

Various Renewable Energies and its Statistical Impact in India

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Abstract – Due to rapid growth in industrialization and population, demand of power is also increases in an alarming rate. So to compensate the power requirement man always depends upon various sources of energy. Basically due to huge availability and lack of advance technology we were depends upon on various fossil fuels as a primary energy source up to twentieth century without considering it's hazardous effects. But at present the reserve of these fuels are come to an dangerous level also with their huge utility they provides a very poisonous environment and creates number of ecological imbalances.

Due to these above reasons now we are searching for various energy sources which are in renewable in nature and provide a cleaner environment after its use, thus these are may also called as "Green Energy". Various major renewable energy sources are found from research and explorations are Solar, Wind, Hydro, Geothermal, Tidal and number of these which are underdeveloped stages. By this report we try to focus the generation of various forms renewable energy throughout the country and provide a clear comparison between the development of renewable energy sources over conventional energy utilization by collecting various data's from various sources.

INTRODUCTION

As we know, sun is prime sources of energy for all leaving object in universes. so, it is taken as the main energy source in nature. But, due to insufficient technological advances we are unable to convert whole amount of solar energy comes from the sun to our utility apart from that scientists are exploring various others forms of renewable energy such as Wind, Hydro, Geothermal, Tidal, Biomass etc. These energies are explained in the later stages one by one.

A. Fossil Fuel Power Plants

a.1 Coal Based

Coal is the most abundant fossil fuel on the planet. It is a relatively cheap fuel, with some of the largest deposits in regions that are relatively stable politically,

such as China, India and the United States. Coal power, an established electricity source that provides vast quantities of inexpensive, reliable power has become more important as supplies of oil and natural gas diminish. In 1995, Coal burning produced about 55% of the electricity generated India. In most coal fired power plants, chunks of coal are crushed into fine powder and are fed into a combustion unit where it is burned. Heat from the burning coal is used to generate steam that is used to spin one or more turbines to generate electricity.

a.1.1 Major Causes due to utilization of coal

- Coal mining causes severe erosion, resulting in the leaching of toxic chemicals into nearby streams and aquifers, and destroys habitats.
- About two-thirds of sulfur dioxide, one-third of carbon dioxide emissions and one quarter of the nitrogen oxides emissions in the U.S. are produced by coal burning.
- Coal burning also results in the emission of fine particles matter into the atmosphere. Nitrogen oxide and fine airborne particles exacerbate asthma, reduce lung function and cause respiratory diseases and premature death for many thousands of Americans.
- Smog formed by nitrogen oxide and reactive organic gases causes crop, forest and property damage. Sulfur dioxide and nitrogen oxides both combine with water in the atmosphere to create acid rain. Acid rain acidifies the soils and water killing off plants, fish, and the animals that depend on them.
- Global warming is mainly caused by carbon dioxide emissions and is responsible for at least half of the warming.

Table a.1.2 Major Coal Fired Power plants in India
[1,2,5,6,7]

POWER PLANT	STATE	CAPACITY (MW)
Chandrapur	Maharashtra	2,340
Neyveli	Tamil Nadu	2,280
Vindhyachal	Madhya Pradesh	2,260
Korba STPS	Chattisgarh	2,100
Ramagundam	Andhra Pradesh	2,100
Singrauli	Uttar Pradesh	2,050
Talcher	Orissa	1,970
Anpara	Uttar Pradesh	1,630
Farakka	West Bengal	1,630
Obra	Uttar Pradesh	1,550
Tuticorin	Tamil Nadu	1,550
Raichur	Karnataka	1,470
Wanakbori	Gujarat	1,470
Kolaghat	West Bengal	1,260
Ropar	Punjab	1,260
Vijayawada	Andhra Pradesh	1,260
Kothagudem	Andhra Pradesh	1,180
Trombay	Maharashtra	1,150
Satpura	Madhya Pradesh	1,143
Koradi	Maharashtra	1,100
Rihand	Uttar Pradesh	1,000
Simhadri	Andhra Pradesh	1,000
Suratgarh	Rajasthan	1,000
Nasik	Maharashtra	910
Gandhi Nagar	Gujarat	870
Guru Hargobind	Punjab	860
Tau Devi Lal	Haryana	860
Kota	Rajasthan	850
Ukai	Gujarat	850
Dadri	Uttar Pradesh	840
Kahalgaon	Bihar	840
Khaperkheda	Maharashtra	840
Korba West	Chattisgarh	840
Mettur	Tamil Nadu	840

POWER PLANT	STATE	CAPACITY (MW)
Sanjay Gandhi	Madhya Pradesh	840
Unchahar	Uttar Pradesh	840
Bokaro	Jharkhand	805
Patratu	Jharkhand	770
Chandrapura	Jharkhand	750
Angul Smelter	Orissa	720
Badarpur	Delhi Territory	720
Parli	Maharashtra	690
Bakreshwar	West Bengal	630
Mejia	West Bengal	630
North Chennai	Tamil Nadu	630
Renusagar *	Uttar Pradesh	619
Dhuvaran	Gujarat	534
Bandel	West Bengal	530
Budge Budge	West Bengal	500
Dahanu	Maharashtra	500
Bhusawal	Maharashtra	483
Santaldih	West Bengal	480
Ennore	Tamil Nadu	450
Sabarmati	Gujarat	450
Harduaganj	Uttar Pradesh	440
Tanda	Uttar Pradesh	440
Ib Valley	Orissa	420
Rayalaseema	Andhra Pradesh	420
Tenughat	Jharkhand	420
Durgapur	West Bengal	405
Korba East	Chattisgarh	400
Durgapur DVC	West Bengal	350
Barauni	Bihar	310
Amarkantak	Madhya Pradesh	300
Bokaro Works *	Jharkhand	287
Panki	Uttar Pradesh	279
NTPC BALCO	Madhya Pradesh	270
Rourkela Works	Orissa	269
Torangallu Works	Karnataka	260
Neyveli Zero	Tamil Nadu	250

POWER PLANT	STATE	CAPACITY (MW)
Surat	Gujarat	250
Indraprastha	Delhi Territory	248
Bongaigaon	Assam	240
Sikka	Gujarat	240
Titagarh	West Bengal	240
Jamshedpur Works	Jharkhand	238
Vizag Steel Works	Andhra Pradesh	236
Cossipore	West Bengal	225
Muzaffarpur	Bihar	220
Paricha	Uttar Pradesh	220
Kutch	Gujarat	210
Faridabad	Haryana	165
Mulajore	West Bengal	150
Durgapur Works	West Bengal	140
Rajghat	Delhi Territory	135
Southern	West Bengal	135
Raigarh Works *	Madhya Pradesh	112
Choudwar	Orissa	108
Nagda Works *	Madhya Pradesh	106
	TOTAL	35,753

a.2 Oil Based

In many power plants runs on Diesel oil because of their low cost and less emissive contribution as compared to coal based power stations.

Table a.2.1 Major Oil Fired Power plants in India[8]

POWER PLANT	STATE	CAPACITY (MW)
Chennai Vasavi	Tamil Nadu	200
Whitefield Ind. Park	Karnataka	158
Yelahanka	Karnataka	132
Kozhikode	Kerala	128
Brahmapuram	Kerala	110
Samayanallur	Tamil Nadu	106
Samalpatti	Tamil Nadu	105
Tanir Bavi Barge	Karnataka	208

Kovilkalappal	Tamil Nadu	108
Pampore	Jammu & Kashmir	175
South Bassein	Maharashtra	152
	TOTAL	152

a.3 Gas Based

Natural gases also take part in the generation of power in various gas turbine power plants. They are came into use from 20th century because of their very less emissive effects. But since for high cost and low availability it is rarely used in power generation sectors.

Table a.3.1 Major Gas Fired Power plants in India[8]

POWER PLANT	STATE	CAPACITY (MW)
Uran	Maharashtra	912
Dahbol	Maharashtra	826
Dadri	Uttar Pradesh	817
Kawas	Gujarat	656
Auriaya	Uttar Pradesh	652
Paguthan	Gujurat	655
Gandhar	Gujarat	618
Hazira Essar	Gujarat	516
Faridabad NTPC	Haryana	430
Anta	Rajasthan	413
Kayamkulam	Kerala	349
Kondapalli	Andhra Pradesh	368
Pillaiperumalnallur	Tamil Nadu	330
Kathalguri	Assam	291
Vijeswaran	Andhra Pradesh	272
Indraprastha GT	Delhi Territory	282
Peddapuram	Andhra Pradesh	220
Godavari	Andhra Pradesh	210
Jegurupadu	Andhra Pradesh	205
Trombay	Maharashtra	180
Kochi-Kerala	Kerala	173
Hazira GSEG	Gujarat	159
Utran	Gujarat	135
Lakwa	Assam	120
Perungulam	Tamil Nadu	105
Vatwa	Gujarat	100
Baroda GIPCL	Gujarat	216
Hazira RIL	Gujarat	165
Jamnagar RIL	Gujarat	132
Basin Bridge	Tamil Nadu	124

POWER PLANT	STATE	CAPACITY (MW)
<i>Haldia Chemicals</i>	<i>West Bengal</i>	104
<i>Anola</i>	<i>Uttar Pradesh</i>	100
	Total	1501

Besides all these above reputed and leading power stations data collected there are no of industries whose data are not taken into consideration due to unavailability. But it is assumed that near about 8000 MW to 12000 MW of Fossil fuel energy are consumed in various industries throughout the country except power generation Purposes.

B. Nuclear Power Plants

In India, Nuclear power holds the fourth position among the different resources of electricity, Thermal, hydro and renewable resources being first, second and third respectively. Presently 19 nuclear power plants in India are there, which generates 4,560 MW (2.9% of total installed base) and 4 such power plants are in the pipeline and would be generating around 2,720 MW. India's contribution in fusion development is done through its involvement in the ITER project. Rapid usage of Uranium deterioration of domestic uranium resources caused the decline of electricity production from nuclear energy in India by 12.83% during 2006 to 2008.

But still there are some major Nuclear Power plants are working in India whose data are mentioned in the table below.

Table b.1 Major Nuclear Power plants in India[20]

Power station	Operator	State	Type	Units	Capacity (MW)
<i>Kaiga</i>	<i>NPCIL</i>	<i>Karnataka</i>	<i>PHWR</i>	220 x 4	880
<i>Kakrapar</i>	<i>NPCIL</i>	<i>Gujarat</i>	<i>PHWR</i>	220 x 2	440
<i>Kalpakkam</i>	<i>NPCIL</i>	<i>Tamil Nadu</i>	<i>PHWR</i>	220 x 2	440
<i>Narora</i>	<i>NPCIL</i>	<i>Uttar Pradesh</i>	<i>PHWR</i>	220 x 2	440
<i>Rawatbhata</i>	<i>NPCIL</i>	<i>Rajasthan</i>	<i>PHWR</i>	100 x 1	1180
				200 x 1	
				220 x 4	
<i>Tarapur</i>	<i>NPCIL</i>	<i>Maharashtra</i>	<i>BWR (PHWR)</i>	160 x 2	1400
				540 x 2	
			Total	20	4780

Beside these there are some number of power plants which are in under constructions are[21]

Power station	Operator	State	Type	Units	Capacity (MW)
<i>Kudankulam</i>	<i>NPCIL</i>	<i>Tamil Nadu</i>	<i>VVER-1000</i>	1000 x 2	2000
<i>Kalpakkam</i>	<i>Bhavini</i>	<i>Tamil Nadu</i>	<i>PFBR</i>	500 x 1	500
<i>Kakrapar</i>	<i>NPCIL</i>	<i>Gujarat</i>	<i>PHWR</i>	700 x 2	1400
<i>Rawatbhata</i>	<i>NPCIL</i>	<i>Rajasthan</i>	<i>PHWR</i>	700 x 2	1400
			Total	7	5300

C. Renewable energy Power Plants

c.1 Solar Based power plants

Solar energy is one of a cleanest energy source at free of cost. In early days these energy was absorbed by the living bodies only. Due to rapid advances in technology various artificial solar energy absorbing techniques are generated now a day such as photo voltaic cells. India is densely populated and has high solar insolation, an ideal combination for using solar power in India. India is already a leader in wind power generation. In the solar energy sector, some large projects have been proposed, and a 35,000 km² area of the *Thar Desert* has been set aside for solar power projects, sufficient to generate 700 GW to 2,100 GW. Also India's Ministry of New and Renewable Energy has released various Policies by which the Government aims to install 10GW of Solar Power and of this 10 GW target, 4 GW would fall under the central scheme and the remaining 6 GW under various State specific schemes. Beside these major solar power plants data which collected from various sources are installed throughout the country is represented below.

Table c.1.1 Major Solar Power plants in India[16,17]

Name of Plant	DC Peak Power (MW)	Location	State
<i>Charanka Solar Park</i>	214	<i>Charanka village, Patan District</i>	<i>Gujarat</i>
<i>Mithapur Solar Power Plant (Tata Power)</i>	25	<i>Mithapur</i>	<i>Gujarat</i>
<i>Waa Solar Power Plant (Madhav Power)</i>	10	<i>Surendranagar</i>	<i>Gujarat</i>
<i>Dhirubhai Ambani Solar Park</i>	40	<i>Pokhran</i>	<i>Rajasthan</i>
<i>Bitta Solar Power Plant (Adani Power)</i>	40	<i>Bitta, Kutch District</i>	<i>Gujarat</i>

Name of Plant	DC Peak Power	Location	State
<i>Mahindra & Mahindra Solar Plant</i>	5	<i>Jodhpur</i>	<i>Rajasthan</i>
<i>Rasna Marketing Services LLP</i>	1	<i>Ahmedabad</i>	<i>Gujarat</i>
<i>Sivaganga Photovoltaic Plant</i>	5		<i>Tamil Nadu</i>
<i>Kolar Photovoltaic Plant</i>	3	<i>Yalesandra, Kolar District</i>	<i>Karnataka</i>
<i>Itnal Photovoltaic Plant</i>	3	<i>Belgaum</i>	<i>Karnataka</i>
<i>Azure Power - Ahwan Photovoltaic Plant</i>	2		<i>Punjab</i>
<i>Citra and Sepset Power Plants</i>	4	<i>Katol</i>	<i>Maharashtra</i>
<i>Jamuria Photovoltaic Plant</i>	2		<i>West Bengal</i>
<i>NDPC Photovoltaic Plant</i>	1	<i>Delhi</i>	
<i>Thyagaraj stadium Plant</i>	1	<i>Delhi</i>	
<i>Gandhinagar Solar Plant</i>	1		<i>Gujarat</i>
<i>Tata Power</i>	3	<i>Mulshi</i>	<i>Maharashtra</i>
<i>Azure Power - Sabarkantha</i>	10	<i>Khadoda village</i>	<i>Gujarat</i>
<i>Moser Baer - Patan</i>	30		<i>Gujarat</i>
<i>B&G Solar Pvt Ltd</i>	1	<i>Mayiladuthurai</i>	<i>Tamil Nadu</i>
<i>REHPL - Sadeipali</i>	1	<i>Bolangir</i>	<i>Orissa</i>
<i>Tata Power Orissa</i>	1	<i>Patapur</i>	<i>Orissa</i>
<i>Tata Power</i>	9	<i>Patapur</i>	<i>Orissa</i>
<i>Tata Power</i>	1	<i>Osmanabad</i>	<i>Maharashtra</i>
<i>Amruth Solar Power Plant</i>	1	<i>Kadiri,</i>	<i>Andhra Pradesh</i>
<i>IIT Bombay</i>	3	<i>Gwal Pahari</i>	<i>Haryana</i>
<i>Chandraleela Power Energy</i>	0.8	<i>Narnaul</i>	<i>Haryana</i>
<i>Green Infra Solar Energy Limited</i>	10	<i>Rajkot</i>	<i>Gujarat</i>
<i>TAL Solar Power Plant</i>	2	<i>Barabanki</i>	<i>Uttar Pradesh</i>

Name of Plant	DC Peak Power	Location	State
<i>Numeric Power Systems</i>	1	<i>Coimbatore</i>	<i>Tamil Nadu</i>
<i>Zynergy</i>	1	<i>Vannankulam village, Peraiyur, Madurai district</i>	<i>Tamil Nadu</i>
Total	363		

c.2. Wind based power plants

The development of wind power in India began in the 1990s, and has significantly increased in the last few years. Although a relative newcomer to the wind industry compared with Denmark or the United States, [13-15] India has the fifth largest installed wind power capacity in the world. In 2009-10 India's growth rate was highest among the other top four countries.

Table c.2.2 Major wind Power plants in India [3, 4, 9, 10, 11, 12]

Power Plant	State	Total Capacity (MWe)
<i>Vankusawade Wind Park</i>	<i>Maharashtra</i>	259
<i>Sipla[8]</i>	<i>Rajasthan</i>	102
<i>Samana[9]</i>	<i>Gujarat</i>	101
<i>Theni[10]</i>	<i>Tamil Nadu</i>	99
<i>Saundatti[11]</i>	<i>Karnataka</i>	84
<i>Khandke[12]</i>	<i>Maharashtra</i>	50
<i>Narmada[13]</i>	<i>Andhra Pradesh</i>	50
<i>Harapanahalli[14]</i>	<i>Karnataka</i>	40
<i>Nuziveedu Seeds</i>	<i>Karnataka</i>	50.4
<i>Kayathar Subhash</i>	<i>Tamil Nadu</i>	30
<i>Ramakkalmedu</i>	<i>Kerala</i>	25
<i>Muppandal Wind</i>	<i>Tamil Nadu</i>	22
<i>Gudimangalam</i>	<i>Tamil Nadu</i>	21
<i>Puthlur RCI</i>	<i>Andhra Pradesh</i>	20
<i>Lamda Danida</i>	<i>Gujarat</i>	15
<i>Chennai Mohan</i>	<i>Tamil Nadu</i>	15

Power Plant	State	Total Capacity (MWe)
<i>Jamgudrani MP</i>	<i>Madhya Pradesh</i>	14
<i>Jogmatti BSES</i>	<i>Karnataka</i>	14
<i>Perungudi Newam</i>	<i>Tamil Nadu</i>	12
<i>Kethanur Wind Farm</i>	<i>Tamil Nadu</i>	11
<i>Hyderabad APSRTC</i>	<i>Andhra Pradesh</i>	10
<i>Muppandal Madras</i>	<i>Tamil Nadu</i>	10
<i>Poolavadi Chettinad</i>	<i>Tamil Nadu</i>	10
<i>Shalivahana Wind</i>	<i>Tamil Nadu</i>	20.4
	Total	1084.8

Table c.2.3 State wise wind Power Contribution

State	Capacity(MW)
<i>Tamil Nadu</i>	7134
<i>Gujarat</i>	2,884
<i>Maharashtra</i>	2310.7
<i>Karnataka</i>	1730.1
<i>Rajasthan</i>	2072
<i>Madhya Pradesh</i>	275.5
<i>Kerala</i>	32
<i>Orissa</i>	2
<i>West Bengal</i>	2.1
TOTAL	16442.4

c.3 Hydro Electric Power Plants

India was the 7th largest producer of hydroelectric power in 2008 after Norway and 3.5% the world total in 2008. The potential for hydroelectric power in India is one of the greatest in the world. India is endowed with economically exploitable and viable hydro potential assessed to be about 84,000 MW at 60% load factor. In addition, 6780 MW in terms of installed capacity from Small, Mini, and Micro Hydel schemes have been assessed.

Table c.3.3 Major Hydro Power Stations in India[18,19]

Station	State	Operator	Generator units	Capacity (MW)
Tehri Dam	Uttarakhand	THDC India Ltd.	4*250, 4*100, 4*250	2400
Srisaillam Dam	Andhra Pradesh	APGenco	6 × 150, 7 × 110	1,670

Station	State	Operator	Generator units	Capacity (MW)
Nagarjunasagar	Andhra Pradesh	APGenco	1 X 110, 7 X 100.8, 5 X 30	965
Sardar Sarovar	Gujarat	SSNNL	6X200, 5X140	1,450
Baspa-II	Himachal Pradesh	JHPL	3 X 100	300
Nathpa Jhakri	Himachal Pradesh	SJVNL	6 X 250	1,500
Bhakra Dam	Punjab	BBMB	5 X 108, 5 X 157	1,325
Dehar (Pandoh)	Himachal Pradesh	BBMB	6 X 165	990
Baira Suil	Himachal Pradesh	NHPC	3 X 60	180
Chamera-I	Himachal Pradesh	NHPC	3 X 180	540
Chamera-II	Himachal Pradesh	NHPC	3 X 100	300
Pong	Himachal Pradesh	BBMB	6 x 66	396
Uri Hydroelectric Dam	Jammu & Kashmir	NHPC	4 X 120	480
Dulhasti	Jammu & Kashmir	NHPC	3 X 130	390
Salal	Jammu & Kashmir	NHPC	6 X 115	690
Sharavathi	Karnataka	KPCL	10 X 103.5, 2X27.5, 4X60	1,469
Kalinadi	Karnataka	KPCL	2X50, 1x135, 5X150, 3X50, 3X40	1,240
Linganamakki Dam	Karnataka			55
Idukki	Kerala	KSEB	6 X 130	780
Bansagar Dam	Madhya Pradesh			425
Bargi Dam	Madhya Pradesh			105
Madikheda Dam	Madhya Pradesh			60
Omkareshwar	Madhya Pradesh	NHPC	8 X 65	520
Indira Sagar	Madhya Pradesh	NHPC	8 X 125	1,000
Loktak	Manipur	NHPC	3 X 35	105
Khuga Dam	Manipur			
Koyna	Maharashtra	MahaGenco	4X70, 4X80, 2X20, 4X80, 4X250	1,960
Ghatghar Pumped Storage Scheme	Maharashtra	MahaGenco	125 X 2	250
Mettur Dam	Tamil Nadu	TNEB	50 x 4	240
Mulshi Dam	Maharashtra		6 X 25	150

Station	State	Operator	Generator units	Capacity (MW)
Jayakwadi Dam	Maharashtra			12
Rangeet	Sikkim	NHPC	3 X 20	60
Teesta-V	Sikkim	NHPC	3 X 170	510
Tanakpur	Uttarakhand	NHPC	3 X 40	120
Dhauliganga-I	Uttarakhand	NHPC	4 X 70	280
			Total	22917

Also, 56 sites for pumped storage schemes with an aggregate installed capacity of 94,000 MW have been identified. It is the most widely used form of renewable energy. India is blessed with immense amount of hydro-electric potential and ranks 5th in terms of exploitable hydro-potential on global scenario. The present installed capacity as on 30-06-2011 is approximately 37,367.4 MW which is 21.53% of total Electricity Generation in India

D. Comparison between various energy sources

Based upon the data available from different sources we analyze the production rates of different sources of energy in India. Thus, we establish a relation between Renewable and Non renewable energy sources which is represented in the table and graph below.

Table d.1-Comparison of Energy Sources

ENERGY SOURCES	Capacity(MW)
Total Fossil	45,753*
Nuclear	10,080
Green Energy	39,722

* considering 10,000 MW by other fossil fuel sources

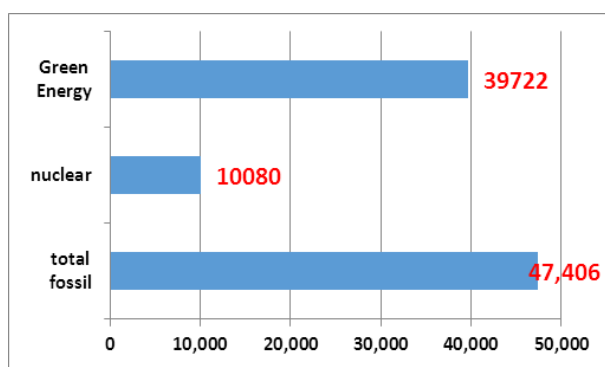


Fig. : Generated Energy from Various Sources

E. Conclusion and future scope

The above comparison represent that at present according to the data taken and avail from various sources, production of Non Renewable is higher as

compared to Renewable energy one. So, still we require more advanced and efficient technology by which all sorts of renewable natural energy sources can be utilized up to its maximum extent by exploring and adopting these energies as a prime energy among all the available energy sources.

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