grid, dynamic control of voltage, weather data integration, distribution and substation automation.

REFERENCES

1. www.iea.org/statistics/electricity
2. www.thehindubusinessline.com/economy
3. www.helloinspire.com
4. www.nrel.gov
5. mnre.gov.in
6. "Demand Management". Office of Energy. From the government of western Australia.
7. Annual Report 2005; Technical Report; Terna: Roma, Italy, 2005.
8. A bottom-up approach to residential load modelling. IEEE Trans. Power Syst.
9. "Demand side load management using a three step optimization methodology," Smart Grid Communications (Smart Grid Comm), 2010 Ist IEEE International Conference on, 2010,
10. http://www.ecoideaz.com/expert corner/smart-grid-systems-in-India
11. https://www.zmescience.com/ecology/climat/
12. https://power.min.nic.in/