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Potential and Installed Capacity of Major Renewable Energy Sources in India

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Abstract-

In India, Most of the power generation is carried out by conventional energy sources, coal-fired and oil-based power plants which heavily release the greenhouse gases emission and centralized electrical power faces the problem like blackout , so overcome this greenhouses gas emission and blackout we go through renewable energy in distributed manner. This paper gives an overview of the potential of renewable energy, wind, solar, Biomass, and small hydro power in India while evaluating the current status of potential and installed capacity of renewable energy in India.

Keywords: Wind Power, Solar Power, Biomass, Small Hydro Power(SHP).

I. Introduction

In India electrical energy comes from four sources namely, Thermal, Hydro, Nuclear and Renewable Energy. Source-wise Power Installed Capacity in India [1] shown in fig.1. Renewable energy has a huge potential to usher in universal energy access. In a decentralized, renewable energy is an appropriate, scalable and feasible solution for providing power to power deficient or un-electrified hamlets and villages. Over 1.2 million households are using solar energy to meet their lighting energy needs and almost similar numbers of the households meet their cooking energy needs from biogas plants [2].

Renewable energy database is updated regularly in the country. In India, The National Institute of Wind Energy (NIWE), lately known as Centre for Wind Energy Technology(CWET), has developed the Wind Atlas of India. NIWE also collects data from Solar Radiation Resource Assessment stations to assess and quantify solar radiation availability and develop Solar Atlas of the country. National Institute of Solar Energy(NISE) has assessed the State wise solar potential by taking 3% of the waste land area to be covered by Solar PV modules. The Indian Institute of Science(IISc), Bengaluru has developed Biomass Atlas of India, and the Alternate Hydro Energy Centre(AHEC), Indian Institute of Technology, Roorkee has assessed small hydro potential in the country. Sector-wise Installed Capacity of Renewable Energy in India fig.2.India has an estimated renewable energy potential of about 900 GW from commercially exploitable sources. Wind – 102 GW (at 80m height); Small Hydro about 20 GW; Bioenergy 25 GW; and 750 GW solar power, assuming 3% wasteland is made available [3].

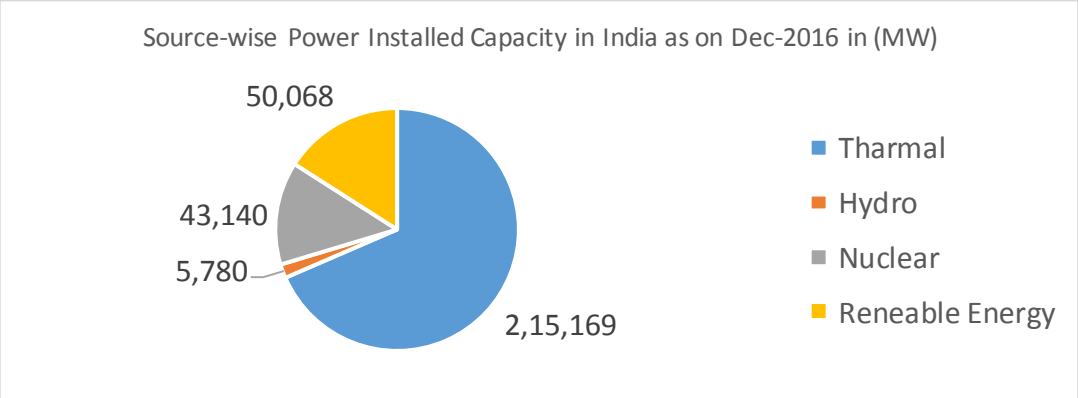

Fig.1

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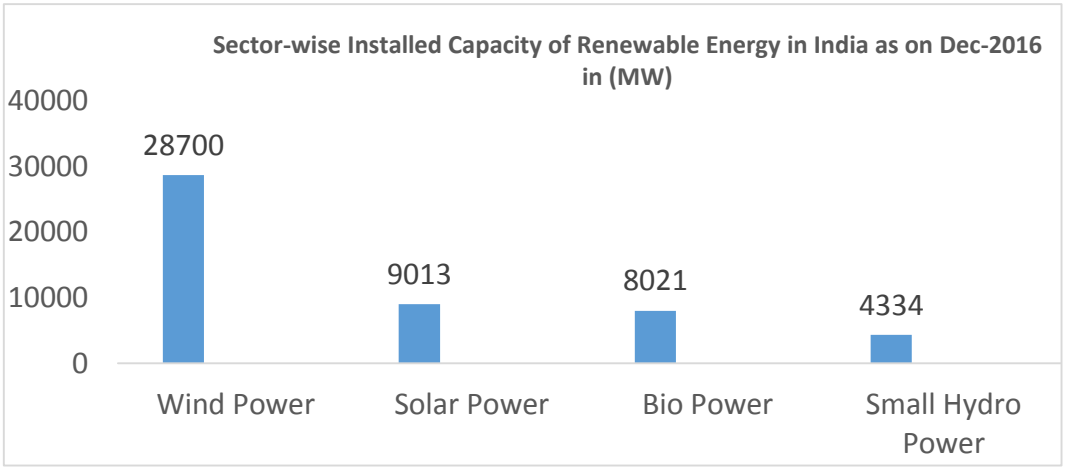

Fig. 2

II. Wind Power

A total capacity of 28,700 MW_has been installed up to December, 2016, mainly in Tamil Nadu, Gujarat, Andhra Pradesh, Karnataka and Rajasthan. Wind generators of unit sizes between 225 kW and 2.1 MW have been deployed across the country. India now ranks 4th in the world after China, USA, Germany in grid connected wind power installations. The Ministry had taken up a new initiative in 2014 for implementation of wind resource assessment in uncovered / new areas with an aim to assess the realistic potential at 100 m level in 500 new stations across the country under the National Clean Energy Fund. National Institute of Wind Energy has used advanced modelling techniques and revised the estimate the wind power potential at 100m at 302 GW [4].

The potential for grid interaction of wind power generation has been estimated at about **102GW** taking sites or places having wind power density greater than 200 Watt/sq. m at 80 m hub-height with 2% land availability in potential areas for setting up wind farms **@ 9 MW/sq. km.** Some state with most potential for Wind Power, Andhra Pradesh (14497), Gujrat (35071), Karnataka (13591), Tamil Nadu (14152). The wind power Global Capacity [5] of top 10 countries Shown in fig 3.

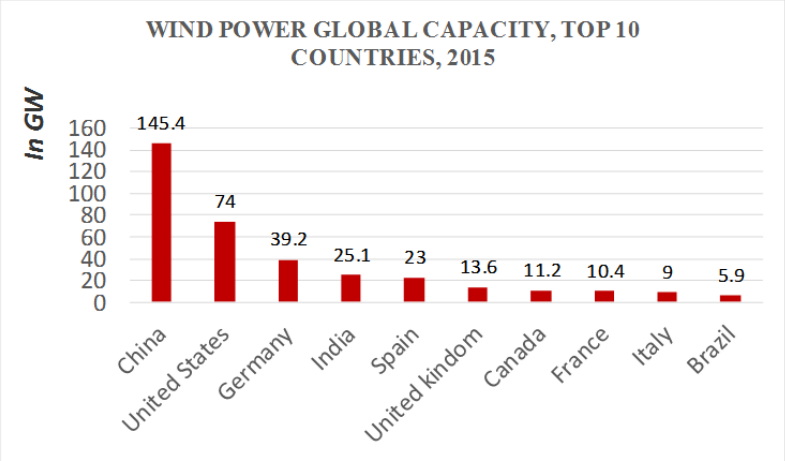

Fig.3

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III. Biomass

Biomass has always been a vital energy source for the country considering the benefits it offers. It is renewable energy, widely available and has the potential to provide significant employment in the rural areas. About 32% of the total primary energy use in the country is still comes from biomass and more than 70% of the country's population depends upon it for its energy needs. Ministry of New and Renewable Energy(MNRE) has estimated the potential and role of bio-energy in the Indian context and thus has initiated a many programmes for promotion of efficient technologies. Biomass power generation in India is an industry that attracts investments of over Rs.600 cr every year, and generating more than 5000 million units of electrical energy and employed of more than 10 million man-days in the rural areas yearly.

Biomass power and cogeneration programme is implemented with the primary objective of promoting technologies for best use of country's biomass resources for grid power generation. Biomass materials used for power generation include bagasse, , cotton stalk, rice husk, coconut shells, de-oiled cakes, jute wastes, coffee waste, groundnut shells, saw dust etc.

The current availability of biomass in India is estimated at about 500 million metric tons per year. MNRE has estimated surplus biomass availability at about 120 – 150 million metric tons per annum covering forestry residues and agricultural corresponding to a potential of about **18GW**. This apart, about 7GW additional power could be generated through bagasse based cogeneration in the country's 550 Sugar mills, if these sugar mills were to adopt technically and economically best levels of cogeneration for extracting power from the bagasse produced by them.

IV. Solar Power

India is endowed with huge potential of solar energy, about 5 EWh/yr or 5,000 trillion kWh/yr solar heat is incident over India's land with most parts of land receiving 4-7 kWh/sq.m/day. thus both technology for conversion of solar radiation into heat energy and electrical energy, namely, solar thermal and solar photovoltaics(SPV)[6], can effectively be harnessed providing huge scalability for solar in India. Off-grid decentralized and low-temperature applications will be advantageous from a rural electrification perspective and fulfilling other energy needs or demand for power and cooling and heating in both rural and urban areas. From an energy security point of view, solar is the most secure of all sources, since it is abundantly available. Theoretically, a small fraction of the total incident solar energy (if captured efficiently) can fulfill the entire country's power requirements. It is also clear that given the large proportion of poor and energy un-served population in the country, every effort needs to be made to exploit the relatively abundant sources of energy available to the country. While, today, domestic coal-fired based power generation is the largest and cheapest electricity source, but future scenarios suggest that this could be change. The Solar PV Global Capacity and Concentrating Solar Thermal Power (CSP) of Top 10 Countries [4,5] shown in fig 4 & fig 5 respectively [7].

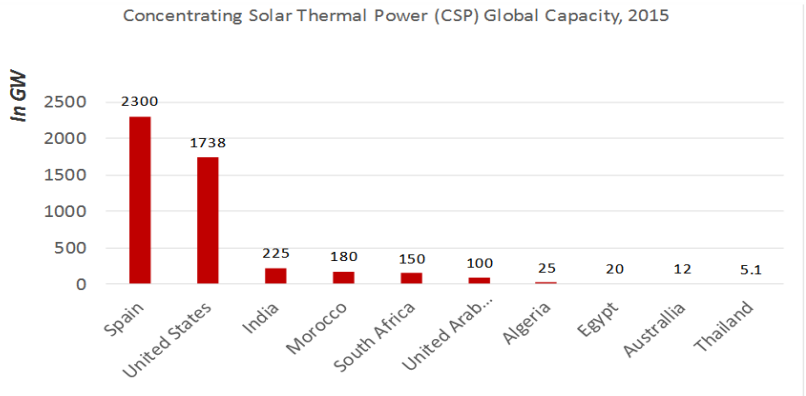

Fig.4

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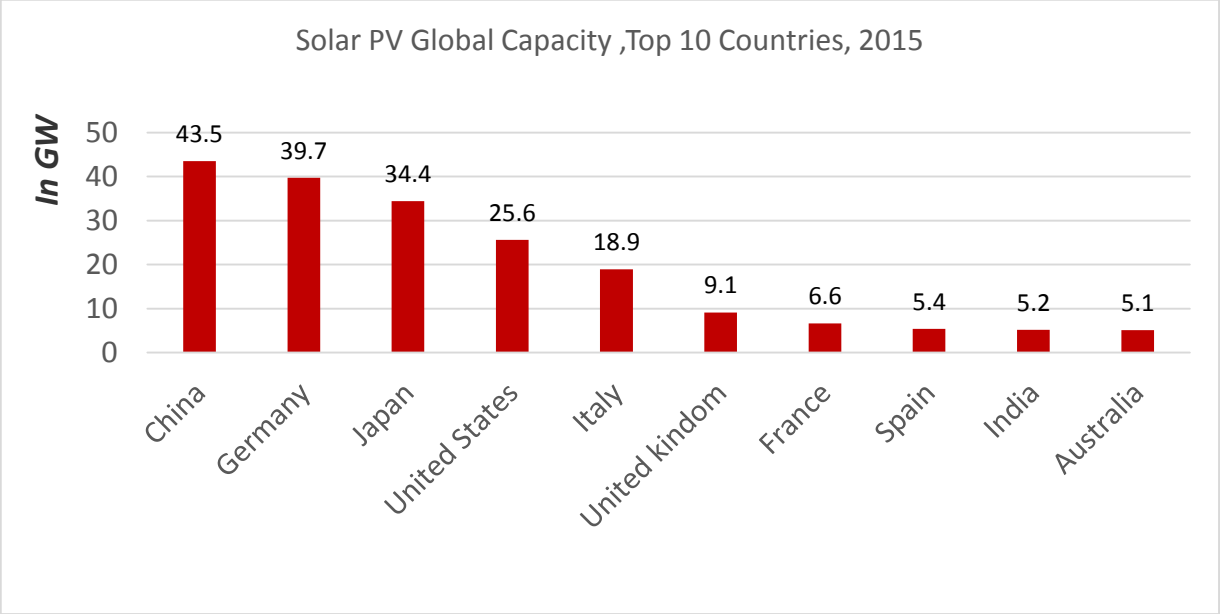

Fig. 5

V. Small Hydro Power (SHP)

Ministry of New and Renewable Energy has been the amenability of developing Small Hydro Power (SHP) up to 25 MW station capacities. The estimated potential for hydro power generation in the country from such type of plants is about 20 GW. Most of the potential is in Himalayan States like Himanchal Pradesh, J&K as river-based projects and in other States on irrigation canals. The viability of these projects improves with increase in the project capacity. The MNRE aim is that at least 50% of the potential in the country is utilize in the next 10 years. The Ministry is encouraging development of small hydro projects both in the public as well as private sector. Equal attention is being paid to grid-interactive and decentralized projects.

The focus of the SHP programme is to lower the cost of equipment, increase its reliability and set up projects in areas which give the maximum advantage in terms of capacity utilization. The MNRE aim is that the SHP installed capacity should be about 7GW by the end of 12th Plan. Ministry of New and Renewable Energy has created a database of potential sites of small hydro and 6,474 potential sites with an aggregate capacity of 19,749.44 MW for projects up to 25 MW capacity have been identified[8].

VI. State-wise Renewable Energy Potential

State wise Renewable Energy Potential Shown in Table 1

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Table.1

State wise Renewable Energy Potential (in MW)								
SI No.	State/UTs	Wind Power	Small Hydro Power	Bio-Energy			Solar	Total
				Biomass Power	Bagasse-cogeneration	Waste to Energy		
1	Andhra Pradesh	14497	978	578	300	123	38440	54916
2	Arunachal Pradesh	236	1341	8			8650	10236
3	Assam	112	239	212		8	13760	14330
4	Bihar	144	223	619	300	73	11200	12559
5	Chhattisgarh	314	1107	236		24	18270	19951
6	Goa		7	26			880	912
7	Gujrat	35071	202	1221	350	112	35770	72726
8	Haryana	93	110	1333	350	24	4560	6470
9	Himanchal Pradesh	64	2398	142		2	33840	36446
10	J&K	5685	1431	43			111050	118208
11	Jharkhand	91	209	90		10	18180	18580
12	Karnataka	13591	4141	1131	450		24700	44015
13	Kerala	837	704	1044		36	6110	8732
14	Madhya Pradesh	2931	820	1364		78	61660	66853
15	Maharashtra	5961	794	1887	1250	287	64320	74500
16	Manipur	56	109	13		2	10630	10811
17	Meghalaya	82	230	11		2	5860	6185
18	Mizoram		169	1		2	9090	9261
19	Nagaland	16	197	10			7290	7513
20	Orissa	1384	295	246		22	25780	27728
21	Punjab		441	3172	300	45	2810	6788
22	Rajasthan	5050	57	1039		62	142310	148518
23	Sikkim	98	267	2			4940	5307
24	Tamil Nadu	14152	660	1070	450	151	17670	34152
25	Telangana						20410	20410
26	Tripura		47	3		2	2080	2131
27	Uttar Pradesh	1260	461	1671	1250	176	22830	27593
28	Uttarakhand	534	1708	24		5	16800	19071
29	West Bengal	22	396	396		148	6260	7222
30	Andaman & Nicobar	365	8				0	373
31	Chandigarh					6		6
32	Dadar & Nagar Haveli						0	0
33	Daman &Diu	4					0	4
34	Delhi					131	2050	2181
35	Lakshadweep						0	0
36	Puducherry	120				3	0	123
37	other					1022	790	1812
	Total	102772	19749	17536	5000	2554	748990	896602

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VII. Conclusion

Indian ranked 4th in Wind installed capacity over the world. India's wind potential about 102GW, therefore installed capacity is only 28GW. We should reduce the difference in potential and installed capacity. India 9th rank in Solar PV and 3rd rank in concentrated solar power installed capacity over the World. There is great potential of solar about 748GW, used either as heat or electricity, but installed only 9GW, therefore great difference between them. We should reduce different between them. Small Hydro power(SHP), the estimated potential for power generation in the country from such plants(up to 25M) is about 20GW. Some State with most potential of small hydro power are Uttarakhand (1.7 GW), Karnataka(1.4GW), J&K(1.4GW). potential of about 18,000 MW. This apart, about 7000 MW additional power could be generated through bagasse based cogeneration in the country's 550 Sugar mills, if these sugar mills were to adopt technically and economically optimal levels of cogeneration for extracting power from the bagasse produced by them.

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