

CURRENT STATUS AND THE FUTURE POTENTIALS OF RENEWABLE ENERGY IN INDIA - A REVIEW

PREETI H. NARNAWARE^{1*},RAMESH G. SUROSE²SWATI V. GAIKWAD³^{1,2,3}Department of Applied Chemistry, Dr. Babasaheb Ambedkar College Engg. & Research, Nagpur, Indiapreeti.p.shende@gmail.comrameshsurose@gmail.comswatigaikwad71@gmail.com

Abstract - India is on the path of rapid economic growth along with speedy overall development. India will require an assured supply of 3–4 times more energy than the total energy consumed today to meet the energy requirement for such a fast growing economy, simultaneously it has to face the global threat of climate change and different environment related problems. Renewable energy is a clean and sustainable source of energy derived from nature and it has potential to provide solutions to the venerable energy problems being faced by the developing countries like India. To overcome energy shortage in India the renewable energy sources like wind energy, solar energy, geothermal energy, ocean energy, biomass energy and fuel cell technology can be used. Today, renewable energy account for about 33% of India's primary energy utilization. India is increasingly adopting painstaking renewable energy techniques and taking positive steps for carbon emissions, cleaning the air and ensuring a more sustainable future. In this paper, efforts have been made to summarize the availability, current status, major achievements and future potentials of renewable energy options in India.

Keywords: - Renewable energy, current status, future potentials

I. INTRODUCTION:

Energy is one of the most vital building blocks in human development and a key factor influence the sustainable development of any nation.¹ The conventional sources of energy have major intimidation to our existing and future global safety environmental values, health and society. So there is urgent necessitate promoting renewable energy in present Indian power sector in sustainable and eco-friendly way.² Renewable energy is energy that comes from resources which are continually replenished such as sunlight, wind, rain, tides, waves and geothermal heat. Renewable energy is one of the cleanest sources of energy options with least carbon emissions or pollution. It has the potential to significantly reduce reliance on coal and other fossil fuels. By expanding renewable energy, India can improve air quality, reduce global warming emissions, create new industries and jobs, and move world towards a cleaner, safer, and affordable energy. Future.³ About 16% of global final energy consumption comes from renewable resources, with 10% of all energy from traditional biomass, mainly

used for heating, and 3.4% from hydroelectricity.⁴ Moreover, India is on the trail of quick economic growth along with rapid overall development; simultaneously it has to face the global threat of climate change. India has unique renewable energy resources and development of country depends to a large extent on harnessing these sources.² India being a developing country faces multifaceted problems at alarming rate in energy sector due to the two most important transformations; industrialization and urbanization.¹ India has over 17 GW of installed renewable power generating capacity. Installed wind capacity is the largest share at over 12 GW, followed by small hydro at 2.8 GW. The remainder is dominated by bioenergy with solar contributing only 15 MW. The Eleventh Plan calls for grid-connected renewable energy to exceed 25 GW by 2012. JNNSM (targets total capacity of 20 GW grid-connected solar power by 2022. Renewable energy technologies are being deployed at industrial facilities to provide supplemental power from the grid, and over 70% of wind installations are used for this purpose.⁵

II. CURRENT STATUS OF RENEWABLE ENERGY SOURCES IN INDIA:

India is the fourth largest energy consumer in the world after the United States, China, and Russia.⁶ To better understand the current situation in India and the potential of the renewable energies market, it is essential to look at the trends in energy consumption, growth of the current grid, and the availability of transport and equipment used there.

At present, for renewable energy India has one of the world's largest programmes. The Ministry of Non-Conventional Energy Sources has been supporting R&D for technology and manpower development in renewable energy. Current emphasis is on reduction in cost and increase in efficiency. For sustained development of this sector, efforts are being made so that the market and the consumer drive renewable energy to a large extent.⁶ The activities include all main renewable energy sources of concern to India, such as solar energy, wind energy, biogas, biomass, small hydropower and other promising technologies.

India's Renewable Energy Potential: - Presently India has enormous renewable energy potential through solar, wind, biomass, small hydro etc. The potential is concerted in certain parts of country. The solar and wind potential is mainly in the southern and western States viz. Tamil Nadu, Karnataka, Andhra

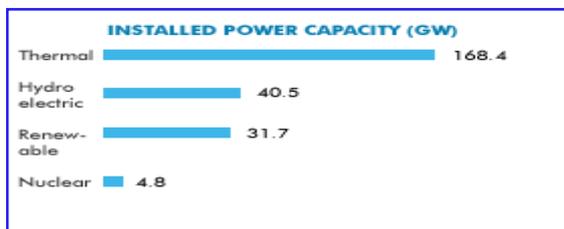
Pradesh, Maharashtra, Gujarat and Rajasthan, however the work out on mapping of potential is continuing in several other areas in the country. Table No-1 shows the potential in MW of different renewable energy sources.

Table No-1:- current potential of renewable energy in India.

Technology	Potential (MW)
Wind	102,800(80m hub height)
Small Hydro (up to 25MW)	19,700
Biomass with bagasse	22,500
Solar	50MWp/km2

Source: Ministry of New & Renewable Energy (MNRE)

Installed capacity of power in India:-As mentioned in report of power sector of india of April 2014, total thermal installed capacity in India stood at 168.4 GW. Following figure shows the Installed power capacity of India in(GW) from different sources

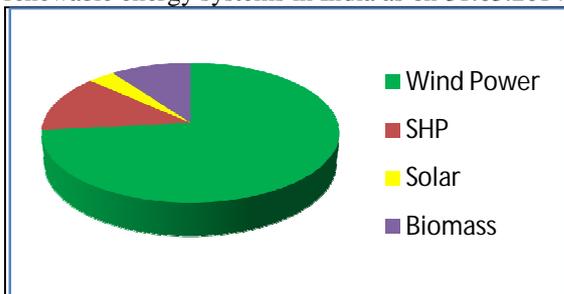


Source: Ministry of New & Renewable Energy (MNRE)

Installed Renewable Energy Capacity in India:-

According to the Investor guide Re-invest 2015the total installed renewable energy capacity is 33&91.74MW,out of which wind energy is 22,465.03 MW, and SHP, Biomass, saolar are 3990.83, 4273.13MW,3062.82MW respectively.

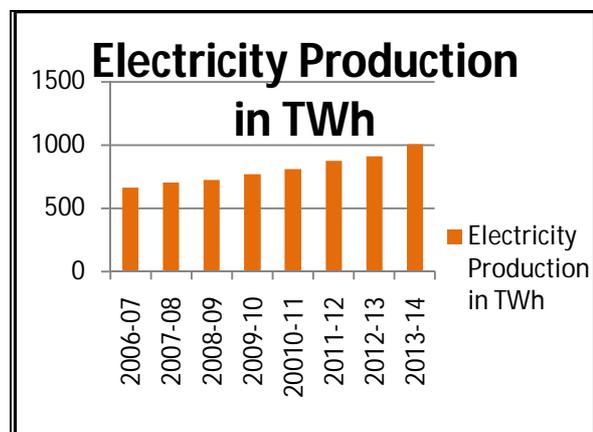
Following figure shows the installed renewable power generation capacity (in GW) of various renewable energy systems in India as on 31.03.2014



MW Source: MNRE,Annual Report 2013-14

Year by Year Electricity Production Growth in India:-

India being a developing country, its energy market is still in a growing stage. India’s power market is estimated to nurture at a CAGR of 7.5-8% till 2017-18. Power consumption is expected to rise from ~1127 TWh in FY2013 to ~3793 TWh in FY2032 at a CAGR of 6%, while power generation has grown from FY2007 to FY2013 at CAGR of 5.5%. From April 2013 to March 2014, electricity generation grew at 5.96%. As per the India renewable energy status report 2014 - may 14, 2014, Electricity Production of India in 2006-07 was 663 TWh which reaches to 1006 TWh in 2013-14. Following Graph shows the growth in electricity production of India from year 2006-07 to 2013-14.



MW Source: MNRE,Annual Report 2013-14.

Electricity Production Growth in India

Physical Progress (Achievements):-

In last few years, an appreciable growth in Indian renewable energy sector has been observed it is very clear that the cumulative grid interactive power capacity of renewable energy has been increasing tremendously and the installed capacity is 31,702 MW as on 31st March, 2014. T able No-2 shows the cumulative achievement of power in MW from renewable energy sources.

SOLAR ENERGY:

India has an predictable solar power potential of about 1,00,000 MW out of which the total installed capacity as of 31st March 2014 was 2,647 MW. Solar energy potential is the highest in the country among all the different renewable energy resources. In India as most parts of the country have about 300 clear sunny days in a year and receive on an average of 4-7 kwh (kilowatt-hour) solar radiation per square meter per day. The lowest annual solar radiation is received by north-eastern parts of the country whereas the Rajasthan receive the highest. If only a little amount of this form of energy could be used, it will be one of the most important supplies of energy specially when other sources in the country have depleted, energy comes to the earth from the sun.

The solar power where sun hits atmosphere is 1017W. The solar power on the surface of earth is 1016W. The total worldwide power demand of all needs of civilization is 1013W. Therefore, the sun gives us 1000 times more power than we need. If we can use 5% of this energy, it will be 50 times what the world will require.

The equivalent energy potential is about 6,000 million GWh of energy per year. As compared to this,

the present level of generation of electricity in 2008-09 from all resources was 0.7 million GWh. The National Solar Mission targeting 20,000 MW grid solar Power, 2,000 MW of off-grid capacity including 20 million solar lighting systems and 20 million square meters solar thermal collector area by 2022 is under implementation.

Table no-2: Cumulative achievement of power in MW from renewable energy sources

Ministry of New & Renewable Energy			
Programme/ Scheme wise Physical Progress in 2014-15 (During the month of February, 2015)			
Sector	FY- 2014-15		Cumulative Achievements (as on 28.02.2015)
	Target	Achievement	
I. GRID-INTERACTIVE POWER (CAPACITIES IN MW)			
Wind Power	2000.00	1512.80	22644.63
Small Hydro Power	250.00	221.60	4025.35
Biomass Power & Gasification	100.00	0.00	1365.20
Bagasse Cogeneration	300.00	170.00	2818.35
Waste to Power	20.00	8.50	115.08
Solar Power	1100.00	750.77	3382.78
Total	3770.00	2663.67	34351.39
II. OFF-GRID/ CAPTIVE POWER (CAPACITIES IN MW_{EQ})			
Waste to Energy	10.00	10.54	143.27
Biomass(non-bagasse) Cogeneration	80.00	46.47	578.29
Biomass Gasifiers	0.80	0.75	18.56
-Rural			
-Industrial	8.00	6.20	153.40
Aero-Generators/Hybrid systems	0.50	0.22	2.48
SPV Systems	60.00	52.77	227.12
Water mills/micro hydel	4.00	2.00	15.21
Bio-gas based energy system	0.00	0.30	4.07
Total	163.30	119.25	1142.40
III. OTHER RENEWABLE ENERGY SYSTEMS			
Family Biogas Plants (numbers in lakh)	1.10	0.45	47.98
Solar Water Heating – Coll. Areas(million m ²)	0.50	0.66	8.76

According to the latest update of the MNRE, Solar in India has crossed the 2 GW landmark (grid-connected and offgrid systems combined). As on 31st October 2013, the total solar installed capacity stood at 2219 MW, out of which grid-connected solar capacity was 2080 MW and off-grid systems was 139 MW.⁶ Jawaharlal Nehru National Solar Mission (JNNSM) was started to establish India as a global leader in

solar energy, by creating the policy conditions for its large scale usage across the country as quickly as possible. The Mission has been planned in 3-phases, beginning in the 11th Plan and first year of the 12th Plan (up to 2012-13) as Phase I, the remaining 4 years of the 12th Plan (2013-17) as Phase II and the 13th Plan (2017-22) as Phase III. The targets set by the JNNSM are as follow.

Sector	Utility Grid Power including rooftop (in MW)	Off Grid Installations (in MW)	Solar	Solar Collectors (in million square meters)
11 th Plan	1,100	200		7
12 th Plan	4,000 – 10,000	1000		15
13 th Plan	20,000	2000	2000	20

WIND ENERGY:

India has an expected wind power potential of 1,02,772 MW out of which the total installed capacity as of 31st March 2014 was 21,136.30 MW.

The use of wind power in India has been gaining importance with rapid installation in the last few years. Wind energy makes up the majority about 68 per cent of the total renewable energy capacity installed in India. Initial estimates from Centre for Wind Energy Technology (C-WET) suggest that wind energy potential at 80 metres height (with 2 per cent land availability) would be over 100 GW. Some studies have estimated even higher potential ranges up to 300 GW. By the end of October 2013, India had a total installed capacity of 19,933 megawatt (MW), with 1,699 MW installed in 2012-13. The total wind power generation in 2011-12 was 23,399.5 gigawatt hour (GWh), or about three and a half times the output of a new 1,000-MW nuclear reactor. The 12th Five Year Plan aims to install 15,000 MW between 2012 and 2017, which will almost double the total capacity of wind power in India.⁶

SMALL HYDRO POWER (SHP):

India has an expected small hydro power (less than 25 MW) potential of around 20,000 MW out of which the total installed capacity as of 31st March 2014 was 3,816.91 MW including offgrid and grid connected power plants. Energy from small hydro is the oldest. Small hydropower is one of the least expensive and most attractive forms of renewable energy lies largely untapped⁹. It is a very attractive renewable energy source because it uses mature and largely indigenous technology and its maximum power production is in the summer, which coincides with peak seasonal demand in India. India has an estimated small hydropower potential of about 15GW, of which about 2.5GW has been developed.

Hydro projects in India, which are under 25 MW in capacity, are classified as “small hydropower” and considered as a “renewable” energy source. The use of small hydro power (SHP) in India goes way back in history, with the country’s first SHP plant having come up in 1897. The sector has been growing rapidly for the last decade. The Number of SHP plants has doubled. SHP is by far the oldest renewable energy technology used to generate electricity in India. The total installed capacity of SHP projects in India was 3,632 MW in March 2013. This is spread over 950 projects; hence, the average SHP project capacity is 3.8 MW. This does not include micro-hydro plants. The draft 12th Five Year

Plan (2012-17) has, as its target, 2,100 MW of SHP capacity⁴. The total potential country-wide capacity is estimated at 19,749 MW, of which about 1,250 MW is under development. The current total installed capacity of small hydro power plants is 3746.75 MW.

BIOMASS & BIOGAS ENERGY:

India has an estimated biomass power potential of around 17,536 MW out of which the total installed capacity as of 31st March 2014 was 1,914.50 MW including both off-grid and grid connected power plants. For bagasse cogeneration power, India has a potential of about 5,000 MW out of which the total installed capacity as of 31st March 2014 was 2,648.40 MW.

In an agrarian economy like India Biomass has huge potential. Biomass is one of the most important source of renewable energy derived from numerous sources, counting the by-products from the timber industry, firewood, agricultural residues such as bagasse, crop straw, animal dung and wastes generated from agro-based industries and the carbonaceous waste of various human and natural activities. Currently, biomass contributes about 14 % of the total energy supply worldwide and 38 % of this energy is consumed in developing countries, predominantly in the rural and traditional sectors of the economy.

In India, a total of 4,449 MW has been installed under bio energy, both in grid connected and off-grid capacities. Table No-3 shows the details of offgrid and on grid capacity installed.

Table No-3

S.N	Type	Grid Connected	Capacity Installed (MW)
1	Biomass	On-grid	1265
2	Bagasse cogeneration	On-grid	2337
3	Waste to power (Urban)	On-grid	96
		Off-grid	116
4	Biomass Cogeneration (Non-bagasse)	Off-grid	475
5	Biomass gasifiers (rural)	Off-grid	17
6	Biomass gasifiers (industrial)	Off-grid	143
Total			4449

Source: MNRE achievements

The biomass power generation potential in India is estimated at 30000 MW. It results in a saving of about Rs.20, 000 crores every year. Biomass can be used in three ways – gasification, methane gas production and combustion. The technologies being promoted include combustion either for power in captive or grid connected modes, or for heat applications.

III. FUTURE POTENTIAL OF RENEWABLE ENERGY SOURCES.

India has a lot of potential for renewable energy. Solar is the prime free source of inexhaustible energy available to all. And, India is one of the sun's most favored nations, blessed with about 5,000 TWh of solar segregation every year. Even if a tenth of this potential was utilized, it could mark the end of India's power problems by using the country's deserts and farmland to construct solar plants.⁴

Energy requirement of India can be accomplish by increase in renewable and non-conventional energy sources have been planned. As per 12th Five Year Plan, the total domestic energy production by 2016-17 will be 669.6 MTOE and by 2021-22 it is predictable to reach 844 MTOE. This will get together around 71 per cent and 69 per cent of

expected energy utilization, with the balance to be met from imports, projected to be about 267.8 MTOE by 2016-17 and 375.6 MTOE by 2021-22. The Wind Energy division is planned to grow at 10-15% to meet the demand for power. Solar Energy is also anticipated to reach 20 GW of energy capacity till 2022 due to heavy and important incentives offered by the government.

The private sector is expected to play a key role, as by 2017-18, more than 35% of the country's power generation is expected from the private sector.

To make the country self sufficient in electricity large number of solar energy projects are to be installed. This would also reduce CO₂ in the air and also this will further reduce the air pollution. Hence the initiative can be taken to provide clean and green energy to the common people as the energy demand since last few years had been increased. Recently one of the appreciating initiative taken by Lokmat news paper was installation of its own solar energy project at Butibori , MIDC area in Nagpur. Table No-4shows the state wise cumulative achievement of energy by 2022.

Provisional State-wise break-up of Renewable Power goal to be achieved by the year 2022 So that cumulative achievement is 1,75,000 MW.

State/UTs	Solar Power (MW)	Wind (MW)	SHP (MW)	Biomass Power (MW)
Delhi	2762			
Haryana	4142		25	209
Himachal Pradesh	776		1500	
Jammu & Kashmir	1155		150	
Punjab	4772		50	244
Rajasthan	5762	8600		
Uttar Pradesh	10697		25	3499
Uttarakhand	900		700	197
Chandigarh	153			
Northern Region	31120	8600	2450	4149
Goa	358			
Gujarat	8020	8800	25	288
Chhattisgarh	1783		25	
Madhya Pradesh	5675	6200	25	118
Maharashtra	11926	7600	50	2469
D. & N. Haveli	449			
Daman & Diu	199			
Western Region	28410	22600	125	2875
Andhra Pradesh	9834	8100		543
Telangana		2000		
Karnataka	5697	6200	1500	1420
Kerala	1870		100	
Tamil Nadu	8884	11900	75	649
Puducherry	246			
Southern Region	26531	28200	1675	2612
Bihar	2493		25	
Jharkhand	1995		10	

Orissa	2377			
West Bengal	5336		50	
Sikkim	36		50	
Eastern Region	12237		135	244
Assam	663		25	
Manipur	105			
Meghalaya	161		50	
Nagaland	61		15	
Tripura	105			
Arunachal Pradesh	39		500	
Mizoram	72		25	
North Eastern Region	1205		615	
Andaman & Nicobar Islands	27			
Lakshadweep	4			
Other (New States)		600		120
All India	99533	60000	5000	10000

REFERENCES

- [1] Asok Rajkumar, Balasubramanian.,Karthickumar. International Journal of Advancements in Research & Technology, Volume 2, Issue 2, February- 2013.
- [2] Yog Raj Sood, Naveen Kumar Sharma, 2nd International Conference on Emerging Trends in Engineering and Technology (ICETET'2014), May 30-31, 2014 London (UK).pg-102-107
- [3] Investors Guide Re-invest 2015 January 2015.pg-1-27.
- [4] Surendra Kumar Yadav, Govind Chandra Mishr,International Journal of Engineering Research and Technology, Volume 6, November-2013, pg. 709-716
- [5] D. S. Arora (IRADe) , Sarah Busche (NREL) , Shannon Cowlin (NREL) , Tobias Engelmeier (Bridge to India Pvt. Ltd.) , Hanna Jaritz (IRADe) , Anelia Milbrandt (NREL) , Shannon Wang (REN21 Secretariat), Indian Renewable Energy Status Report Background Report for DIREC 2010. pg.35.
- [5] Vivek Panwar, Tarlochan Kaur, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 2, February 2014, pg-7118-7125.
- [6] Peter Meisen(President, Overview of Renewable Energy Potential of India
- [7] Renewable Energy and Energy Efficiency Status in India.
- [8] Md Aquil Ahmad, Shadab Khalid, Shadman Hussain Qaisar and Tiwari Gourav, The Contemporary Scenario of Indian Renewable Energy Sector International Research Journal of Environment Sciences, Vol. 3 (11), November 2014.pg-82-89.
- [9] Unleashing the Potential of Renewable Energy in India Gevorg Sargsyan Mikul Bhatia Sudeshna Ghosh Banerjee Krishnan Raghunathan Ruchi Soni 2010 South Asia Energy Unit Sustainable Development Dep.
- [10] Ashwani Kumar, Kapil Kumar, Naresh Kaushik, Satyawati Sharma, Renewable and Sustainable Energy Reviews, Volume 14, Issue 8, October 2010, Pg 2434–2442.
- [11] P. Garg, Energy Scenario and Vision 2020 in India Journal of Sustainable Energy & Environment vol.3, 2012.pg. 7-17.
- [12] S. P. Sukhatme, Can India's future needs of electricity be met by renewable energy sources? A revised assessment CURRENT SCIENCE, VOL. 103, NO. 10, NOVEMBER 2012 pg. 1153
- [13] R. K. Gera, Dr H.M.Rai, Yunus Parvej, Himanshu Soni, Renewable Energy Scenario in India: Opportunities and Challenges, Indian Journal of Electrical and Biomedical Engineering Volume.1 Number.1 January-June 2013, pp.10-16
- [14] Report On Development of Conceptual Framework For Renewable Energy Certificate Mechanism for India.
- [15] Energy statistics 2014, central statistics office, govt. Of India.