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REVIEW OF DISTRIBUTED GENERATION PRODUCTION AND INTERCONNECTION WITH RENEWABLE RESOURCES IN INDIA

Surbhi Bakshi
Research Scholar
Deptt. of Electrical Engineering
PEC University of Technology, Chandigarh, India
surbhi_pec@yahoo.com

ABSTRACT
Distributed Generation plays a very significant task in the electricity generation theory in the world. In India too, it is one of the major forms of renewable energy resources offering to the electricity and power sector of India. In this paper, the development for DG has been discussed so far in India. The major renewable energy resources available in India are focused along with their advantages and production pollution less electricity contributing in forming Indian power sector clean and green. The relevance of DG in India is put in to light along with the different policies and projects implemented by the Ministries of India utilizing renewable resources. Certain issues related to Distributed Generation are also discussed that must be determined for making DG system more competent and consistent.
Index Terms—Renewable resources in India, Distributed Energy Resources (DER), Distributed Generation (DG)

I. INTRODUCTION

Distributed generation (DG) is defined as small-scale electric generation of power (generally 1 kW – 50 MW) generated at site close to consumers or are in close contact with an electric distribution system. DG options can be either classified on the basis of engines and turbines or on the basis of fuels used ie. it is renewable or non renewable. In the same way Distributed energy resources (DER) are defined as small power sources that can aggregate to supply necessary power for meeting regular demands of consumers. With the modernization of electricity grid, DER technologies like storage and advanced renewable technologies help in facilitating the conversion to a smarter grid [1]. In India there are number of renewable energy technologies that are being employed in many DG projects which includes the use of wind energy, solar energy, hydrogen energy etc. Various technology options for DG in India are illustrated in figure 1 below [2].

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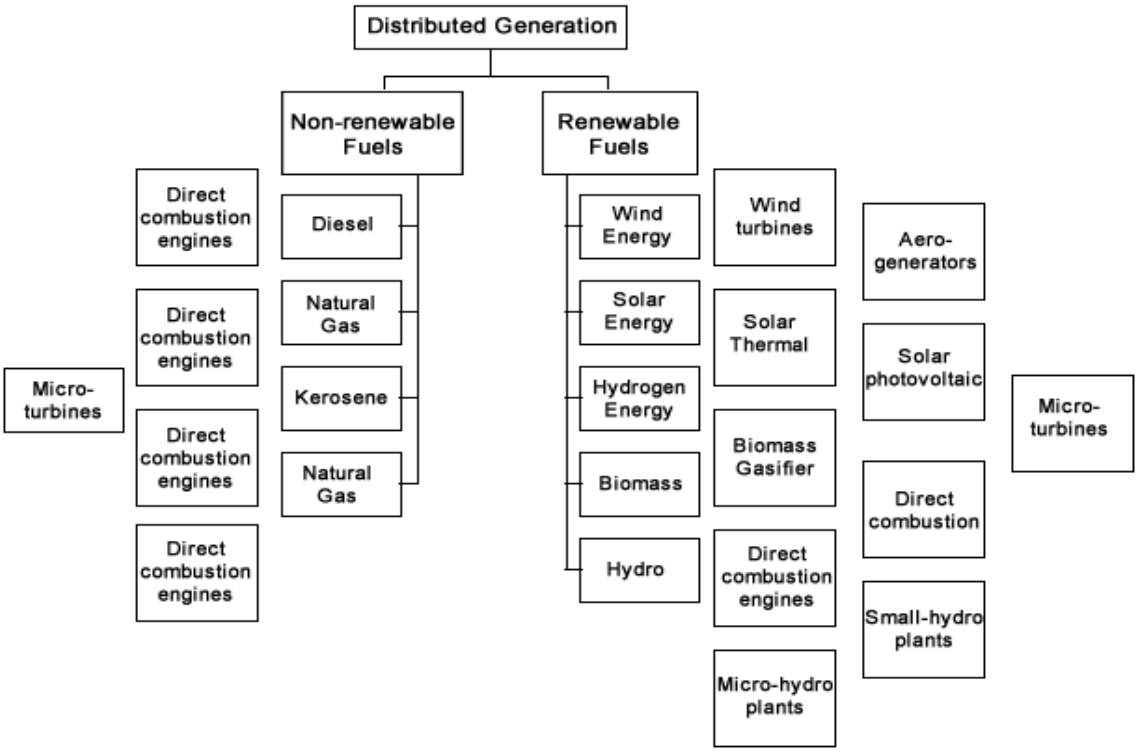

Fig 1: Technology options for distributed power generation

There is a need to find solutions of various challenges as addressed by India for getting sustainability of energy in 21st century. The practices are needed to be found to remove complexities obstructing the development like: when demands of consumers and supply are not matching or the problems faced while substituting the one directional system with hybrid systems exploiting different types of supplies and sources of energy. The designing of novel systems which influence active infrastructure based on central generation is one of the major challenges. [3].

INDIA is increasingly becoming reliant on overseas supplies of fossil fuels for empowering our industrialisation. When these resources were inexpensive and abundant, it was logic to move our methods of production away from native resources. But presently, the dilemma of declining production has become more scant and costly. It is time for us to utilize our home energy production and teach masses about dropping demands for energy resources located away from site by meeting large needs as possible using native energy sources [4].

This paper presents an outline of the renewable resources that can be helpful in the power generation using DG in India. Also, issues that must be kept in mind while working on this technique are presented. In order to overcome these issues methodology is also discussed. After the introduction of distributed systems, the paper is organised as follows: Relevance of distributed generation in India in section II. Challenges of DG are discussed in section III. After discussing Technical impacts of DG, conclusions are drawn in section IV.

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II. RELEVANCE OF DISTRIBUTED GENERATION IN INDIA

In India consumption of electricity per capita is low and is only 4% of total consumption in US, 40% in China, 7% in Japan and 23% of world average. The table 1 below is showing the energy indicators around the world.

Table 1: Selected energy indicators [5]

Country	Energy Consumption per capita(kWh)
China	1379
Australia	10640
Brazil	1934
Denmark	6599
Germany	6898
India	**553**
Indonesia	440
United Kingdom	6231
United States	13066
Japan	7816
World	2429

India had decided that by 2015 DG would meet 10% of India's future power. For fulfilment of this plan, take a quick look on the renewable energy resources for DG [6].

(A) SOLAR POWER: India has the abundance supply of solar energy. In this sector, some large projects have been proposed that are being discussed. In Andhra Pradesh, AP Transco has entered into agreements with IPPs to install 619 MW in year 2014 and the installed capacity is 279 MW as in September 2015 [7]. Gujarat has specially made Asia's largest solar park at Charanka village which is generating 2 MW solar power. Rajasthan has passed 500 MW of its total photovoltaic capacity, having reached 510.25 MW by the end of the 2012-13 fiscal year.

(B) WIND POWER: Tamil Nadu has 35% of the total of India's wind power capacity. As per TEDA, 7253MW is the total capacity in Tamil Nadu of installed systems. During the fiscal year 2014-15, the total generation of electricity is nearly 15% of the capacity utilisation factor i.e. 9.521 billion Kwh. Maharashtra is considered second to Tamil Nadu for the installation of wind power projects in India. The installed capacity of wind energy is 4167.26 MW as on 30 September 2014.

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(C) HYDRO POWER: In 2008 India was the 7th largest producer after Norway of hydroelectric power. The prospective of hydroelectric power in India is very large as compared to others in the world. The Babail minihydel project in Uttar Pradesh was accepted in September 1986 and was awarded Rs 6.22crore to PGM in Sep 1988 as a turnkey project [9]. The dam under the Bhatgar project in Maharashtra was part of the world's largest irrigation project, known as Lloyd Barrage.

(D) BIO-FUELS AND WASTE-TO-ENERGY PRODUCTION: Andhra Pradesh signed a formal agreement of Jatropha planting with the Reliance Industries . The Indian Railways has started to use the oil from the Jatropha plant to power its diesel engines instead of using degradable resources.
One of the project initiated by the government using wood and dung cake fuel for cooking purpose in Shri Nagar and Nagla Ramoli is illustrated in table 2 [5] below.

Table 2: Renewable energy interventions in Shri Nagar and Nagla Ramoli

Type of interventions	Capacity per unit		Total no. of units installed in cluster
	Capacity	Unit	
Biomass Gasifier	10	kW	2
Solar home lighting system	37	Wp	95
Solar Street light	170	Wp	06
Biogas plant	4	M^3	11
	2	M^3	01
Total			12

III. DISTRIBUTED GENERATION CHALLENGES

At present, the small sources contained in distributed generation have no link with power grid. So the grid is unknown to the power actually generated using such sources. Additionally, sources present in DG are also weather dependent like wind or solar resources and at any time their energy supply can be stopped depending upon weather conditions. Apart from it, small generators break down more easily as proper monitoring equipments and personnel maintenance is not possible in small sources.
However, various other issues are also to be determined like with the increase in diffusion of DG different technical problems will be introduced in the working of distribution systems [13]. DG can be accountable for a variety of issues like destitute quality of voltage, unnecessary trips for protection on strong feeders etc. Quality of voltage is a very significant factor in a distribution system with comparatively huge DG amount. Ministry of New and Renewable Energy, India found that there is some universal as well as local challenges for Renewable Energy based Distributed Generation [14-15], like,

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1) Intrinsic irregular character of renewable sources of energy
2) Adequate mobilization requirement for paying the charges of user user
3) Comparatively more per capita costs as compared to conventional systems of power
4) Need for servicing companies for confined program execution.
5) Absence of maintenance services providers and operation are some issues that needs attention.

IV. CONCLUSION

India is on correct pathway to follow progress of DG with the utilization of renewable resources available. Along with efforts are also put in harnessing various forms of captive and co-generation techniques. Two Indian ministries that are Ministry of Power is concerned for electrifying rural areas and Ministry of New and Renewable Energy (MNRE) for developing DG by satisfying the requirement of one another. Liberalization as well as support of Government is required for creating environment to achieve set targets in this track. Some challenges are also discussed that are needed to overcome with utmost sincerity to get success in Distributed Generation.

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