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A Study on the Environmental Impacts of Distributed Generation Projects in India

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Abstract — Distributed generation (DG) plays an important role in restructuring process of Power sector industries. This Paper emphasizes on the role of distributed generation & its Environmental impacts in Indian Power Scenario, as it has much potential to improve Distribution system performance, increasing supply reliability & reduction in transmission line losses.

Keywords-Distributed Generation; Wind Power; Environmental Impacts

I. INTRODUCTION

India is a Large Consumer of Fossil Fuels such as Coal, Crude Oil Etc.The Rapid increase in use of Non Renewable Energies such as fossil fuels, Oil, Natural Gas Created problems of Demand & Supply. Because of which the future of such sources is becoming uncertain. India has significant potential for generation of power from renewable energy sources. Wind Energy projects are cleaner energy generation options in comparison to other technologies. The zero dependence on fossil fuels makes it a preferred choice in comparison to non-renewable energy options. Wind Power Based DG Projects can contribute to both grid interactive and off grid power provisioning in India. Hence, its deployment becomes an obvious choice for ensuring country wide energy security and access, particularly in remote areas, where off-grid applications are the preferred solution. Promoting this will lead to both economic growth and social development in the country.

II. DISTRIBUTED GENERATION

Distributed Generation [1] is defined as installation and operation of small modular power generating technologies that can be combined with energy management & storage systems. It is used to improve the operations of the electricity delivery systems at or near the end user. These systems may or may not be connected to the electric grid. [6]

A distributed generation [1] system can employ a range of technological options from renewable to non-renewable and can operate either in a connected grid or off-grid mode. The size of a distributed generation system typically ranges from less than a kilowatt to a few megawatts. Distributed resources can either be grid connected or independent of the grid. Those connected to the grid are typically interfaced at the distribution system.

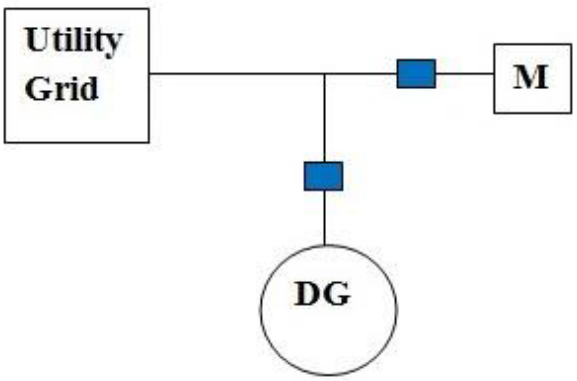

Fig. 1 *Interconnection of DG*

2.1. Classification of Distributed Generation

Distributed Generation [1] are classified on three basis:

- On the basis of Generation technology used: Conventional Type & Non Conventional Type.
- On the basis of Prime mover used: Turbine Type, Engine Type & Fuel Cells Type [2].
- On the basis of Connection: Isolated, Grid Connected [4], captive type, cogeneration, Stand by Type.

TABLE I

SIZE OF DISTRIBUTED GENERATION

Type	Size
Micro Distributed Generation	1 Watt < 5 MW
Small Distributed Generation	5 KW < 5 MW
Medium Distributed Generation	5 MW < 50 MW
Large Distributed Generation	50 MW < 300 MW

2.2. Generation Technologies for Distributed Generation

In power system network electricity generation by DG technologies [4] resources are connected to transmission network.DG supports both renewable & non renewable generating technologies [2]. In General following technologies are used for DG are Diesel engines with very large storage tanks (five days are common),Reciprocating engines similar to diesels that burn natural gas from a pipeline, Micro turbines on natural gas, Wind turbines, Solar arrays, Geothermal, Stream turbine from a small local stream, Wave & Tidal Power[2].

TABLE II

AVAILABLE TECHNOLOGIES FOR DISTRIBUTED GENERATION

Technology	Typical available size
Internal Combustion Engines	5 kW –10 MW
Geothermal	5–100 MW
Wind Turbine	200 W –3 MW
Biomass	100 kW –20 MW
Small Hydro	1–100 MW
Ocean Energy	0. 1–1 MW
Solar Thermal	1–10 MW
Photovoltaic Arrays	20 W –100 kW
Battery Storage	0. 5–5 MW
Fuel Cells	250 kW –5 MW

III. IMPACTS OF DISTRIBUTED GENERATION

Renewable Energy based Distributed Generation projects are cleaner energy generation options in comparison to other technologies. The zero dependence on fossil fuels makes it a preferred choice in comparison to non-renewable energy options. It is evident that the CO_2 emissions from wind power are much lower than that of coal or natural gas based energy generation.[3][5]

3.1 Wind Power in India

India ranks fifth amongst the wind-energy producing countries of the world after Germany, Spain, USA and China. Estimated potential is around 45000 MW at 50 m above ground level. Wind farms have been installed in more than 9 States. More than 95% of installed capacity belongs to private sector in seven States. A good number of wind turbine manufacturers are active in India and producing Wind Electric Generators (WEGs) of rating 225 kW to 2100 kW. The Ministry of New & Renewable Energy (MNRE), Govt. of India has established a centre for wind energy technology at Chennai with field test station at Kayathar to act as technical focal point for wind power development in the country. Financial assistance for renewable source of energy is available through Indian Renewable Energy Development Agency (IREDA), a supporting arm of MNRE.[6]

TABLE III

STATE WISE WIND POWER CAPACITY

State	Capacity in MW
Kerala	35.1

Madhya Pradesh	879.7
Andhra Pradesh	1031.4
Karnataka	2638.4
Rajasthan	3307.2
Gujrat	3645.4
Maharashtra	4450.8
Tamil Nadu	7455.2
Others	4.3
Total	**23447.5**

3.1.1 Impacts of Wind Power Projects

As compared to Non renewable energy options, wind projects have relatively lower associated emissions. Wind projects are even cleaner to solar projects as it can remain operational throughout the day, unlike solar which can operate only in presence of sun. Also wind projects are normally of higher capacity in comparison to solar projects.[8]In order to analyze the impact of commissioning and operations of wind farms, five wind project sites are considered. These sites were located in states Madhyapradesh, Tamilnadu and Maharashtra. Summary of the findings from site visits is depicted in table below.

TABLE IV

SUMMARY: WIND PROJECTS SITES

Impact Category	**Site Location**				
	Dewas Madhyapradesh	Jaora Madhyapradesh	Morgiri Maharashtra	Panirl TamilNadu	Vaigiakula TamilNadu
Project Completion Status	Completed	Completed	Not Completed	Completed	Completed
No. of Machines	64	19	Project Under Construction	06	01
Soil Erosion	No	No	Yes	No	No
Noise Pollution	No	No	No	No	No
Natural Habitat Loss	No	No	Yes	No	No
Tree Loss	No	No	Yes	No	No

The following table shows the environmental and socio-economic impacts associated with operational activity that may cause an impact on the environmental and social attribute; the actual impact; the law, act or policy that is used/can be used to manage the issue. Impacts have been analyzed at the site level for environmental and social attributes of air, noise, water, biodiversity, human health and safety, community and land.[9]

TABLE V

ENVIRONMENTAL IMPACTS OF WIND POWER BASED DG PROJECTS

Parameter	**Activity responsible for Pollution**	**Associate Issues**	**Significance of Impact**	**Related Laws**

Noise	Running & Operations of Wind mill.	Effect of Noise on Surrounding Areas	Noise Pollution was not reported by vicinity resident persons	Noise Rules 2000
Land	For Windmill Projects 2-3 acres of land is required for per MW on an average in agricultural or forest areas	Perceived Conflict with local community if common resources are put to commercial Use.	Agricultural Land was found to be acquired by paying market rates. In such cases local persons are allowed to use natural resources which come under project area.	Land Acquisition Act Forest Act 1980
Water	Wind Farms Operation do not result in Water Pollution			
Air	Wind Farms Operation do not result in Air Pollution			

IV. BENEFITS & LIMITATIONS OF DISTRIBUTED GENERATION

4.1 Benefits of Distributed Generation

- It may reduce the need for Large Infrastructure because DG can be constructed at Load Location [4].
- It has a lower capital cost, less Installation time & payback period.
- With some technologies produce zero pollutants emissions over its useful life.
- The connection of DG to the power system could improve the voltage profile, power quality and support voltage stability. Therefore, the system can withstand higher loading situations.
- It can be use in remote areas where central transmission access is not available sometimes take advantage of renewable energy sources because of the high cost of fossil fuel transport or of extending transmission[2].
- It Provides Power for local use, It may reduce pressure on distribution & Transmission.
- The installation of DG takes less time and payback period. Many countries are subsidizing the development of renewable energy projects through a portfolio obligation and green power certificates. This incentives investment in small generation plants.
- It offers Customers a Choice in Meeting their Energy Needs.

4.2 Limitations of Distributed Generation

- There are No Uniform National Interconnection Standards for Small Distributed Generation System. [1]
- Interconnection [4] may involve communication with several different organizations.
- The Environment Regulations & permits process that have been developed for larger distribution generation projects make such type of large DG Projects uneconomical.
- The Setting of Relay should be done consistently when DG Connection or Disconnection has to be made with the network as short circuit level of network has changed.[4]
- Sometimes it uses power electronics based converters to increase control over system but it may inject harmonics in the system.[4]
- It is a site specific technology and sites that are well suited to the harnessing of water power and are also close to a location where the power can be economically exploited are not very common.

CONCLUSION

Based on the aforesaid discussion and data about the utility and reliability of Distributed Generation [1] system. This can be concluded that Wind based DG projects have comparatively low environmental externalities that too are limited to project development phase. These projects don't generate solid or liquid effluents during operations and thereby pollution of land, surface water or ground water resources is not anticipated from such projects. During the operations phase the impacts on the surrounding environment are negligible, and are reversible in nature and can be mitigated by proper Environmental Management plan. As Wind Power has lowest environmental impact so it is preferable option for DG Projects.

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