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## Full Length Research Article

### OVERVIEW OF WIND ENERGY IN INDIA

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#### ABSTRACT

With the conventional resources of energy striving hard to meet the demands of the growing population, the renewable resources are landing as the remedy to meet the major part of the energy consumption. The advent of newer technologies has made it a cakewalk for the renewable energy sources to capture the market. In this paper, we emphasize about the need for a smoother shift of energy from the conventional towards the renewable energy resources and developing an in-built consciousness about the necessity for a change of energy in the upcoming future. Also, in this paper we emphasize on wind power in India.

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#### INTRODUCTION

Power Generation has always been a challenge to the modern world. The status of a country's development is proportional to its energy consumption. On the whole, at most of the times, power demand has exceeded the generation. This demand of power is met by either the conventional sources of energy or the renewable energy resources. A conventional source of energy is a resource that does not renew itself at a sufficient rate for sustainable economic extraction in meaningful human timeframes which is the reason for finding an alternative source for conventional resources. A renewable resource, an alternative for conventional resource, is a natural resource which can replenish with the passage of time, either through biological reproduction or other naturally occurring processes. Solar, wind, hydro and geothermal sources are some of the renewable resources. At present, India has a very fast growing market for energy production due to the exponential rise in population. It is largely dependent on the conventional sources of energy especially coal, crude oil and natural gas. The country is expanding its base on the nuclear and renewable energy sources as well. Being a tropical country, among all the renewable sources of energy, it is

largely dependent on wind energy resources which has been discussed here.

#### Renewable Energy Source

The consumption of energy for different countries across the world exceeds the production of energy over the years (<http://www.eia.gov/>). Nowadays, both conventional and renewable sources of energy are used for meeting the demand. India's energy basket has a mix of all the resources available including renewable energy sources. The dominance of coal in the energy mix is likely to continue in foreseeable future. At present India's coal dependence is borne out from the fact that 54 % of the total installed electricity generation capacity is coal based and 67% of the capacity planned to be added during the 11<sup>th</sup> Five year Plan (2007-12). Furthermore, over 70 % of the electricity generated is from coal based power plants. Other energy sources are wind, geothermal, solar, and hydroelectricity represent a 2 percent share of the Indian fuel mix. Nuclear holds a one percent share. The intrusion of renewable energy sources in producing energy is due to the disadvantages faced by conventional energy sources which overcomes its own advantages. They are rise in the pollution levels, global warming and thereby a rise in the amounts of Green-House gases, increased number of occurrence of disasters like earthquakes, danger due to explosions at the mining regions, very less availability of fuels, ruining of the sea ecosystem due to the oil spills, rock fractures due to the extraction of natural gas and so on. The main disadvantage faced conventional energy sources is the emission of CO<sub>2</sub>

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during energy production. The main conventional energy sources emitting CO<sub>2</sub> gas are coal, natural gas and petroleum and their emission over the years in India is shown in Fig. 1. (<http://www.eia.gov/>).

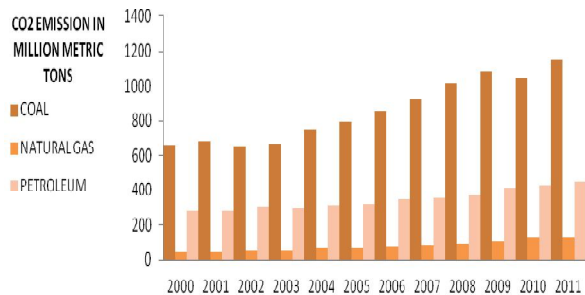


Fig. 1. CO<sub>2</sub> emission from conventional energy sources

Hence, all the above mentioned disadvantages outweigh the advantages of the conventional energy sources requiring a jump towards the renewable sources. These are the reasons why the global investment in US Billion dollars in renewable energy sources or clean energy sources are increasing and is shown in Fig. 2. ([http://gwec.net/wp-content/uploads/2012/06/Annual\\_report\\_2011\\_lowres.pdf](http://gwec.net/wp-content/uploads/2012/06/Annual_report_2011_lowres.pdf)).

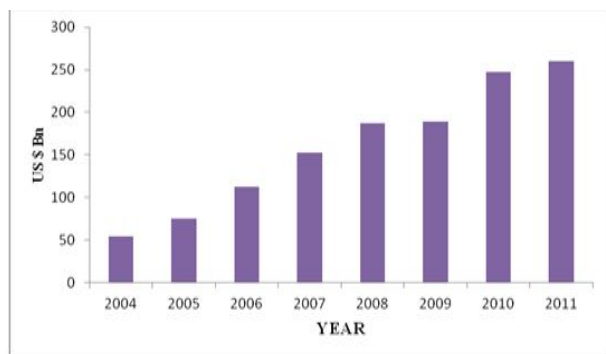


Fig. 2 Global investment in clean energy

The different renewable energy sources which are available for energy production are solar energy, wind energy, geothermal energy and so on. In the Hydro power generation, the potential energy of the water stored in dams is converted to the kinetic energy during its flow from higher levels to the lower levels. This kinetic energy of water rotates the turbine and gets converted to the mechanical energy. This mechanical energy in turn drives the motor shaft and produces electrical energy. Depending on the capacity of the plants, these Hydro power plants are classified into Small Hydro plants and Large Hydro plants. Biomass is a term to represent organic matters. Biomass can either be directly used by combustion process of heat production, or indirectly by conversion to some forms of bio-fuel. Conversion of biomass to biofuel can be achieved by thermal, chemical, and biochemical methods. These bio-fuels again on combustion process generate heat which in turn can produce steam from water or any forms of gas and drive turbines to generate electricity. Geothermal energy is derived by utilizing the heat generated within the earth. The heat so generated is used to convert the water into steam and drive a turbine. This turbine in turn drives the generator shaft resulting in electricity generation. Geothermal energy falls under the

category of renewable energy source because the water utilized during the entire process can be replenished by rainfall and the heat is continuously generated within the surface of the earth. The annual growth rates of renewable energy sources globally is shown in Fig. 3. [3 gsr2013\_lowres.pdf].

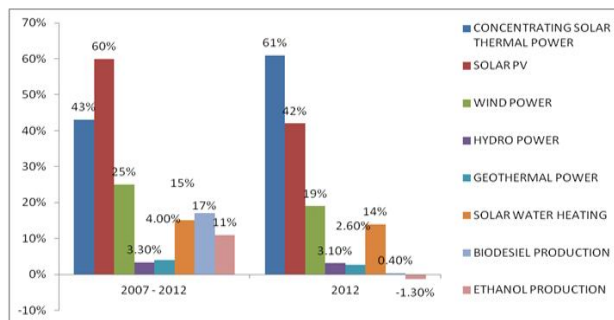


Fig.3. Growth rate of renewable energy sources

The different indicators for proving the intrusion of renewable energy sources over the years are listed in (<http://www.ren21.net/>). Also, the individual renewable energy capacity in GW or GWh for the year 2010, 2011 and 2012 globally are listed in (<http://www.ren21.net/>). In India, the total electricity generation from all the sources of energy over the years is listed in (<http://www.eia.gov/>), in which the electricity generation from renewable energy sources is shown in Fig. 4 (<http://www.eia.gov/>).

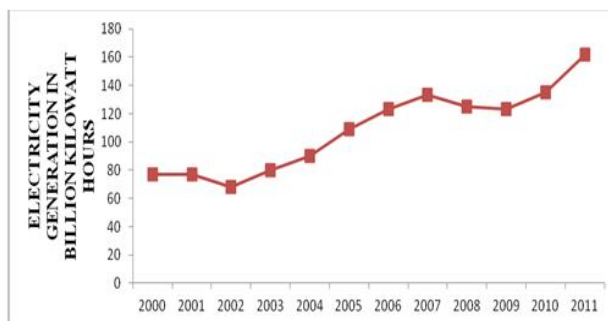


Fig. 4. Renewable energy generation

The top five countries in having more capacity for different renewable energy sources are ranked in (<http://www.ren21.net/>) in which India ranks fifth in generating more power through wind power and solar water heating.

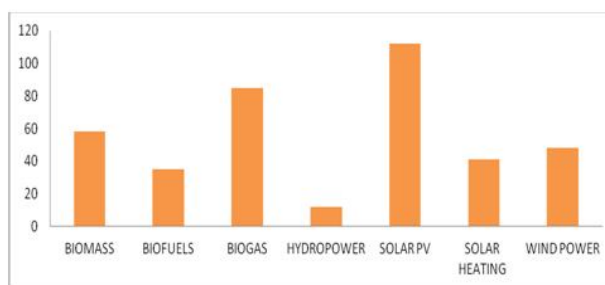


Fig. 5. Direct and indirect jobs in India

The renewable energy sources are given such importance due to the fact that it creates more direct and indirect jobs across

the world in different industries (<http://www.ren21.net/>), in which the number of direct and indirect jobs in thousand across different renewable energy sources is shown in Fig. 5. Wind power which is considered to be the most abundant form of renewable energy in India is discussed below.

### Wind Power

Wind energy is utilized with the help of Wind farms by employing the wind mills and turbines. The general construction of a wind mill comprises of large blades which spin due to the presence of wind. These blades drive the turbine which in turn rotates the generator shaft. This mechanical energy due to the movement of the blades is converted into electrical energy using the generator. This generated electricity can be used to charge batteries, can be connected to a building's main power or to the national power grid. The newly installed wind power capacity in MW across top ten countries in the world is listed in Table 1. ([http://gwec.net/wp-content/uploads/2012/06/Annual\\_report\\_2011\\_lowres.pdf](http://gwec.net/wp-content/uploads/2012/06/Annual_report_2011_lowres.pdf); [http://gwec.net/wp-content/uploads/2012/06/gwec-2006\\_final\\_01.pdf](http://gwec.net/wp-content/uploads/2012/06/gwec-2006_final_01.pdf); [http://gwec.net/wp-content/uploads/2012/06/gwec-08-update\\_FINAL.pdf](http://gwec.net/wp-content/uploads/2012/06/gwec-08-update_FINAL.pdf); <http://gwec.net/wp-content/uploads/2012/06/Global-Wind-2008-Report.pdf>; [http://gwec.net/wp-content/uploads/2012/06/GWEC\\_Global\\_Wind\\_2009\\_Report\\_LOWRES\\_15th.-Apr..pdf](http://gwec.net/wp-content/uploads/2012/06/GWEC_Global_Wind_2009_Report_LOWRES_15th.-Apr..pdf); [http://gwec.net/wp-content/uploads/2012/06/GWEC\\_annual\\_market\\_update\\_2010\\_-\\_2nd\\_edition\\_April\\_2011.pdf](http://gwec.net/wp-content/uploads/2012/06/GWEC_annual_market_update_2010_-_2nd_edition_April_2011.pdf); [http://www.gwec.net/wp-content/uploads/2012/06/Annual\\_report\\_2012\\_LowRes.pdf](http://www.gwec.net/wp-content/uploads/2012/06/Annual_report_2012_LowRes.pdf); <http://www.gwec.net/>)

<http://gwec.net/wp-content/uploads/2012/06/Global-Wind-2008-Report.pdf>; [http://gwec.net/wp-content/uploads/2012/06/GWEC\\_Global\\_Wind\\_2009\\_Report\\_LOWRES\\_15th.-Apr..pdf](http://gwec.net/wp-content/uploads/2012/06/GWEC_Global_Wind_2009_Report_LOWRES_15th.-Apr..pdf); [http://gwec.net/wp-content/uploads/2012/06/GWEC\\_annual\\_market\\_update\\_2010\\_-\\_2nd\\_edition\\_April\\_2011.pdf](http://gwec.net/wp-content/uploads/2012/06/GWEC_annual_market_update_2010_-_2nd_edition_April_2011.pdf); [http://www.gwec.net/wp-content/uploads/2012/06/Annual\\_report\\_2012\\_LowRes.pdf](http://www.gwec.net/wp-content/uploads/2012/06/Annual_report_2012_LowRes.pdf); <http://www.gwec.net/>). The generation of wind power in MW in India over the years is shown in Fig. 6. ([https://www.irena.org/DocumentDownloads/Publications/IRENA\\_GWEC\\_WindReport\\_Full.pdf](https://www.irena.org/DocumentDownloads/Publications/IRENA_GWEC_WindReport_Full.pdf)).

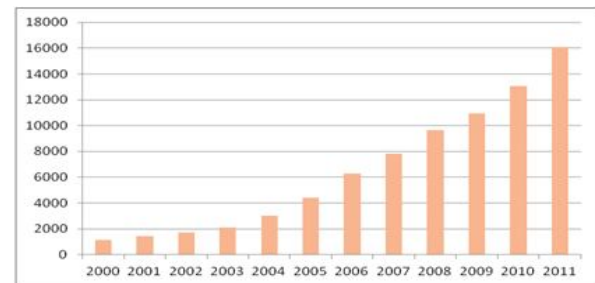


Fig. 6. Generation of wind power

The India's policy and regulatory framework for the development of new and renewable energy after the two oil crises is discussed in ([https://www.irena.org/DocumentDownloads/Publications/IRENA\\_GWEC\\_WindReport\\_Full.pdf](https://www.irena.org/DocumentDownloads/Publications/IRENA_GWEC_WindReport_Full.pdf)). The different phases for development of renewable energy is listed in Table 3. ([https://www.irena.org/DocumentDownloads/Publications/IRENA\\_GWEC\\_WindReport\\_Full.pdf](https://www.irena.org/DocumentDownloads/Publications/IRENA_GWEC_WindReport_Full.pdf)).

Table 1. Newly installed wind power

COUNTRY	2006	2007	2008	2009	2010	2011	2012	2013
US	2,454	5,244	8,358	9,996	5,115	6,810	13,124	1,084
GERMANY	2,233	1,667	1,665	1,917	1,493	2,086	2,415	3,238
INDIA	1,840	1,575	1,800	1,271	2,139	3,019	2,336	1,729
SPAIN	1,587	3,522	1,609	2,459	1,516	1,050	1,122	175
CHINA	1,347	3,304	6,300	13,803	18,928	17,631	12,960	16,100
FRANCE	810	888	950	1,088	1,086	830	757	631
CANADA	776	386	526	950	690	1,267	935	1,599
PORTUGAL	694	434	712	673	363	377	145	196
UK	634	427	836	1,077	962	1,293	1,897	1,883
ITALY	417	603	1,010	1,114	948	950	1,273	444
REST OF THE WORLD	2,405	1,815	3,285	3,994	5,389	5,628	8,737	9,834

Table 2. Installed wind power capacity

CATEGORY	2005	2006	2007	2008	2009	2010	2011	2012	2013
AFRICA & MIDDLE EAST	271	378	539	635	866	1,065	1,033	1,165	1,255
ASIA	6,990	10,569	15,795	24,188	39,639	61,106	82,070	97,715	11,5939
EUROPE	40,898	48,069	57,139	65,741	76,471	86,647	97,043	10,9817	12,1474
LATIN AMERICA & CARIBBEAN	212	507	533	653	1,306	1,478	2,280	3,552	4,709
NORTH AMERICA	9,832	13,035	18,670	27,437	38,405	44,825	52,763	67,580	70,885
PACIFIC REGION	889	1,000	1,158	1,643	2,221	2,516	2,861	3,219	3,874

The different countries in the world can be categorized into five as Africa & Middle east, Asia, Europe, Latin America & Caribbean, North America and Pacific region ([http://gwec.net/wp-content/uploads/2012/06/Annual\\_report\\_2011\\_lowres.pdf](http://gwec.net/wp-content/uploads/2012/06/Annual_report_2011_lowres.pdf).) and the installed wind power capacity in MW across the different categories over the years is shown in Table 2. and for individual countries in each category is discussed in ([http://gwec.net/wp-content/uploads/2012/06/Annual\\_report\\_2011\\_lowres.pdf](http://gwec.net/wp-content/uploads/2012/06/Annual_report_2011_lowres.pdf); [http://gwec.net/wp-content/uploads/2012/06/gwec-2006\\_final\\_01.pdf](http://gwec.net/wp-content/uploads/2012/06/gwec-2006_final_01.pdf); [http://gwec.net/wp-content/uploads/2012/06/gwec-08-update\\_FINAL.pdf](http://gwec.net/wp-content/uploads/2012/06/gwec-08-update_FINAL.pdf); <http://gwec.net/>)

Table 3. India's policy and regulatory framework

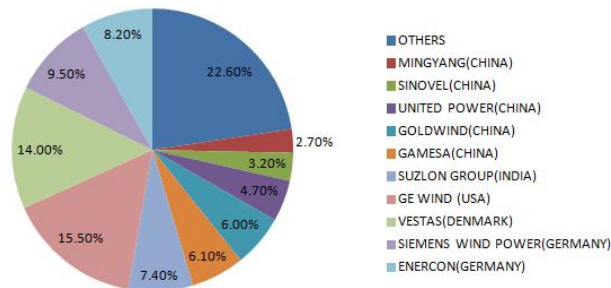
Phase 1 (Technology demonstration and R&D)	1981 - 1990
Phase 2 (Economic liberalisation and institutionalisation)	1991 - 2000
Phase 3 (Passing of Electricity Act, provision of tariffs by the states)	2000-2008
Phase 4 (New incentives and reinforcement of tariff Scheme)	2009 - 2012

The total capacity of wind power in MW installed in main states of India as on 2012 and 2013 is shown in Table 4. ([www.inwea.org](http://www.inwea.org); [http://www.indianwindpower.com/news\\_views.html#tab1](http://www.indianwindpower.com/news_views.html#tab1))

**Table 4. Total capacity of wind power in MW**

State	Capacity in MW as on 31.03.2012	Capacity in MW as on 31.04.2013
Andhra Pradesh	245.50	471.45
Gujarat	2966.30	3196.58
Karnataka	1933.50	2148.9
Kerala	35.10	54.8
Madhya Pradesh	376.40	395
Maharashtra	2733.30	3107.45
Rajasthan	2070.70	2721.2
Tamil Nadu	6987.60	7162.88

The tariffs fixed the Government of India for using wind power across different states, across different wind zones is listed in ([www.inwea.org](http://www.inwea.org)). India ranks fifth in total generation of wind power as on June 2013 with a capacity of 19,564 MW. (<http://www.wwindea.org/home/index.php>). India renewable energy sources currently accounts for 12.5% of overall installed power capacity i.e., 27.5 GW with an installed capacity of 19 GW of wind energy as on March 2013 ([http://www.indianwindpower.com/news\\_views.html#tab1](http://www.indianwindpower.com/news_views.html#tab1)). Indian Government has set a target of generating 18.5 GW and 4 GW from solar energy. (<http://www.wwindea.org/home/index.php>) during the 12th Five year plan (2012 - 2017) Wind energy is produced with the help of wind turbines and hence the manufacturers of wind turbine plays an important role in overall generation of wind power across the world. The market share of top ten wind turbine manufacturers as on 2012 is shown in Fig. 7. (<http://www.ren21.net/>)

**Fig. 7. Wind turbine manufacturers**

The different challenges faced by Government of India in integrating the wind power is ([http://www.gwec.net/wp-content/uploads/2012/06/Annual\\_report\\_2012\\_LowRes.pdf](http://www.gwec.net/wp-content/uploads/2012/06/Annual_report_2012_LowRes.pdf)).

## Conclusion

Among the developing countries in the world, India was the first to generate power from wind energy. This generation of power is growing strongly since 2003. India had a varied and complex policy and regulatory framework which supports generation of wind energy over the last two decades. The development of wind energy in India is a response to chronic electricity shortages and to have a independent energy. The drivers for generating wind power in India are anti-nuclear, environmental sustainability or climate change concerns which differ from other countries. The wind power when combines with other renewable energy sources or other conventional energy sources can be used in meeting the future demand.

## REFERENCES

- <http://www.eia.gov/>
- [http://gwec.net/wp-content/uploads/2012/06/Annual\\_report\\_2011\\_lowres.pdf](http://gwec.net/wp-content/uploads/2012/06/Annual_report_2011_lowres.pdf).
- <http://www.ren21.net/>
- [http://gwec.net/wp-content/uploads/2012/06/gwec-2006\\_final\\_01.pdf](http://gwec.net/wp-content/uploads/2012/06/gwec-2006_final_01.pdf)
- [http://gwec.net/wp-content/uploads/2012/06/gwec-08-update\\_FINAL.pdf](http://gwec.net/wp-content/uploads/2012/06/gwec-08-update_FINAL.pdf)
- <http://gwec.net/wp-content/uploads/2012/06/Global-Wind-2008-Report.pdf>
- [http://gwec.net/wp-content/uploads/2012/06/GWEC\\_Global\\_Wind\\_2009\\_Report\\_LOWRES\\_15th.-Apr..pdf](http://gwec.net/wp-content/uploads/2012/06/GWEC_Global_Wind_2009_Report_LOWRES_15th.-Apr..pdf)
- [http://gwec.net/wp-content/uploads/2012/06/GWEC\\_annual\\_market\\_update\\_2010\\_-\\_2nd\\_edition\\_April\\_2011.pdf](http://gwec.net/wp-content/uploads/2012/06/GWEC_annual_market_update_2010_-_2nd_edition_April_2011.pdf)
- [http://www.gwec.net/wp-content/uploads/2012/06/Annual\\_report\\_2012\\_LowRes.pdf](http://www.gwec.net/wp-content/uploads/2012/06/Annual_report_2012_LowRes.pdf)
- <http://www.gwec.net/>
- [https://www.irena.org/DocumentDownloads/Publications/IRENA\\_GWEC\\_WindReport\\_Full.pdf](https://www.irena.org/DocumentDownloads/Publications/IRENA_GWEC_WindReport_Full.pdf)
- [www.inwea.org](http://www.inwea.org)
- [http://www.indianwindpower.com/news\\_views.html#tab1](http://www.indianwindpower.com/news_views.html#tab1)
- <http://www.wwindea.org/home/index.php>

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