# "Renewable Energy Resources With Smart Microgrid Model In India"

Manikant Kumar, Dr. Pratibha Tiwari

**ABSTRACT:** Along with the development of civilization is increasing energy consumption. Due to which India is facing an energy crisis. It is estimated that global energy demand will double in 2030. India Trhurga other developing countries will face a crisis. Returning to the problem Fall growth of renewable energy resources will increase. Even for electricity generation from renewable sources. (Naturally replenished) renewable energy such as sunlight, wind, rain, tides, and geothermal heat, as will have to depend on natural resources. High energy demand and environmental concerns in the papers smart microgrid is forced to change the existing power grid. This paper dynamic demand response and smart microgrid for residential and industrial consumption in the context of renewable energy production, including the proposed management approach. The objectives of this research, renewable energy resources with a smart microgrid has played an important role. Power system in rural areas in India to meet growing energy demand. The model deployed PLC networks, data management system, sensors, Switchgears, Transformers and other utility tools to integrate Smart Grid Smart homes are used together. Analytical results Residential renewable energy generation and smart meters show the effectiveness of the proposed system to optimize control of the electrical grid and is designed to improve energy conservation.

**Index Terms**: renewable energy programs, solar, photovoltaic, wind, biomass

## I. INTRODUCTION

In India, the global energy crisis and environmental deterioration are working on several research Smart Grid solution. Existing electricity grid software, sensors, and information and communication technologies as well as smart grid is being transformed [1]. Smart microgrid, grid and renewable energy production with two-way flow of energy between consumers can be. Residential smart meter or sensor devices in real time how much electricity has been consumed Its use is used. Smart microgrid platform can be programmed such that only the power consumed from the utility grid, renewable energy sources, while residential consumers consumed power is not billed. The rapid growth in global energy demand, not only the present but also to spend more money on power system will apply significant burden. Residential demand response and smart microgrid with the dynamic renewable energy production: two aspects of these problems can be addressed. Dynamic demand response, consumer Web portal based home energy management controller, which decides the price and user preferences through the use of information, can control power consumption. Therefore, consumers shift load from peak to off-peak periods can choose low-cost energy. As an alternative to conventional energy production for residential renewable energy. Electricity demand in the current situation and to meet the large amount of work that could help. However, investment costs and return on investment for the first time over the simple system. In general, there are two types of microgrid: grid-connected and off-grid microgrid [2].


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Microgrid first grid-connected renewable energy use. Distributed energy is not enough, the remaining energy will be drained from the main grid. - 20% [3], the real-time power consumption through smart metering, according to several studies, the reaction is believed to reduce power consumption as such. India is located in the northeast of the South Asia region. Myanmar, the Southeast and the southern boundary of the Bay of Bengal. India's total land area is 3,287,263 square kilometers. In 2016 the population of the country Gross Domestic Product (GDP) of US $ 51,939 per capita GDP reached $ 15,189 average annual growth rate of 7.4% [4] up. Currently, 78.7% of the total population in India are using for electricity [5]. 938.82 kWh per capita electricity productions, which is very low compared to other developing countries in the world. Because of the country's social and economic development, in particular energy and electricity demand is growing rapidly. Is known that the energy of the primary energy sources such as natural gas and coal reserves in India, compared to the country's development requirements are limited. Known energy reserves in India such as natural gas and coals that are the primary energy sources are limited in comparison to the development requirements of the nation. Under the renewable energy policy 1997 of India, Government has been set a target to meet 4.94% of the total generation (82,415 MW) by 2016 and 5% of total generation (155,870MW) by 2017from renewable energy sources [5]. Currently, the renewable sources contribute less than 12.12 % of total electricity generation of around 85,632.81 MW against the estimated demand for 303,083.21MW [5].

## II. PRESENT POWER SCENARIO IN INDIA

Electricity is a key ingredient of socio-economic development of a country. Power division was established in 1947 under the Ministry of Power, Energy and Mineral Resources in India. Power division is responsible for formulating policy relating power generation, transmission and distribution of the country. Generation of electric power in India is not sufficient to meet the consumers growing demand. The Government has given top priority to the development of the sector considering its importance in overall development of the country. The Government sets the goal of providing electricity to all citizens by 2020 [6]. At

present the power demand in India is about 303,083.21MW, whereas the generation range is only 82,415 MW though the generation capacity is 169,403MW [7]. So it is not possible.

***Table 1:-*** *Present Power Scenario in India*

| SI.NO | Items | Status(2016) |
|---|---|---|
| 1 | Electricity Growth | 7.4% |
| 2 | Total Consumer | 938.823 Billion |
| 3 | Transmission Line | 313,437 CKM |
| 4 | Distribution Line | 596,100 CKM |
| 5 | Per Capita Generation | 746KWH Per Capita |
| 6 | Access to Electricity | 78.7% |
| 7 | % Generation Capacity | 149,403MW |
| 8 | % Demand | 303083.21MW |

India relies heavily on natural gas resources for its generation, but the present reserve would be depleted by the year of 2016 [7]. The electricity also generate from other sources such as diesel, coal etc. A little portion of electricity is generated from renewable resources. Different fractions of total electricity generation from various sources are given in Fig. 1 and Fig. 2.

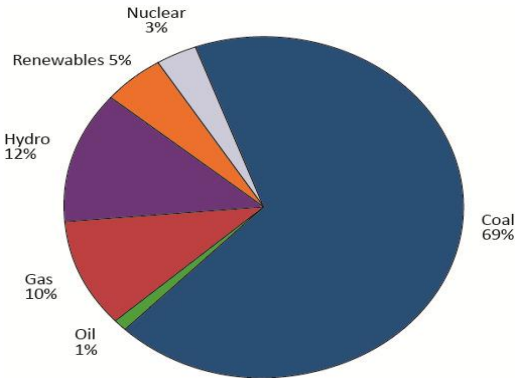


***Fig 1:-*** *Fuel wise generation capacity in 2016*

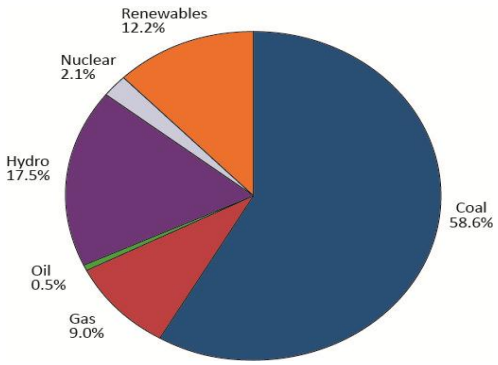


***Fig 2:-*** *Fuel wise generation capacity (by planning) in2017*

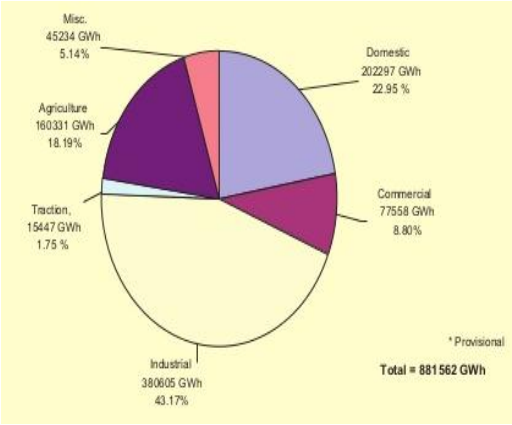


*Fig.3. Power consumption pattern of the country, 2016*

## III. RENEWABLE ENERGY RESOURCES IN INDIA

Renewable energy, such as sunlight, wind, rain, tides, geothermal heat generated from natural resources such as renewable energy resource is virtually unlimited source. Use of renewable energy in both developed and developing countries has increased significantly in recent times. Renewable energy technology in Asia, China has achieved considerable success in using. While initial installation costs of renewable energy, but it gradually declined and the purchasing power of people will come down. Government to expand the use of renewable energy and ensuring energy security for the future has taken steps to develop. Approved according to the Renewable Energy Policy 1997, aiming to produce electricity from renewable resources by 2016, 77,044MW has been set (5% of total production) by 2017 (12.2% of total production) [5]. Renewable energy policy to attract and encourage the private sector has been adopted. In addition, the Government Sustainable Energy Development Authority (SED A) that extend and develop renewable energy, promote energy saving and to create awareness among users of electricity have been installed is to install. India is the economic potential of renewable energy resources.

- Solar Energy
- Wind Energy
- Biomass Energy

**a. Solar Energy** Solar power, a clean renewable resource with zero emission, has got tremendous potential of energy which can be harnessed using a variety of devices. With recent developments, solar energy systems are easily available for industrial and domestic use with the added advantage of minimum maintenance. Solar energy could be made financially viable with government tax incentives and rebates. An exclusive solar generation system of capacity of 250 to KWh units per month would cost around Rs. 5 Laces+, with present pricing and taxes. Most of the developed countries are switching over to solar energy as one of the prime renewable energy source. The current architectural designs make provision for photo voltaic cells and necessary circuitry while making building plans. India's power sector has a total installed capacity of approximately 1, 46,753 Megawatt (MW) of which 54%

is coal-based, 25% hydro, 8% is renewable and the balance is the gas and nuclear-based. Power shortages are estimated at about 11 % of total energy and 15% of peak capacity requirements and are likely to increase in the coming years. In the next 10 years, another 10,000 MW of capacity and investment of about Rs. 24 lash core are required. Fortunately, India lies in sunny regions of the world. Most parts of India receive 4-7 kWh of solar radiation per square meter per day with 250-300 sunny days in a year. India has abundant solar resources, as it receives about 3000 hours of sunshine every year, equivalent to over 5,000 trillion kWh. India can easily utilize the solar energy or Solar Power. Today the contribution of Solar power with an installed capacity of 9.84 MW, is a fraction « 0.1 percent) of the total renewable energy installed 13, 242.41(as on 31st October 2008 by MNRE). Solar power generation has lagged behind other sources like wind, small hydropower, biomass etc. But now realizing the potential of solar energy, Prime Minister of India unveiled a National Climate Change Action Plan in June 2016. The plan will be implemented through eight missions with main focus on solar energy in the total energy mix of the country.

b. **Wind Energy**: - Wind power is one of the most efficient alternative energy sources. There has been good deal of development in wind turbine technology over the last decade with many new companies joining the fray. Wind turbines have become larger, efficiencies and availabilities have improved and wind farm concept has become popular. It could be combined with solar, especially for a total self-sustainability project. The economics of wind energy is already strong, despite the relative immaturity of the industry. The downward trend in wind energy costs is predicted to continue. As the world market in wind turbines continues to boom, wind turbine prices will continue to fall. India now ranks as a "wind superpower" having a net potential of about 45000 MW only from 13 identified states.

c. **Biomass Energy**: - Biomass energy can play a major role in reducing India's reliance on fossil fuels by making use of thermo-chemical conversion technologies. In addition, the increased utilization of biomass-based fuels will be instrumental in safeguarding the environment, creating new job opportunities, sustainable development and health improvements in rural areas. Biomass energy could also aid in modernizing the agricultural economy. A large amount of energy is expended in the cultivation and processing of crops like sugarcane, food grains, vegetables and fruits which can be recovered by utilizing energy-rich residues for energy production. The integration of biomass-fuelled gasifies and coal-fired energy generation would be advantageous in terms of improved flexibility in response to fluctuations in biomass availability with lower investment costs. Waste-to-energy plants offer two important benefits of environmentally sound waste management and disposal, as well as the generation of clean electric power. Waste-to-energy facilities produce clean, renewable energy through thermo chemical, biochemical and physicochemical methods. Moreover, waste-to-energy plants are highly efficient in harnessing the untapped sources of energy from a variety of wastes.

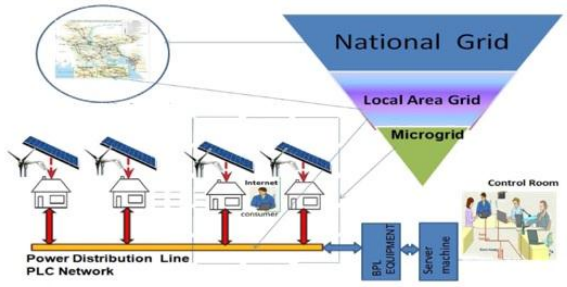


***Fig 4:-*** *Simplified architecture of the purpose model*

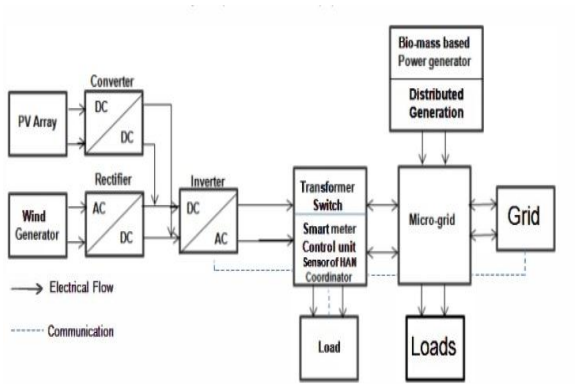


***Fig 5:-*** *Basic block diagram of purpose smart microgrid model with renewable energy resource*

In summary, the average solar radiation in India is relatively high. This would give a relatively good possibility and opportunity to engage the solar photovoltaic technology as a component of renewable energy system. As a relatively coastal belt and off-shore area of country, India benefit from wind resources that is a great potential for rural electrification. Other renewable energy resources include bio-fuel, gasohol, geothermal, hydro, river current, wave and tidal energy. Potentialities of these sources are yet to be explored.

***Table 2:-****Summarization of present power generation from renewable resources in India*

| SI.NO | Type of Renewable Source | Capacity(inMW) |
|---|---|---|
| 1 | Wind | 26866.66 |
| 2 | Solar | 6762.85 |
| 3 | Small Hydel Power Project | 4273.47 |
| 4 | Biomass Power | 4831.33 |
| 5 | Waste to Power | 115.08 |
| | Total –Grid Connection power | 42849.38 |

## IV. PROPOSED SMART MICROGRID ARCHITECTURE WITH RENEWA BLE ENERGY RESOURCESES

The residential renewable energy resources must be integrated into the national grid via micro grid by using PLC network. A simplified architecture and a simple block diagram of the proposed web-enabled smart microgrid with

renewable energy resources are shown in Fig. 4 and Fig. 5. At present in the India, there are no known cases of grid-connected residential renewable energy resources. This is opposed to the US, Japan, Australia and other parts of the world where the practice is far more established. Basically, proposed systems involve three connected components:

**Energy resources-** PV array, wind generator, bio-mass based power generator and distributed generation of micro-grid.
**Electronics equipment-** grid-tie inverter, DC-DC converter, rectifier and AC transfer switch.
**Meter and network equipment-** smart meter, control unit and sensor (coordinator) of home area network (HAN).

The PV array and wind turbines are interlinked through a DC bus. Generated electricity from renewable energy resources is used by the home appliances and equipment (load demand). If there is surplus electricity being generated, the inverter and AC transformer switch will feed it into main grid via microgrid. Conversely, if the load is greater than generated electricity, the main grid automatically supplies electricity to the home via microgrid. Control unit of smart meter regulates the flow of power between load and microgrid depending upon power consumption on load. Power electronic converters have been used to extract optimum power of PV array and to allow for variable speed operation of wind turbines. The smart meter enable to bidirectional communication of data and collect information regarding the electricity feed back to the microgrid or main grid from customer premises. A smart meter system includes real-time energy consumption and production information, communication infrastructure and control units. Web-enabled smart meter can be programmed with many functions such as power consumption by electrical appliances in home and demand reporting, load profile, energy usage and billing reports. Consumer can access the information via web server. Communication Architecture of the proposed smart microgrid Model: PLC based communication network for proposed smart microgrid model is shown in Fig.5. The smart grid is a digitally-enhanced version of the traditional grid, where deployed advance communication technologies and computing technologies [1].

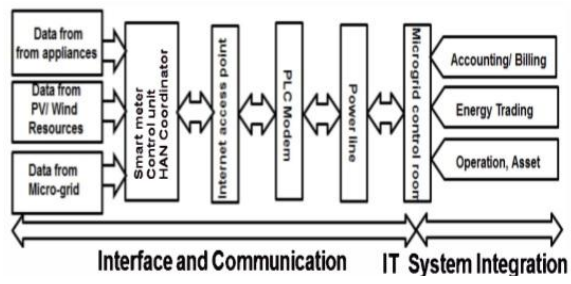


***Fig6:-*** *Communication architecture of proposed smart micogrid model*

In Fig.6, coordinator of HAN device is connected with home appliances and smart meter. Smart meter is connected with micro-grid by using PLC modem and coupling circuit. The control unit manages the home HAN network configuration, as well as exchanges the information between each home appliances and PLC network. In this gateway, power utility company is able to be connected to not only smart meter but also to the existing electric appliances in home via web platform. Technologies are now widely available that bi-directional communication for PLC network [1]. So PLC network is well-suited to rural areas and cost effective solution to communicate between power utility companies and its customers where there is no other communication networks exist. Fig.7 presents complete flow chart of control scheme for our proposed model. When system starts, it checks the parameters from main grid such as voltage, frequency, power factor and feed to control unit of micro grid. Then, check the availability of microgrid power generation; make dynamic demand response profile for microgrid. After that it compares the generated power that is enough to feed the total load of microgrid. If it is not enough, it calls main grid. Main grid automatically power supplies to microgrid. If it is enough then it will go ahead. It checks AC bus of renewable energy sources. If generations power enough to feed the residential load then it will go to switch on position to connect AC bus of renewable sources. Control unit again checks, if generated power is more the residential load, surplus power feed to main grid via microgrid. Conversely, main grid automatically power feed into load. Proposed smart microgrid model follows the above close-loop system.

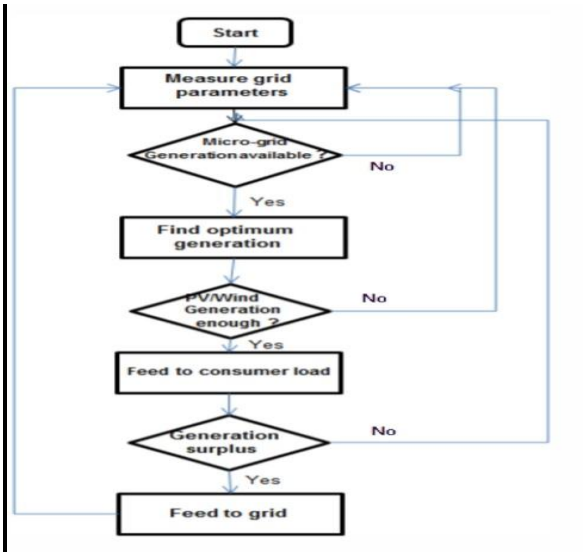


***Fig7:-*** *Complete flow chart four proposed scheme*

## V. PROSPECT ANALYSIS FOR RURAL AREA

In 2016, the installed capacity of renewable energy based power is 250 MW [5]. Nearly 801,358 solar home systems have been installed in India until January 2016 [7]. The worldwide trend has been moving toward grid-connected application supported by market stimulation measure. In Bangladesh, market is manly off-grid application. Recently, government utilities are involved in large scale grid-connected renewable energy based project development. In comparison, the fIrst investment cost is higher than ordinary power generation system. Cost will return back around 10-12 years. We analyze the opportunity and implementation outcomes of our proposed system in prospective of Uchahar in India. In the rural area, easily 400W solar

modules can be placed on rooftop of house with wind generators. Assume 20 household are connected with microgrid. An ordinary house in rural area in Uchahar, may consume around 400-500 KWh per day. From the solar radiation pattern surveyed in Uchahar and the help of solar energy calculator PV watt version 1 and wind speed data in [10]. We have collected the data of power consumption in 2016 for some typical household. Finally, comparison graph from monthly energy demand and estimated generation from smart microgrid is shown in Fig. 8. From the Fig.8, it is evident that a household can save their electricity bill by installing grid-connected renewable energy sources.

## VI. CONCLUSIONS

This paper proposes a combined web-enabled dynamic demand response and optimized renewable energy generation system in rural area of India for smart microgrid. In conclusion, it can be claimed the application of smart microgrid by using PLC network can bring revolution change in national grid of India. Web-enabled residential smart meter employ web principles to interconnect home electrical appliances to smart micro grid. We identify many benefits in using the web as an integration platform for smart microgrid. There is considerable opportunity for Bangladesh to meet its future power demand and thus economic growth through renewable energy. A smart microgrid can benefit use of renewable energy without storage devices, may improve the quality of life of rural people and provide income-generating opportunities with environmental impacts in India. Additionally, in this paper we have proposed and optimized scheme which is suitable for rural area of India to demonstrate how the smart microgrid model can be deployed in rural area. Finally, we analyzed the future prospects of this model with respect typical household rural area in India. For further study, we will go for simulation and hardware implementation of our model and coverage internet service in rural area of India by using PLC network.

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