Review on Distributed Generation in India

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ABSTRACT

Due to the depletion of traditional energy, as well as increase in the Energy demand because of growing rates of urbanization, increased energy consumption & economic growth of many countries in the world. To fulfill the increased energy demand India need better cost effective & environmental friendly solution. The alternative way to overcome the above problem is the introduction of distributed generation which can be conveniently located closer to load centers. The main idea behind the Distributed Generation (DG) is that generation in small scale and which can be easily placed at the distribution side. This paper includes various benefits of Distributed generation, different Government polices and technologies of distributed generation.

Keywords: C-Commercially available fuel, Distributed generation (DG), NR-nonrenewable.

I. Introduction

Distributed generation is defined as small scale generation, which is not directly connected to the bulk transmission system & it is not centrally dispatched [1]. In other words Energy is generated and distributed using the small scale technologies, mainly renewable, including but not limited to, wind turbines, photovoltaic cells, geothermal cells etc. Onsite power generation has many benefits compare to the centralized power generation systems, as the onsite power generation reduces the cost related to the transmission & distribution of power over very long distances ,they may be ranging in between few KW's to several MW's. Decentralized generation can take place at two levels, i.e. at a local level, At the 1st level site specific energy sources are used to generate electricity, constituting a microgrid which is a cluster of generations serving a limited number of consumers. At the second level the same technologies are used at small scale and they are installed by an individual energy consumer such a system is called Distributed generation or Decentralized generation. These sources can be individually connected to grid, so that they can supply power to the grid when necessary, creating a proconsumer i.e. a producer and a consumer of electricity.

II. Need of distributed generation

In spite of several policy initiatives by the Government of India as mentioned below, including special focus extending the national grid through "Rajiv Gandhi Grameen vidyutikaran yojana' near about 56% of rural households still do not have access of electricity. The below table 1 shows the projected electricity demand & currently the India has grid connected to total installed capacity of 212GW for electricity generation & it is estimated that to rise at an average annual growth rate of 8% its installed electricity generation would reach up to 779GW within two decades. To meet this huge expected demand of energy, centralized generation & extension of grid will not be economically & technically viable option. However Distributed generation/Decentralized Generation based on locally available energy resources & supply of this additional electricity supply into the rural electricity grid, can be an important part of the solution to meet the electricity demand of rural population. **[5]**

Table1: projected electricity demand of India

Year	Installed capacity(GW) For 8%GDP growth
2011-2012	220
2016-2017	306
2021-2022	425
2026-2027	575
2031-2032	779

III. Distributed generation & Government policies

Distributed generation is a new concept in the electricity infrastructure & there is no generally accepted definition of Distributed generation. Generally Distributed generation is onsite generation connected directly to the distribution network or at the customer site of the meter. DG can be from conventional or renewable sources such as biomass, bio-fuels, biogas, minihydro, solar etc. The below table 2 shows summary of DG option in India [4].

Table 2: Summary of DG option in India.

DG option	Type	Technology status	Capacity factor
Diesel	NR	C,I	N
Gas engine	NR	C	N
Micro turbine fuelled by natural gas	NR	D	N
Fuel cell fuelled by natural gas	NR	D	N
Wind turbines	R	C,I	13% AVG Max 30-38%
Photovoltaic	R	C,I	Max 25%
Biomass gasifier	R	C	N
Gas engine	R	Gasifier I	-
Biomas cogeneration	R	C,I	50% higher if aux –fuel used

NR-Non renewable R-Renewable I-Indigenous D-Demonstration C-Commercially available fuel N-Not constrained by the supply

Conventional fuel based DG can be a better option for energy production but setting up DG facility based on renewable energy will reduce the infrastructure investment. The definition of distributed generation does not define the rating of the generation source, as the maximum rating depends on the local distribution network conditions, for example voltage level. However it is better to introduce categories of different ratings of distributed generation as fallows

Micro distributed generation: 1Watt <5KW;
Small distributed generation: 5KW<5MW;
Medium distributed generation: 5MW<50MW;
Large distributed generation: 50MW<300MW;
These small scale projects generate electricity near the demand centers and thus avoid transmission losses.

a. Government polices

The Government of India has adopted an integrated energy policy which aims to provide energy security to all its citizens and for the rural area through conventional as well as alternative sources of energy. Some of the policies adopted by the Indian Government are as follows.

1. The Electricity Act, 2003 has given a push to distributed generation particularly in the situation of rural electrification. The Act specifies distributed generation and supply through stand-alone conventional and renewable energy systems.

2.The National Electricity Policy notified on 12 February 2005 advise under the Rural Electrification component, that to provide a reliable rural electrification system, wherever conventional grid is not possible, decentralized distributed generation facilities using non renewable or renewable sources of energy together with local distribution network to be provided.

3.Two specific schemes, the" Rajiv Gandhi GrameenVidyutikaranYojna" and the" Remote Village Electrification Scheme" will provide up to 90% of capital subsidy for rural electrification projects using decentralized distributed generation options based on conventional and non-conventional fuels.

4. KutirJyotiyojna

Due to the shortcomings in the method of implementation, these schemes had a limited impact on the rural electrification scenario in the country. The primary reasons for their failures were

- The responsibility of implementing these schemes for village electrification was given to State Electricity Boards which were in bad financial health and hence were unable to provide sufficient funds.
- A substantial infrastructure became useless because state utilities which were given the responsibility of maintenance of rural electricity infrastructure did not have the necessary manpower in remote rural locations.

IV. Decentralized Generation in India

In India, many renewable energy technologies are being employed in a number of decentralized generation projects. The figure below illustrates the technology options for decentralized power generation. In

Indian rural areas, smart micro-grids can provide clean, reliable, affordable, and scalable electrical power. For Indian economy rising fuel costs, under investment in old infrastructure and climate changes are some of the biggest challenges being faced by the energy industry today. Micro-Smart Grid can deliver benefit by the use of renewable energy sources, while improving the reliability, security, and useful life of electrical infrastructure. The development of basic smart grid technologies can be accelerated by bringing together all stakeholders namely, state and local governments, utility companies, public electricity regulators, and IT companies towards a common goal.

V. Technologies of distributed generation

Reciprocating Engines: Reciprocating engines can be fueled either by diesel or natural gas, with varying emission outputs. All engines used for power generation are four-stroke and operate in four cycles of intake, compression, combustion, and exhaustion. The best usage of reciprocating engines is, it will provide continuous power supply or backup energy power[2, 4]. These engines are manufactured in different sizes.

1. Microturbines: Microturbines are an emerging class of small-scale distributed power generation system having the size range of 30-400 kW. Microturbines consist of a compressor, combustor, turbine, and a generator. The compressors and turbines have radial-flow designs. Most of the designs are single-shaft and use a high-speed permanent magnet generator producing variable voltage, variable frequency alternating current (AC) power. Most of the micro turbine units are designed for continuous operation with higher electric efficiencies.

2.Combustion Gas Turbines: Simple cycle combustion turbine units start at about 1MW. These turbines can also be configured as combined cycle power systems to achieve upto 15MW, also called as industrial turbines or miniturbines. Combustion turbines have relatively low installation costs, low emissions, and require infrequent maintenance. Cogeneration DG installations are particularly advantageous when a continuous supply of steam or hot water is desired.

3. Fuel Cells: There are many types of fuel cells currently under development having 5 to 1000+ kW size range, including phosphoric acid, proton exchange membrane, molten carbonate, solid oxide, alkaline, and direct methanol. Fuel cells have very low levels of NOx and CO emissions because the power conversion is an electrochemical process.

4. Photovoltaics (PV): Photovoltaic systems are most commonly known as solar panels. Photovoltaic solar panels are made up of smaller cells connected together which convert light radiation into electricity. The PV cells produce direct-current (DC) electricity, which must then be inverted for use in an AC system. Photovoltaic systems produce no emissions, they are reliable, and require minimum maintenance to operate.

5.Wind Turbines: Wind turbines utilizes wind to produce electricity and require no additional investments in setting up large infrastructure such as new transmission lines, and are thus commonly employed for remote power applications.

6. Solarpanel: Primary issue with solar power is that it is intermittent. Popular sources of power for Distributed generation are solar heat collection panels and solar panels on the roofs of buildings or free-standing. Solar heating panels are used for heating water and when the water is heated into steam it is effectively and economically used in steam turbines to produce electricity.

7. Vehicle-to-grid: Future generations of electric vehicles may have the ability to deliver power from the battery in a vehicle-to-grid into the grid when needed. An electric vehicle network is also an important distributed generation resource.

8. Waste-to-energy:Municipal solid waste (MSW) and natural waste, such as sewage sludge, food waste and animal manure will decompose and discharge methane-containing gas that can be collected as used as fuel in gas turbines or micro turbines will produce electricity as a distributed energy resource. Additionally, a California-based company, Gate 5 Energy Partners, Inc. has developed a process which transforms natural waste materials, such as sewage sludge, into biofuel that can be combusted to power a steam turbine which produces power.

VI. Benefits of Distributed Generation

Distributed generation is distributed resource or generating source located at the load side of the power system. The power rating of the distributed generating source is smaller & can be sufficient to satisfy the particular load center requirements in the distribution side. Distributed generation sources include both renewable and non-renewable resources. At present worldwide the more concentration has been given for the development of renewable energy resources, however the distributed generation along with the smart grid technologies helps to increase the reliability & power quality. [3, 4]

a. Advantages of Distributed Generation

Distributed generation technologies include the generation sources such as solar, wind, fuel cells, Biomass, Icengines, micro turbines, & wind turbines. The rating of power generation sources will be from few KW to several MW's. The various advantages of distributed generation are

1] Distributed generation increases the reliability of power supply to the consumers. However in power system the DG units are placed at the load side which reduces the transmission & distribution losses -it can greatly reduce the losses during transmission and distribution of power from central location and hence simultaneously improve the reliability of the grid network.

2] The location of DG sources reduces the complexity of network & it lead to the reduction in the cost construction for transmission & distribution.

3] The location of DG sources in the power system improves the voltage profile, power quality & supports the voltage stability of the system.

4] Again the DG technologies can be considered as a part of smart grid &microgrid in order to improve the efficiency of the system.

5] As compared to the conventional plants, these plants require less time for construction & the payback period is also less compared to conventional plants.

6] The distributed generation technologies are flexible in operation as well as size & they can be easily extended.

7] Some of the distributed generation technologies have higher overall efficiency and reduced pollution such as combined heat and power (CHP) & some micro turbines.

b. Disadvantages of Distributed Generation

Distributed generation technologies have certain demerits on the environment such as

1] Wind farms & PV systems require large area as compared to the conventional technologies for the same installed capacity of small hydro, tidal & wave power plants may influence the ecosystem & fishery.

2] The incomplete combustion of Biomass may produce unpleasant emissions.

3] Protection design requires good communication between distributed generation project developers & grid authority while design process. [3]

VII. Conclusion

This paper includes the basic concept of Distributed generation, the need of Distributed generation in India to meet the consumer requirement of electricity. The paper consists the efforts of Government of India in providing electricity to rural & citizens in last four decades which were mainly focused on extension of grid to remote unelectrified areas. It is finally concluded that to make DG system viable in open markets electricity market regulatory authorities and Government policy makers should modify market structure & reactive power pricing mechanism.

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