International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

Options for Rural Electrification via Decentralized Electricity Generation: An overview

Manoj Kumar Shukla[1]
[1]*Lecturer (TPO), Kalaniketan Polytechnic College, Jabalpur (MP) India,*

Abstract: ***The remoteness of Indian villages makes it difficult to be connected with regular electrification grid. As we know that in present time for an all-round development in any field requires sufficient electric supply whether it is agriculture, lighting, industrialization etc. In the present world increasing importance is placed on energy security and sustainable development, role of renewable energy has become even more significant. A combination of factors has contributed to the emphasis for generating electricity through renewable sources of energy. Electrification of rural areas, for instance poses many challenges, foremost amongst which are the investment, operational costs and the difficulties associated with extending grid connected electricity lines to remote areas. In this context, renewable sources of energy including solar power and small scale hydro power have emerged as an economical and sustainable alternative source to promote medium term electricity generation to the rural populace, albeit in small measures.***

Keywords: Decentralized electricity Generation (DEG), Decentralized Distribution Network (DDN), Hydro Power Plant (HPP), Small Hydro Plant (SHP)

I. INTRODUCTION

Reliable access to electricity is one of the top priorities for providing economic growth to human development. To ensure electricity to uncovered Indian homes needs to install extended grid based generation. For this renewable source of electricity generation has to be encouraged. Energy consumption in the world varies as per the living condition. From figure 1 and 2, we can observe that per capita consumption in India is very less. There are number of reasons behind this situation. Low income group, less development of infrastructure, striving for meeting basic livelihood needs, technological unawareness among people living in remote/rural areas are some of the reasons for low capita consumption.

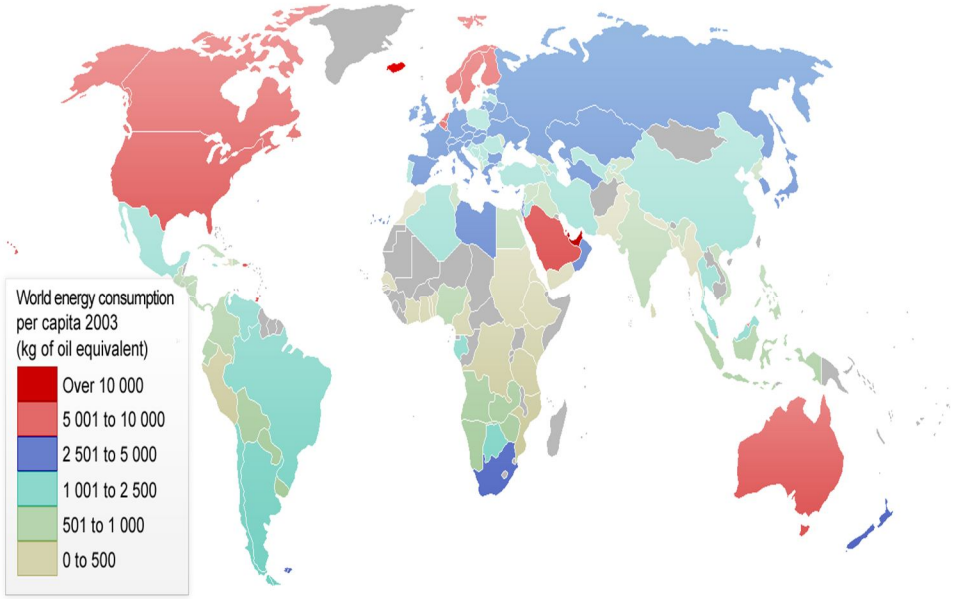

Figure 1. Per capita energy consumption per capita based on 2003 data.
Reference: International Energy Agency.

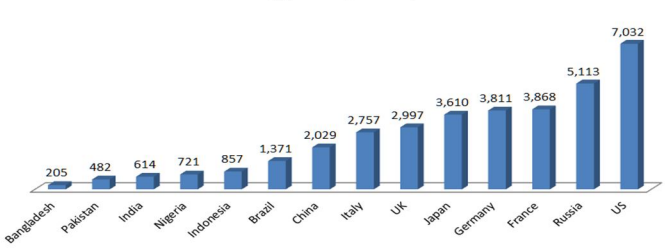

Figure 2: Per capita energy utilization
(Kilograms of oil equivalent)
Reference: The World Bank

To increase the access of electricity to remote population, renewable energy can be an option. Following are the key factor which encourages renewable energy:

A. A large untapped potential
B. Concern for the environment
C. The need to strengthen India's energy security
D. Pressure on high-emission industry sectors from their shareholders
E. A viable solution for rural electrification

Also with a commitment to rural electrification, the Ministry of Power has accelerated the rural Electrification Program. The Ministry of Power has set an agenda of providing Power to all. It seeks to achieve this objective through a comprehensive and holistic approach to power sector development at the National level, State level, State Electricity Board (SEB), Distribution, Feeder and Consumer levels.

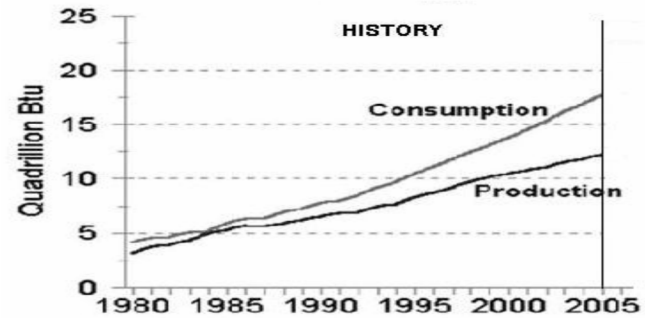

Figure 3: India's Energy balance.
Reference: US Energy Information Administration.

India has had a negative Energy Balance for decades, which has forced the purchase of energy. India is a large consumer of coal. However, more than 1/3 of energy consumed comes from renewable resources, predominantly from large hydropower. India relies heavily on coal energy to produce electricity. Second is hydro power, followed by natural gas.

II. ELECTRICITY POWER GENERATION SCENARIO

India is currently experiencing strong economic growth, while at the same time attempting to extend power services to millions. Expanding electrical capacity is essential. Renewable energy remains a small fraction of installed capacity, yet India is blessed with over 1,50,000 MW of exploitable renewable energy. Efforts should be made towards accelerating these sustainable energy resources before committing to the same fossil fuel path. The fossil fuel strategy will surely bring price volatility from dwindling supplies and adding pollution from carbon combustion. Tapping India's wind, solar, biomass, and hydro could compensate the energy gap from domestic resources. Brief details of these renewable sources of energy are discussed in following section.

A. Hydro Power

As far local distribution system is concerned, small hydro (designated as less than 25 MW) is the most prominent source of renewable energy source for energy production. Some key figures concerning small hydro in India are out of approximate total potential of 15,000 MW and with 4,096 potential sites have been identified. With available mature and reliable technology electricity in remote areas can be provided by application of small hydro power.

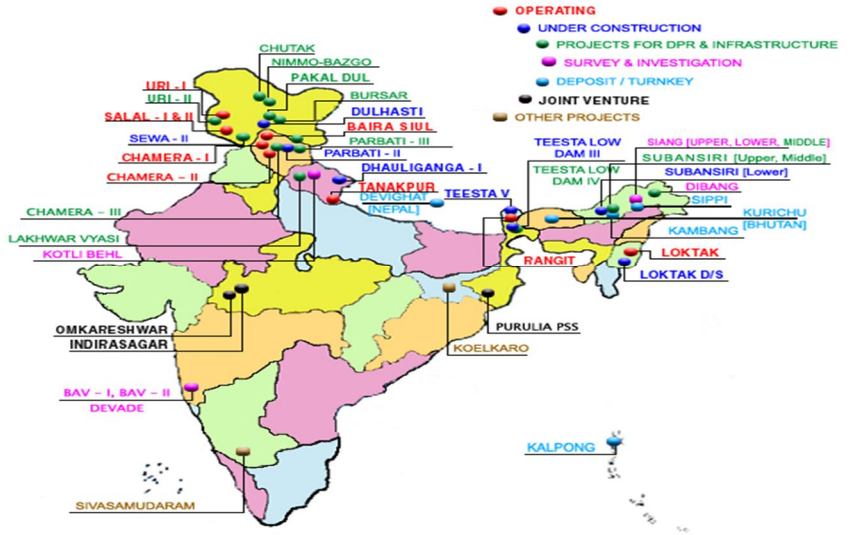

Figure 4: Major Hydro Power Plants in India
Reference: National Hydro Power Corporation, Government of India

Two types of technology are used for hydro power generation viz high head systems and low head systems. Generally small hydro power station comes under low head system. Ministry of Non-conventional Energy Sources is focused on nation-wide resource assessment for setting up of commercial projects, industry based research and development and development of water mills.

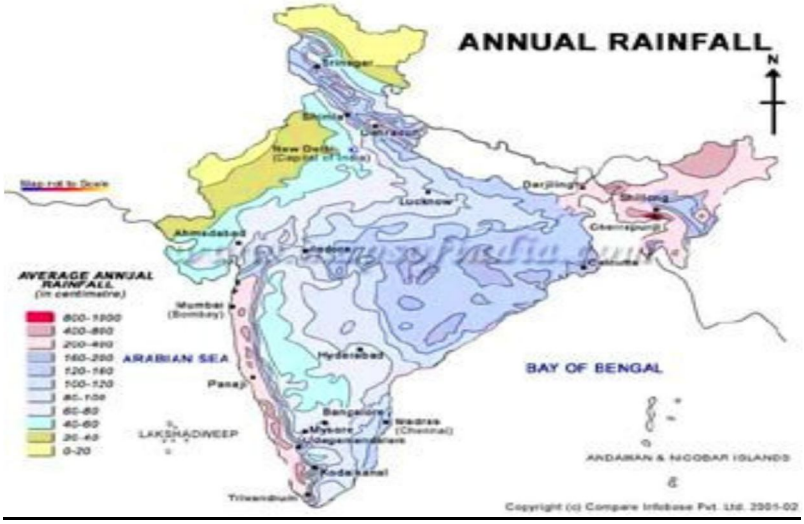

Figure 5: Average annual rainfall
Reference: http://www.mapsofindia.com/maps/india/annualrainfall.htm

As seen from figure that many regions of India is receiving good annual rainfall. If this water is stored in the ponds with creation of some natural height, then it can be used as an input for setting up small hydro power stations.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

B. Solar Energy

Because of its country location between the tropic of cancer and the equator, India has an average annual temperature that ranges from 25°C to 27.5 °C. This means that India has huge solar potential. Solar energy has several applications like photovoltaic (PV) cells which are placed on the roof top of houses or commercial buildings and collectors such as mirrors or parabolic dishes that can move and track the sun throughout the day are also used. This mechanism is being used for concentrated lighting in buildings. Photovoltaic (PV) cells have a low efficiency factor yet power generation systems using photovoltaic materials have the advantage of having no moving parts. PV cells find applications in individual home rooftop systems, community street lights, community water pumping, and areas where the terrain makes it difficult to access the power grid. The efficiency of solar photovoltaic cells with single crystal silicon is about 13 % - 17%. High efficiency cells with concentrators are being manufactured which can operate with low sunlight intensities.

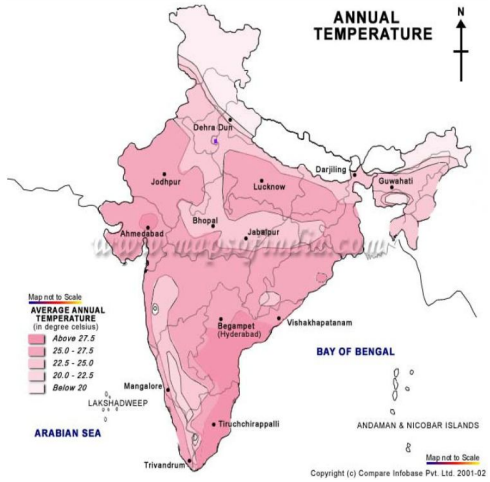

Figure 6: Annual temperature zone
Reference: http://www.mapsofindia.com/maps/india

As seen from figure that many regions of India is receiving good sunlight. This sunlight can be converted to electricity with the help of PV cells.

C. Wind Energy

India is surpassed by one of the world's fastest growing markets for wind energy. By the mid 1990s, the subcontinent was installing more wind generating capacity than North America, Denmark, Britain, and the Netherlands.

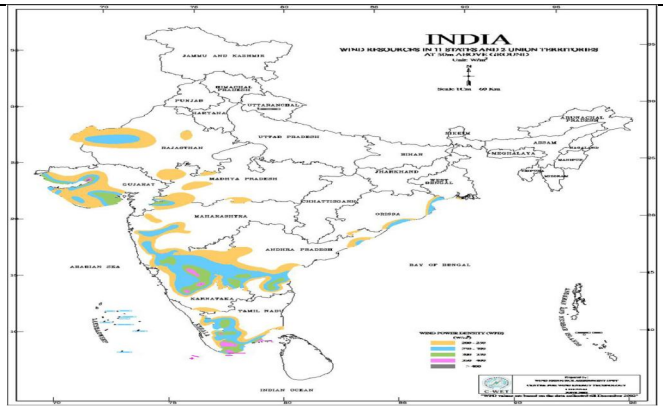

Figure 7: Wind Energy in India
Reference: http://www.cwet.tn.nic.in/html/departments_wpdmap

It is one of the most environment friendly, clean and safe energy resources. It has the lowest gestation period as compared to conventional energy. Equipment erection and commissioning involve only a few months. There is no fuel consumption, hence low

operating costs and low maintenance costs. Installation of a wind turbine requires very limited area. The essential requirements for establishment of a wind farm are high wind resource at particular site, adequate land availability, suitable terrain and good soil condition, maintenance access to site and nearby power grid. Some limitation of a Wind energy are wind machines must be located where strong dependable winds are available most of the time, because winds do not blow strongly enough to produce power all the time so energy from wind machines is considered "intermittent" that is it comes and goes. Therefore electricity from wind farms must have a back-up supply from another source. Electricity produced by wind power sometimes fluctuates in voltage and power factor, which can cause difficulties in linking its power to a utility system. The noise made by rotating wind machine blades can be annoying to nearby neighbors.

D. Biomass Energy

Biomass includes solid biomass (organic and non-fossil material of biological origins), biogas (principally methane and carbon dioxide produced by anaerobic digestion of biomass and combusted to produce heat and/or power). Liquid biofuels (bio-based liquid fuel from biomass transformation) and municipal waste (wastes produced by the residential, commercial and public services sectors and in specific installations to produce heat and/or power). The most successful forms of biomass are sugar cane in agriculture, pulp and paper residues in forestry and manure in livestock residues. It is argued that biomass can directly substitute fossil fuels, as more effective in decreasing atmospheric CO_2. The most common methods for this are combustion, gasification, fermentation, anaerobic digestion. India is very rich in biomass.

Economic, social and environmental benefits of renewable energy have been recognized and are attracting policy makers to frame policy accordingly. The electricity consumption and generation forecasts of India are as a part of the emerging economies. So it is needed to promote renewable energy. Growth in net electricity consumption is expected to be rapid pace in India. Emerging economies have projected growth in net electricity consumption as a driven large part by gross domestic product (GDP) and population growth. Because of the links between reliable electricity supply, GDP growth and living standards, emerging economies are attempting to increase access to reliable electricity supply.

E. Projected Energy Consumption Of India By 2030

Currently many households in India do not have access to electricity. Government has set a target of electrifying all households. Among all potential renewable resource of energy generating capacity in India, hydro power plays an important role especially small hydro power. Contribution of Small Hydro Power can play a vital role in this mission because of its many advantages like eco friendly nature, no CO_2 release, flood control, renewable source of energy. In order to achieve this target proper policy planning, effective monitoring and performance evaluation of Hydro Power Plants (HPP) is to be made prime concern. Also since there are many types of Hydro power plant schemes like micro, mini, small and large power plants which make its wide spectrum of application for power generation. Huge opportunity of growth is present in this sector and the efficient utilization of resources is to be used to obtain the goal. Work should be done to obtain optimum power from HPP keeping in mind hydel importance economically. Hydro power is by far the single largest renewable source of energy in India. While most of this energy is from large HPP, small HPP have also started making a dent in India. In terms of small/mini/micro HPP potential, in the present scenario large HPP is focused more but it has many problems like its construction, operation and managing. Considering the investment in HPP, generation cost is less as compared to thermal.

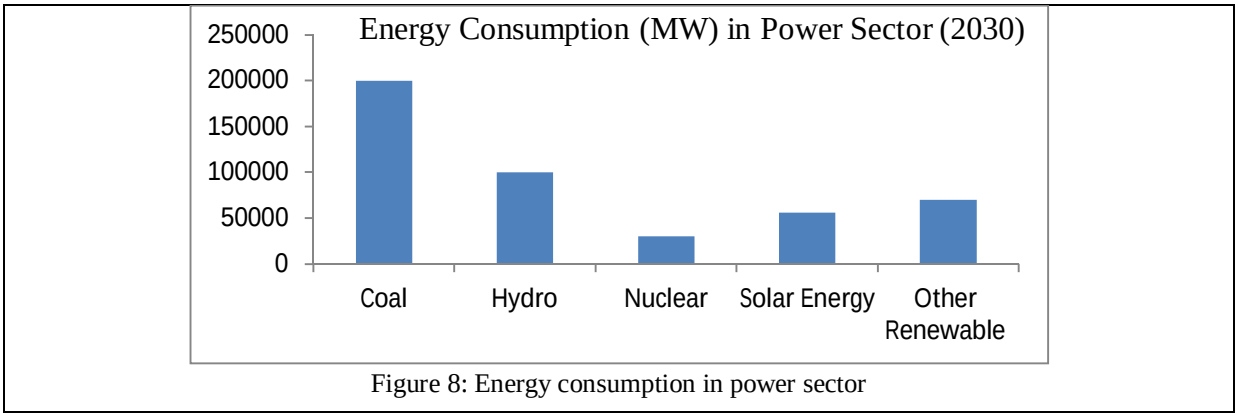

Figure 8: Energy consumption in power sector

Energy productions from different sources of energy are shown in figure 11 & 12.

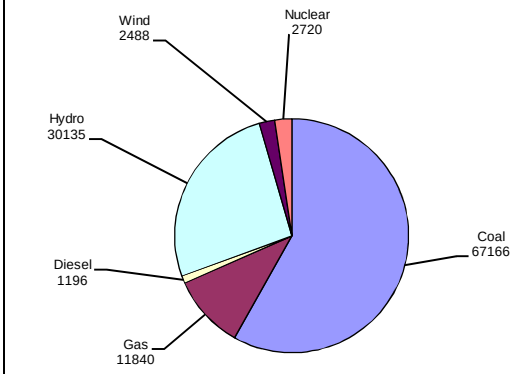

Figure 9: Energy productions from different sources of energy in MW.

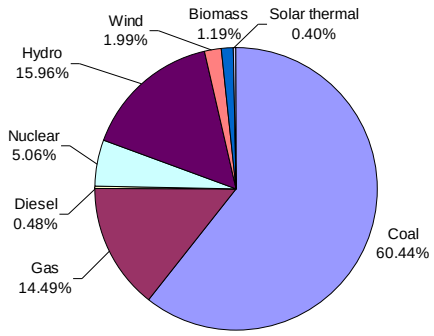

Figure 10: Energy productions from different sources of energy in percentage.

It is a matter of serious attention for all of us connected with our Country's development that even after more than half century of our independence, we are not able to ensure availability of reasonable level of electric supply to the citizens. Instead of looking for whole GOI support, with the advent of small/mini/micro HPP, less capital and less area is required that can support very much in the plant setup and promote Decentralized Energy (DE) generation. Contribution of NGO, local youth and technical peoples can be taken for meeting basic need of electric supply for all.

F. Reasons for improper development of HPP.

Before discussing the objectives of present research work, barriers in the traditional approach of Hydro power plant setup are discussed. The energy of running water has been exploited for many years. However traditional approaches have suffered disadvantages due to social, environmental and economical factors such as building a dam, alters the landscape, affects local community, changes the character of river and prevents the free movement of fish. Permanent or partial blockage of a river for energy conservation adversely effects nature due to the variation of flow. Building large scale HPP can be polluting and damaging to surrounding ecosystems. Changing the course of waterways can also have a detrimental effect on human communities, agriculture and ecosystem further downstream side. (Reference: TERI information monitor on environment science, 1 2, pp. 81-93 1. Water power & dam construction, 1995). However setup of small/ mini and micro hydro power helps in fulfillment of decentralized energy generation and distribution.

III.DECENTRALISED ENERGY GENERATION

The most common means of generating electricity in most countries around the world is via centralized generation. Whether a central plant is a 1000MW coal plant, a wind farm, a large dam or a nuclear reactor, the model is same. The plant is typically located some distance from where the power is required. Electricity is generated on large scale then transmitted at high voltage via transmission towers often great distances. Voltage must then be stepped down to a distribution level. Between 5 and 10% grid losses are common as a result of transmitting power large distances. This means that central generators must generate 5% to 10% more power than is required. Indeed an additional 5% to 10% of generating capacity is required to meet demand and this means additional capital funds must be spent that could be avoided if DE was instead employed.

Decentralized Energy (DE) is defined as the electricity generation at or near the point of use, irrespective of size, technology or fuel used both off-grid and on-grid. It can include renewable energy, cogeneration plant and industrial energy recycling. What determines whether electricity generation is DE is not so much how electricity is generated rather where power is generated. DE technologies generate electricity where it is needed. Central generation on the other hand generates electricity in large remote plants and power must then be transported over long distances at high voltage before it can be put to use. It does not matter what technology one employs, whether it is used in connection with an existing grid, in a remote village, whether the power comes from a

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

clean renewable source or from burning fossil fuel. If the generator is on-site it is DE. The figure below, illustrates the extent to which DE is currently being employed in various countries.

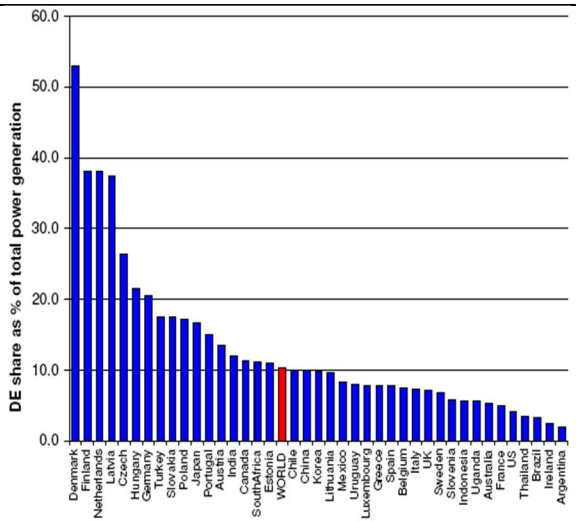

Figure 11: DE share of total generation in different countries.
Reference: WADE 2006 World Survey of Decentralized Energy

DE can also be an attractive economic option in a wide range of communities ranging from multibillion dollar high tech factories to remote and impoverished villages with little financial wealth and no modern energy. For example in a modern data center an array of high tech fuel cells may be an attractive investment to supply reliable and clean power on-site. In such applications, an electrical grid and fuel supply infrastructure (such as pipes for natural gas) are prerequisite. On the other side of the spectrum, in a remote village with no existing power grid or source of modern energy villagers may also invest in DE, for example in the form of a small wind turbine, hydel turbine or PV panel to provide basic illumination. In highly populated areas DE can complement existing central generation capacity and is useful in diverse applications as individual homes, buildings (Universities, Hotels, Supermarkets and Banks) and heavy Industries. In rural areas DE can also be very practical for a wide array of applications like Water pumping, rural electrification, Cottage industry, Textile mills, Sugar mills, Food products and Forestry.
For the rural develoment area, there are some of the problems which are to be kept in mind like there are scattered consumers over wide areas in groupings, very small consumption is to be expected and forecasting is difficult. While in urban areas the form of power supply can be exactly planned and selected with great certainty, starting from the power demand to the center of consumption. But the present scenario of electricity demands favors the decentralized establishment of power stations. Major advantages of DE are low capital costs, simple erection, assembly, commissioning and simple maintenance. Building decentralized energy ensures optimum use of existing energy infrastructure because DE generates power where it is needed thus decreasing overall pollution.

A. Relevance Of Distributed Generation In India

In India, distributed generation has found three distinct markets.

1) Back-up small power generation systems including diesel generators that are being used in the domestic and small-commercial sectors.
2) Stand-alone off-grid systems or mini-grids for electrification of rural and remote areas.
3) Large-captive power plants such as those installed by power intensive industries.

Government is promoting distributed generation and supply system through conventional and renewable energy systems especially for rural electrification though it can be used in other situation also. Persons setting up new distributed generation setup are exempted from licensing and licensee related obligations. Facilities are being created for establishing decentralized distributed generation of electricity. Two such schemes are RGGVY (Rajiv Gandhi Grameen Vidyutikaran Yojna) and the RVE (Remote Village Electrification) scheme provide upto 90% capital subsidy for rural electrification projects using DDG (decentralized distributed generation).

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

IV. CONCLUSION

Integrated sustainable decision support system for DDG described here could probably be commercialized in near future. Also further application of study can be implemented to hydro-thermal power plant setup. Further efforts are needed to develop these integrated systems for sustainable power developments for rural electrification. The research includes conducting feasibility study for setup of cascaded hydro power plant fulfilling the constraints and uncertainty analysis. Establishing reliable relationship and perfect correlation start-up procedures for successful operation of the plant, developing process controls that accounts for potential fluctuations in input quality and quantity, optimizing the plant design for given constraints feedback type, inflow content and other factors as per site specific variables. Like any village electrification program, DDG would contribute to rural development by providing sustainable electric power for basic residential needs as well as cottage enterprises and agricultural equipment such as irrigation pumps, reducing T&D losses. The technology described will enable rural areas to generate income by attracting electricity-consuming industries and by exporting surplus electric power to urban demand centers. The export of electricity can benefit rural communities.

REFERENCES

[1] Peter Meisen, “Overview of Renewable Energy Potential of India”, President, Global Energy Network Institute (GENI), October 2006.
[2] Morozowski, “the problem of managing a HEPP: An approach based on traditional techniques and SD”, Brasil.
[3] V S Arunachalam, Center for Study of Science, Technology and Policy, Bangalore, INDIA www.carnegieendowment.org
[4] Decentralized electricity solution setup by TERI 2008.
[5] India Ministry of Non-Conventional Energy Sources (MNES) http://mnes.nic.in/
[6] The President of India www.presidentofindia.nic.in
[7] The Energy & Resources Institute (TERI) http://www.teriin.org/
[8] Maps of India http://www.mapsofindia.com
[9] Zenith Energy http://www.zenithenergy.com/index.HTM
[10] Confederation of Indian Industry (CII) http://www.greenbusinesscentre.com/renenegy.asp
[11] Centre for Wind Energy Technology www.cwet.tn.nic.in