Research Based Learning

SCIENTIFIC ARTICLE WRITING

On the topic

"Wind Energy : Study & Scope in India"

By Mast. Udit Bansal

Purpose: To make them aware about the status of Wind Energy Utilization in India and Madhya Pradesh and to involve the status in research related to the topic "Sources of Energy which the chapter of Physics in Class X-CBSE Curriculum"

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Wind Energy: Study and Scope in India

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Abstract

In the last few decades, the field of Renewable Energy Sources (RESs) is the most attracting field for researchers as far as the global demand of electricity is concerned, with many innovations, technologies, and applications become a reality. Wind Energy is one of the important categories of Renewable sources of energy which will be helpful for the sustainable development of India. Wind Energy and Solar Power is currently is the most dominating category of renewable sources of energy. This paper depicts the current situation and future perspective of utilization of wind energy. In this paper, efforts have been made to summarize the analysis of consumption, current status, and future capability, barriers to implementation and major achievements of solar energy in different states of India.

Keywords - Renewable Energy Sources (RESs), wind energy, sustainable development.

Introduction

At the present time renewable energy is one of the most important topics in world. It is important because the fossil fuel reserves in the world are reducing rapidly and no reserves will be found in the future. In inclusion to that, energy generation from fossil fuel may cause so many environmental problems like global warming and acid rains, etc. In Today's modern world Renewable energy plays a major role. Renewable energy is that the energy that's collected from renewable sources, which are naturally replenished on a person's timescale, like Wind, Sunlight, Rain, Tides, Waves, Geothermal heat etc. Normally renewable energy provides energy for four different areas. They are electricity generation, transportation etc. As an example, Iceland and Norway already generate their electricity by using renewable sources of energy like wind, sun rays, tides, etc. India has also set up a goal to reach 100% renewable energy in the future. Many other countries like Denmark has decided to switch the total energy supply (electricity, heating/cooling) to 100% renewable energy by 2050. Wind energy has been identified as a promising renewable option because it's a way smaller impact on the environment compared to burning of fossil fuels. Many nations in the world identified, and they have formulated policies to ensure that wind power has a growing role in energy resources and energy generation.

[1] Historical background of energy in India

Commercial energy consumption of India has been growing fast in recent years keeping pace with high economic growth rate. Table 1 shows the expansion in commercial energy consumption of India and a couple of other selected countries and regions during the amount 1995–2005. India had the second highest percentage growth in energy consumption among the listed countries after China, during this era . India depends heavily on coal and oil for meeting its energy demand. The shares of different sources in primary conventional energy consumption in 2005 were: coal – 55.0%; oil – 29.9%; natural gas – 8.5%; hydroelectricity – 5.6%; and Nuclear energy – 1.0% . This pattern of energy consumption is very problematic for the country. Coal is a polluting fuel and is the biggest source of national greenhouse gas emissions; its use needs to be curtailed for reducing emissions of both greenhouse gases and local air pollut- ants. India depends heavily on imports for meeting its domestic oil requirements; imports accounted for 72% of India's total oil consumption in 2004–2005.

Table 1 Scenario at Global Level

Country /region	Growth during 1995-2005
Brazil	36.6
China	69.6
India	52.2
Japan	6.2
Germany	-2.7
Mexico	31.8
UK	6
USA	10.2

[2] Methods of utilizing wind energy

There are many methods of utilizing wind energy but most common method is using wind turbine usually consisting of propellers. The turbine are often connected to a generator to get electricity, or the wind used as mechanical power to perform tasks like pumping water or grinding grain. As the wind passes the turbine it moves the blades, which spins the shafts. Around 1910, the primary wind turbines were inbuilt Europe. Later, the event of wind generation in India began within the 1986 with first wind farms being found out in coastal areas of Maharashtra, Gujarat and Tamil Nadu with 55kW Vestas wind turbines. The capacity has significantly increased in the last few years. India has the fourth largest installed wind generation capacity within the world following Denmark and US. In 2009-10 India had the very best rate of growth amongst all four top countries.

[3] Current scenario of wind energy in India

Over the years, there has been considerable increase amount of energy produced by wind-driven turbines thanks to recent advancement within the turbine technologies. Although India may be a relative newcomer to the wind industry compared with Denmark or the US, domestic policy support for wind generation has led India to become the country with the fourth largest installed wind generation capacity within the world. As of 30 June 2018, the installed capacity of wind generation in India was 34,293 MW. Wind power accounts for 10% of India's total installed power capacity. India has set an ambitious target to get 60,000 MW of electricity from wind generation by 2022. MNRE announced a replacement wind-solar hybrid policy in May 2018 which suggests that an equivalent piece of land are going to be wont to house both wind farms and solar panels.

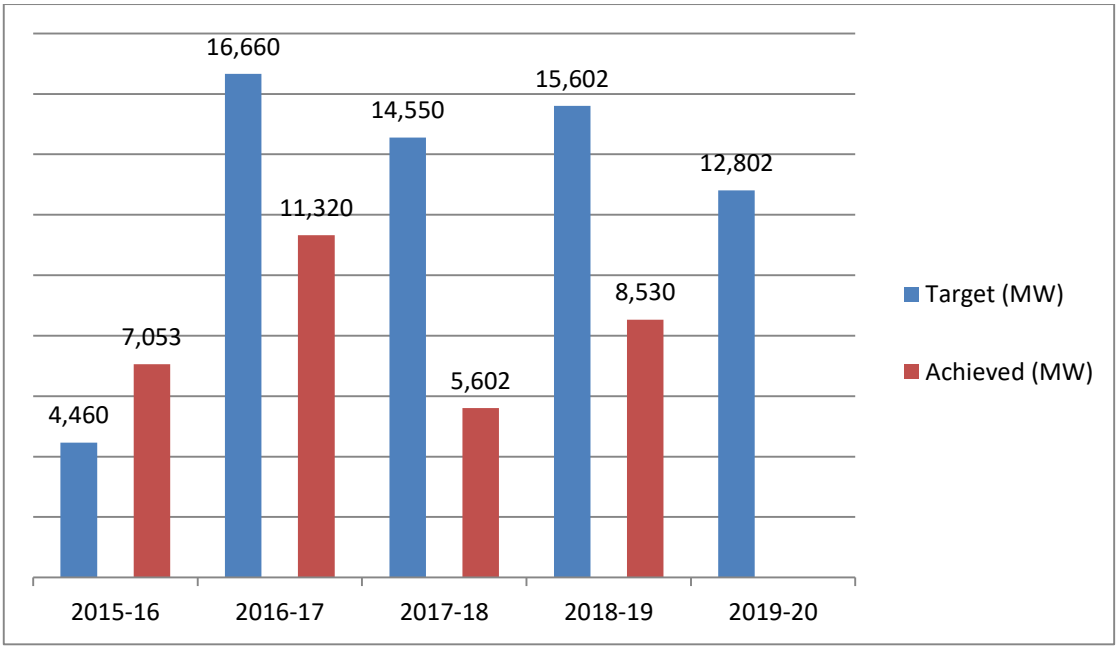

Fig.1Wind energy targets and Achievements in India

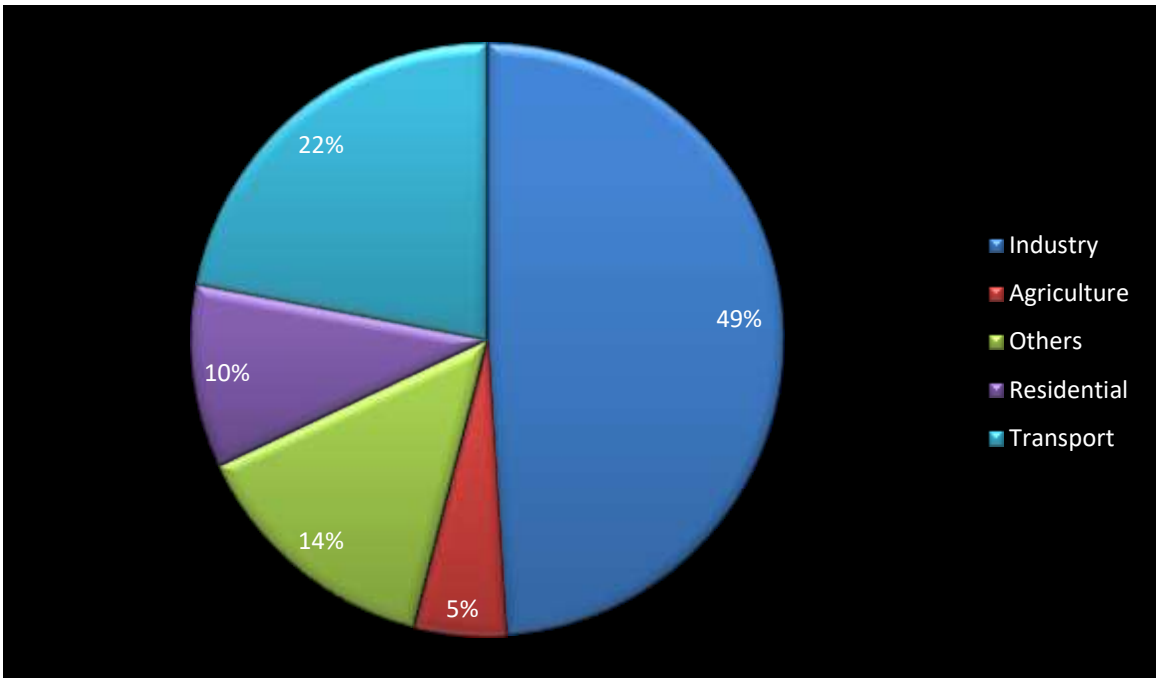

Fig.2:-Sector wise energy consumption in India

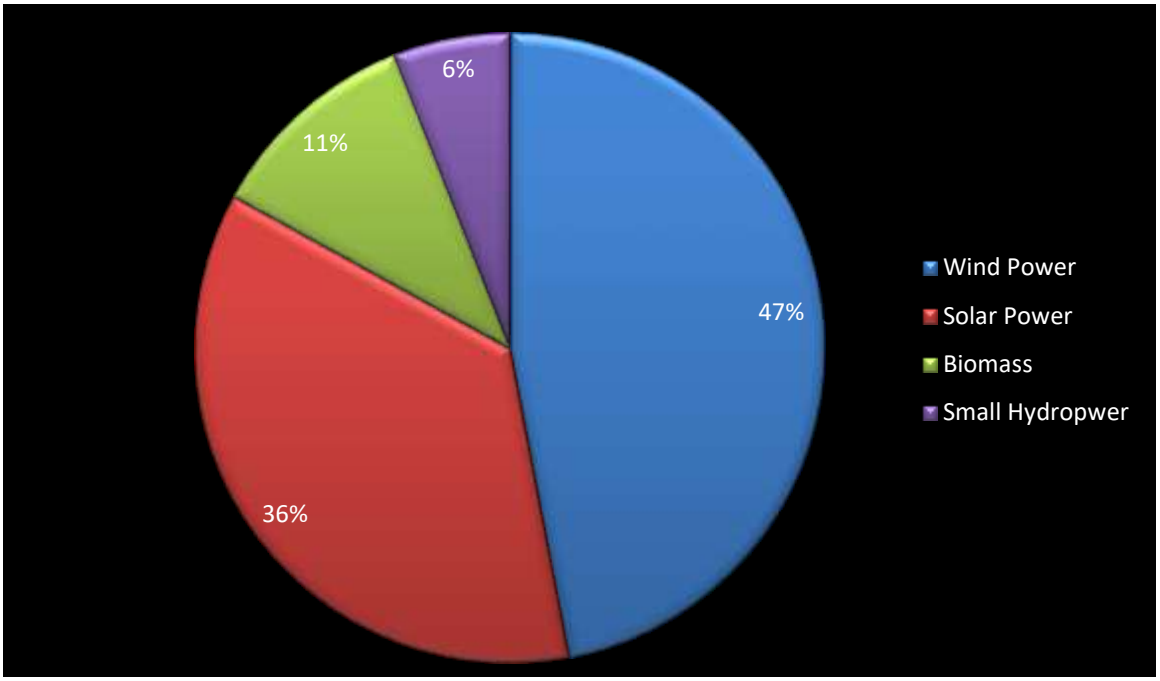

Fig 3 Renewable energy production in India

Table 2 Showing Wind Power distribution India

States /UT's	Wind power distribution in India
Andaman and Nicobar Island	2
Andhra Pradesh	5394
Arunachal Pradesh	201
Assam	53
Bihar	0
Chandigarh	0
Chhattisgarh	23
Dadra and Nagar Haveli	0
Daman and Diu	0
Delhi	0
Goa	0
Gujarat	10609
Haryana	0
Himachal Pradesh	20
Jammu and Kashmir	5311
Jharkhand	0

Karnataka	8591
Kerala	790
Lakshadweep	16
Madhya Pradesh	920
Maharashtra	5439
Manipur	7
Meghalaya	44
Mizoram	0
Nagaland	3
Odessa	910
Pondicherry	0
Punjab	0
Rajasthan	5005
Sikkim	98
Tamil Nadu	5374
Telangana	0
Tripura	0
Uttarakhand	137
Uttar Pradesh	137
West Bengal	22

Table 3 Showing wind power production in India

Rank	Power Plant	Producer	Location	State	MWe
1	Muppandal Wind Farm	Muppandal Wind	Kanyakumari	Tamil Nadu	1500
2	Jaisalmer Wind Park	Suzlon Energy	Jaisalmer	Rajasthan	1064
3	Brahmanvel	Parakh Agro Industries	Dhule	Maharashtra	528
4	Dhalgaon Wind Farm	Gadre Marine Exports	Sangli	Maharashtra	278
5	Vankusawade Wind Park	Suzlon Energy Ltd	Satara District	Maharashtra	259
6	Vaspet	ReNew Power	Vaspet	Maharashtra	144
7	Tuljapur	Siemens Gamesa, ReNew Power	Osmanabad	Maharashtra	126
8	Beluguppa Wind Park	Orange Renewable	Beluguppa	AndhraPradesh	100.8
9	Mamatkheda Wind Park	Orange Renewable	Mamatkheda	Madhypradesh	100.5
10	Anantpur Wind Park	Orange Renewable	Nimbagulla	AndhraPradesh	100
11	Damanjodi Wind Power	Suzlon Energy Ltd.	Damanjodi	Odisha	99
12	Jath	ReNew Power	Jath	Maharashtra	84
13	Welturi	ReNew Power	Welturi	Maharashtra	75
14	Acciona Tuppadahali	Tuppadahalli Energy India Ltd.	Chitrdurga District	Karnataka	56.1
15	Dangiri Wind Farm	Oil Ltd.	Jaisemer	Rajasthan	54
16	Bercha Wind Park	Orange Renewable	Ratlam	M.P	50
17	Cape Comorin	Aban Loyd Chiles Offshore Ltd	Kanyakumari	Tamil Nadu	33

18	Kayathar Subhash	Subahsh Ltd.	Kayathar	Tamil Nadu	30
19	Jasdan ReNew Power	ReNew Power	Jasdan	Gujrat	25.5
20	Ramakkalmedu	Subhash Ltd.	Ramakkalmedu	Kerela	25
21	Gudimangalam	Gudimangalam Wind Farm	Gudimangalam	Tamilnadu	21
22	Shalivahan Wind	Shaivahan Green energy Ltd.	Tirpur	Tamil Nadu	20.4
23	Puthlur RCI	Wescare (India) Ltd.	Puthlur	Andhra Pradesh	20
24	Lamda Danida	Danida India Ltd.	Lamba	Gujrat	15
25	Chennai Mohan	Mohan Breweries and Distilleries	Chennai	Tamil Nadu	15
26	Shah Gajendragarh	MMTCL	Gadag	Karnataka	15
27	Jamgudrani MP	MP Windfarms Ltd.	Deaws	Madhya Prdesh	14
28	Jogmatti BSES	BSES Ltd.	Chitradurga District	Karnataka	14
29	Perungudi Newan	Newam Power Comp. Ltd.	Perungudi	Tamil Nadu	12
30	Kethanur Wind Farm	Kethanur Wind Farm	Kethanur	Tamil Nadu	11
31	Shah Gajendragarh	Sanjay D. Ghodawat	Gadag	Karnataka	10.8
32	Hydrabad TSRTC	Telengana SRTC	Hyderabad	Telangana	10
33	Muppandal Madras	Madras Cements Ltd.	Muppandal	Tamil Nadu	10
34	Poolavadi Chettinad	Chettinad Cement Corp. Ltd.	Poolavadi	Tamil Nadu	10

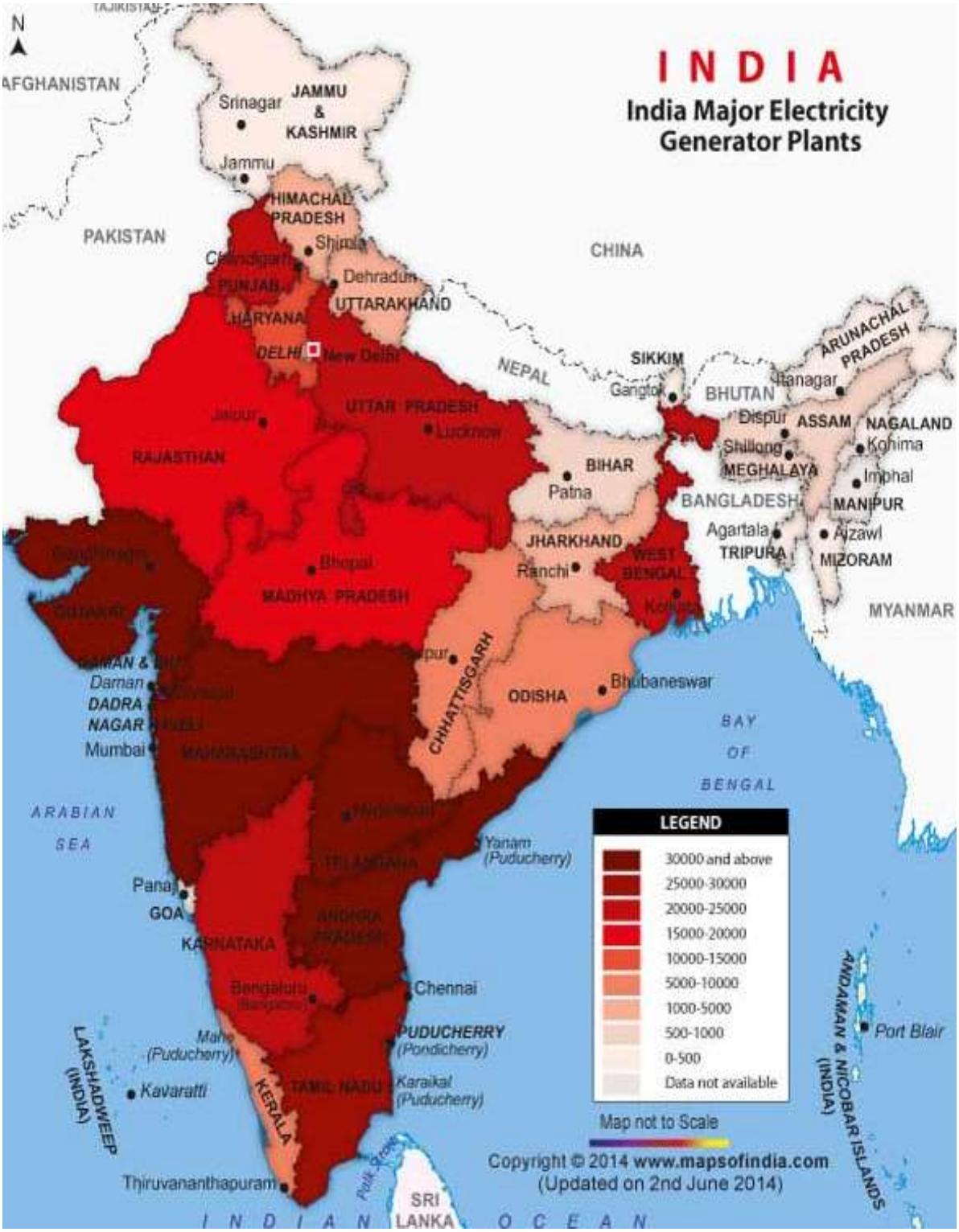

Fig.3 Major wind energy producers in India

4 Utilization of wind energy in Madhya Pradesh

Madhya Pradesh is one among the most important States of India. From 544 kWh in FY 11 to 739 kWh in FY 15, the per capita consumption of electricity within the State has been growing at a

CAGR of seven .95%. However, it remains well below the national average of 1010 kWh per capita in FY 15. The major reason for low per capita consumption is large tribal region within the State.

Table 3: Available generation capacity as on August, 2015

Sources	Capacity Available (MW)
MP Genco Thermal and Hydro	5,237 MW
NHDC & Other hydel	2427 MW
Central Sector share	3230 MW
DVC Thermal	500 MW
IPPs Thermal	2986 MW
Renewable sources	1020 MW
Total	15,400 MW

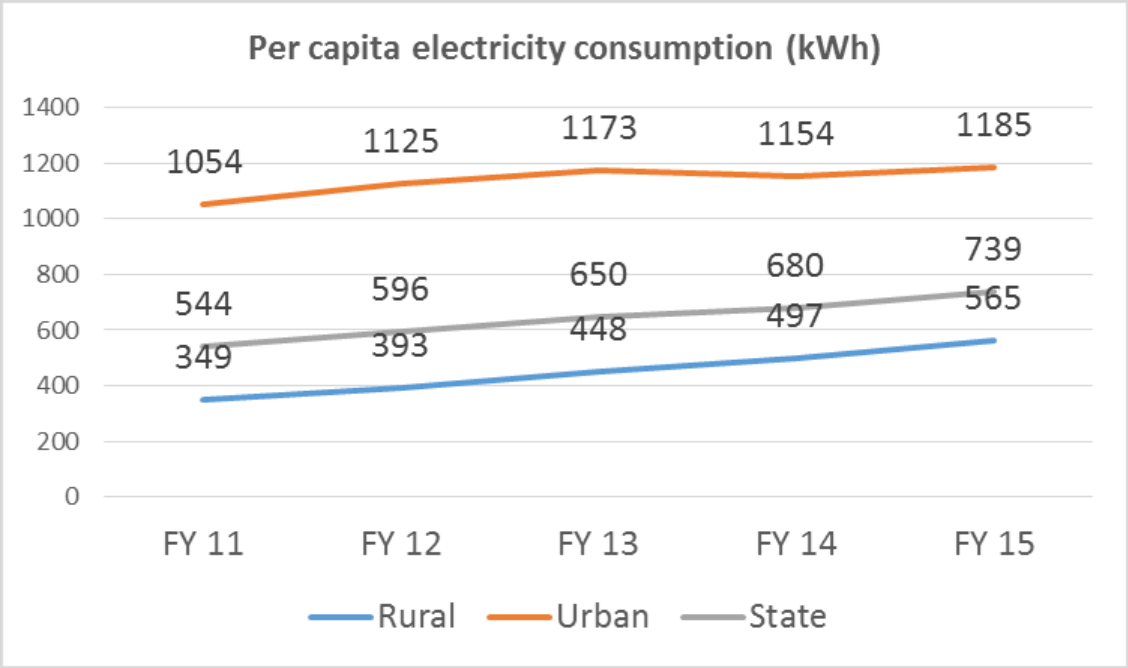

Figure 4: Per-Capita Consumption of Electricity (kWh per person) in recent years

- *Per capita electricity consumption of Madhya Pradesh based on energy demand for the state in FY 2014-15 was registered at 739 kWh (India 1010 kWh)*

- *The reason for lower per capita electricity consumption is large number of BPL consumers and tribal regions.*
- *Other major reason for lower per capita consumption is lower industrial (25.05%) & commercial (7.07%) consumption and higher agricultural consumption (38.74%)*

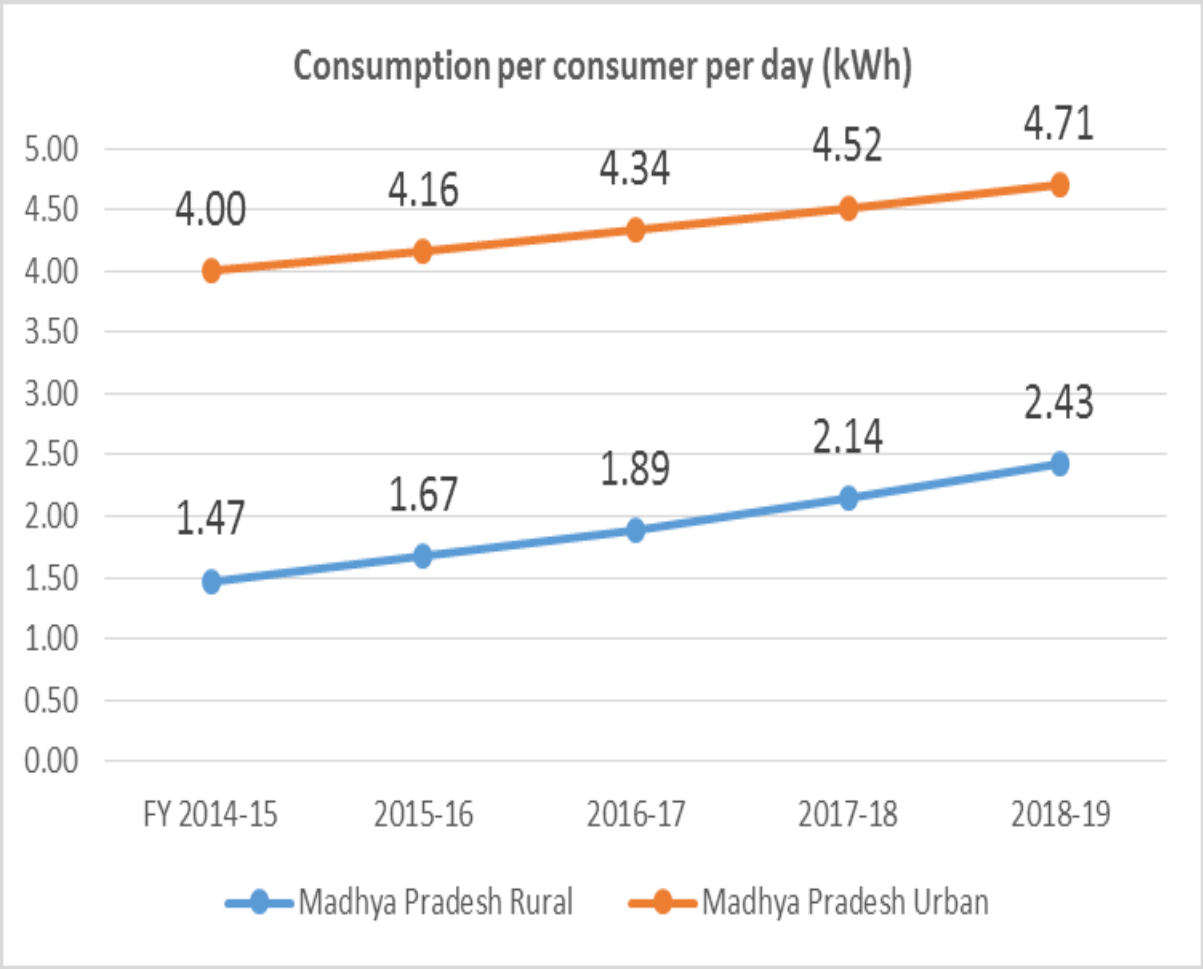

Figure 5: Projected household consumption

Table 4: Category-wise consumption (In MU)

Categories	FY 16	FY 17	FY 18	FY 19
Domestic	11,349	13,206	15,802	19,354
Non Domestic	2,471	2,752	3,049	3,363
Public Lighting	431	466	497	526
Public Water works LT	719	800	864	926
Irrigation LT	18,462	20,796	22,,626	24,459
Lift Irrigation HT	55	56	63	66
Industrial LT	1,125	1,219	1,320	1,424
Industrial HT	8,411	9,213	10,037	10,916
Railway Traction	1,994	2,106	2,225	2,341
Non - industrial HT	1,029	1,092	1,161	1,231
Total	46,045	51,708	57,644	64,606

As seen from above, the consumption share of industries and railway (combined) would be around 22.51% whereas the share of irrigation sales will be around 37.61% in FY 19. Figure 6 shows the resulting wind capacity expansion necessary to reach 20% electricity generation by 2030. This trajectory was designed to supply an aggressive annual rate of growth that reached a sustainable level of producing by accounting for both demand growth and therefore the repowering of aging wind plants. Based on the assumptions used in this study, the wind industry would need to grow from an annual installation rate

of 5 GW/yr in 2007 to a sustained rate of about 15 GW/yr by 2018, which is a threefold growth over the next decade.

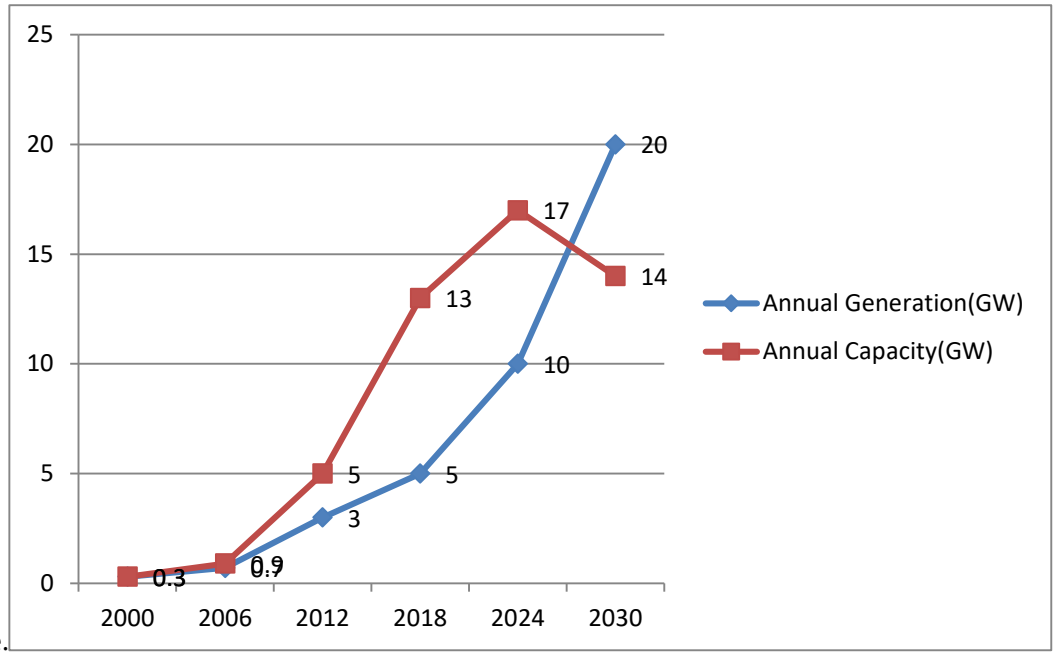

FIGURE 6. Prescribed annual wind energy generation and corresponding annual wind capacity additions through 2030.

[4] Future investment plan for wind energy in India

The ministry has so far spent around 53 per cent or Rs 2,788.44 crore of its total budget allocation for the current financial year. Recently, the minister for power and renewable energy R K Singh told parliament the govt has estimated an investment of about Rs 4 lakh crore over the course of next three years to meet the country's 175 gig watt (GW) renewable energy target by 2022.The minister added that most of the grids connected RE projects in the country are being implemented by private sector developers selected through transparent bidding process.

[5] Highlights of wind energy sector in India

5.1 Recent achievements

1) a complete of 101.83 billion units of power were generated within the country during the year 2017-18 from renewable energy.
2) The Government has declared the trajectory of bidding 60 GW capacity of solar energy and 20 GW capacity of wind energy by March 2020,leaving two years' time for execution of projects.
3) India made a pledge that by 2030, 40% of installed power generation capacity shall be supported clean sources, it had been determined that 175 GW of renewable energy capacity will be installed by 2022. This includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydro power.
4) MNRE has awarded three wind-solar hybrid projects of 1,440 MW capacity in Rajasthan and Tamil Nadu and issued a young to put in 160 MW capacity of wind-solar hybrid projects in Andhra Pradesh.

5.2 Necessity of wind energy policies

Economic stability of a rustic depends on its energy resources. If Indian economy maintains a rate of growth of 9% per annum then, in coming 20–25 years, the financial problems of India would be fully eliminated (Sholapurkar and Mahajan, 2015). Although research and development within the sector of renewable energy began in 1980's in India but thanks to lack of public awareness and limited technology, it couldn't gain popularity during that period (Chaudhary et al., 2015). As the Greenhouse Gas (GHG) emission was increasing exponentially and Indian Government's concern about climate change, energy scarcity and energy security made it possible to develop renewable energy policies in the country. After the wind resource assessments carried out in the late 20th century, several wind energy projects were demonstrated in many windy regions of the country. Thus, wind energy started to grow in India. This growth wasn't much remarkable because conventional resources were highly reliable and awareness about the global climate change was low among the folk . State governments were also least bothered about the wind energy promotion programmes. So, so as to market wind energy and spread awareness about the benefits of using wind generation for electricity generation, Central Government of India with the assistance of MNES (Ministry of Non-Conventional Energy Sources) formulated policies. These policies were launched with the aim of achieving better control and progress in wind energy development. To ensure proper participation of government , several state nodal agencies are opened in several states of the country and thus, policies differing from state to state on the basis of obtainable potential sites, resource assessment, grid connectivity etc. have been drafted by the respective agencies under the rules of MNRE.

5.3 Advantages of Wind Power:-

1) Wind power is cost-effective. Land-based utility-scale wind is one among the lowest-priced energy sources available today.

2) Wind energy mitigates the price uncertainty that fuel costs add to traditional sources of energy, Wind creates jobs.

3) The U.S. wind sector employed quite 100,000 workers in 2016, and turbine technician is one among the fastest-growing American jobs of the last decade . According to the Wind Vision Report, wind has the potential to support quite 600,000 jobs in manufacturing, installation, maintenance, and supporting services by 2050.

4) Wind enables U.S. industry growth and U.S. competitiveness. Wind has an annual economic impact of about $20 billion on the U.S. economy, The us features a vast domestic resources and a highly-skilled workforce, and may compete globally within the clean energy economy.

[6] Indian wind energy policies and programmes

The period from 1994 to 1996 is called the period of 'wind-rush' in Indian history, as Indian wind market saw an impressive growth because there was an increase in private investments. This became possible thanks to the fiscal incentives introduced by Central Government which provided zero-tax planning opportunities to the private investors. In 1995, 'Guidelines for Clearance of projects for the wind energy development' were formed by MNES and modification in the guidelines occurred in 1996 so that all the state level agencies were loaded with following additional charges including proper examination of the individual projects before approving them, notifying capacity additions in every six months, keeping a check on already installed and commissioned projects (Information and National Institute of Wind Energy, 2018). The growth in wind energy

sector slowed down after 1997, as the investors which seek Indian wind market as a tax saving investment went through a major shock as government proposed to impose a minimum alternate tax of 12.9% on them. Profit from marginal decrease was also reduced to 35% in 1997, which earlier was 43–46% (Rajsekhar et al., 1999).

6.1. Electricity Act (2003)

Indian Parliament enacted this act to integrate all the laws associated with electricity generation, transmission, distribution, sales and utility to market electricity. It comprised of National Electricity Policy and Plan, under which Central government had to timely publish and revise electricity and tariff policies with full participation and consultation of State government. A policy on stand-alone system in rural areas, was introduced under this act (Ministry of Law and Justice, 2003). Feed-in tariff for renewables in the country was also an initiative under this act. Renewable Purchase Obligation (RPO) was issued with the help of Electricity Act to obtain a minimum described share of total electricity generation from renewables. State Electricity Regulatory Commissions (SERCs) have essentially defined their RPO levels, having a range of 3–12% for the year 2016/17 (Jethani, 2017).

6.2. Integrated Energy policy (2006)

In 2006, Planning Commission of India formed energy policy which integrated all the sources of energy with the aim of achieving sustainable development. The emission problems from fossil fuels were highlighted and renewable energy promotion through strong policies was proposed. Some noteworthy steps were (Policy and Integrated Energy, 2006; Policy, Integrated Energy, 2005) -

- To build strong network of grid connected power through renewables, subsidies were provided that ensured maximum output (power generation and profit) from the proposed projects.
- Capital subsidies, which were non-productive investments, were proposed to be eradicated by the end of the 10th National plan.
- For promotion of wind power, a policy on utilising a private land for setting up wind farms was also recommended.
- Tradable Tax Rebate Certificates (TTRCs) and capital subsidy on stand-alone systems could be linked to earn benefits, as stand-alone systems in rural areas could not be benefitted by Feed-in tariff policy.
- Some institutional improvements were proposed such as giving individual status to Commission for Additional Sources of Energy (CASE) by de-linking it from MNES and conversion of IREDA to a National apex Institution for renewables which can help tackling financial issues in renewable energy sector in an efficient way.

6.3. Generation based incentive (GBI)

In December 2009, MNRE launched a scheme in which Generation based incentive @ Rs. 0.5 per unit wind electricity generation. The wind energy projects providing electricity to the grid for minimum 4 years and maximum 10 years with a capital of Rs. 1 Crore per MW were to take advantage of this scheme. This plan was supposed to continue till the end of the 11th National plan but it was discontinued in 2011 (Sholapurkar and Mahajan, 2015). But in September 2013, GBI was extended to the 12th five-year plan as well (Ministry of New and Renewable Energy, 2013). Accelerated depreciation at 80% (Jethani, 2016a) although wasn't eliminated, but it had been also provided along side GBI.

6.4. Renewable energy certificates (REC)

Renewable Energy Certification in India was introduced within the year 2010 by Central Electricity Regulatory Commission (CERC) under the Electricity Act, 2003. A new renewable market was formed in India through REC trading, and enhancement of investments in renewable energy also hiked. This also occurred due to increment in Forbearance and Floor prices of RECs (Sholapurkar and Mahajan, 2015; Energy Alternatives India, 2018). In the year 2012, a mean growth of 96% (each month) occurred within the distribution RECs to wind energy projects (Energy Alternatives India, 2018).

6.5. National Clean Energy Fund

In Finance budget 2010–11, considering the issues related with coal, a National Clean Energy Fund (NCEF) was proposed so as to finance and support a clean energy drive within the nation. A great initiative 'Green Energy corridor' is growing under the financing scheme of NCEF (Government of India, 2010-11). Green Energy Corridor project aims at improving the inter-state and intra-state electricity transmissions by connecting the power generated by wind energy. In eight windy states of the country a whopping amount of INR 10000 Crore has been sanctioned for improving transmission network. For transmission infrastructure strengthening projects Indian Government, through NCEF, is providing 40% of the entire cost related to the project as grant and a German bank is additionally helping by giving other 40% within the sort of soft loan (Jethani, 2017).

6.7. National wind-solar hybrid policy

This policy was drafted by MNRE in June 2016. It was found that wind and solar resources complement each other and thus, their hybridisation would be helpful in achieving better grid stability. Already established wind and solar farms had enough space for hybrid plants, so, a policy on hybrid plants was essential. The fiscal incentives which were provided for independent solar and wind projects were also available for hybrid projects (Jethani, 2018). The primary objective of the policy is to provide a framework for the development of grid connected hybrid projects. The aim of this policy is to develop 10 GW capacity of wind-solar hybrid projects by 2022. Two states (Gujarat and Andhra Pradesh) have also launched the hybrid policy. A hybrid system comprising of small wind turbines and aero generators or small wind turbine and solar panels financial aid of INR 1,00,000 per kW will be given to those planning to install small hybrid systems.

6.8. Wind bidding scheme

A scheme was sanctioned by MNRE in June 2016, according to which wind projects of 1 GW capacity connected with Central Transmission utility (CTU) were proposed to be set up by Gov. of India (Jethani, 2016a). The main highlights were –

➢ Digitalisation through e-bidding options.

➢ Transmission of wind generated electricity to least windy states.

➢Declaration of SECI (Solar Energy Corporation of India) as the nodal agency.

➢Helping the windy states in achieving their RPO targets from non-solar resources.

6.9. Policy for repowering of wind energy projects

This policy was introduced in 2016. The aim of the policy is to ensure the optimum usage of wind resources by providing better framework for repowering. An additional partial refund with an interest rate of 0.25% was decided to be provided by IREDA for repowering projects (Jethani, 2016b). State level nodal agencies played an important role in implementation of repowering projects.

6.10. Offshore wind energy development

National Offshore Wind Energy Policy was approved by MNRE in the year 2015. Under this initiative, resource assessment was carried out in coastal areas of Gujarat and Tamil Nadu. For promotion and development of offshore projects in Exclusive Economic Zones (EEZ), NIWE was declared as the Nodal Agency (Upadhyay, 2015). NIWE is also a knowledge partner with Fowind (Facilitating offshore wind in India), an initiative of Global Wind Energy Council (GWEC) for starting and boosting offshore wind energy in India. Resource assessment before implementing the projects was conducted in coastal areas of Tamil Nadu and Gujarat. A pre-feasibility test was conducted with considering the wind farm capacities of 150 MW and 504 MW for design in Tamil Nadu (FOWIND, 2015). Selection of zones included various technical factors comprising a foundation screening study, a wind farm electrical concept study, installation considerations (ports, vessels and logistics and installation methodologies) and operation and maintenance considerations. A Major finding of this study was southern and south-western coastal zone of Tamil Nadu has better resources for offshore wind development than Gujarat's coastal area. Despite this, India's first 1 GW offshore wind project has been proposed in Gujarat on 7th August 2018 (Ministry of New and Renewable Energy, 2018) which can be attributed to various reasons including enthusiastic policy implementation and participation of the state government.

6.11. State-wise wind energy tariff policy

State nodal agencies under the guidelines of MNRE have fixed tariff for purchase of wind power (National Institute of Wind Energy, 2018d).

[7] Challenges of Wind Power

a) Wind power must still compete with conventional generation sources on a cost basis. Depending on how energetic a wind site is, the wind farm might not be cost competitive. Even though the cost of wind power has decreased dramatically in the past 10 years, the technology requires a higher initial investment than fossil-fueled generators.

b) Good wind sites are often located in remote locations, far from cities where the electricity is needed. Transmission lines must be built to bring the electricity from the wind farm to the city. However, building just a few already-proposed transmission lines could significantly reduce the costs of expanding wind energy.

c) Wind resource development might not be the most profitable use of the land. Land suitable for wind-turbine installation must compete with alternative uses for the land, which might be more highly valued than electricity generation. Turbines might cause noise and aesthetic pollution.

d) Wind power plants have relatively little impact on the environment compared to conventional power plants; concern exists over the noise produced by the turbine blades and visual impacts to the landscape.

e) Turbine blades could damage local wildlife. Birds have been killed by flying into spinning turbine blades. Most of these problems have been resolved or greatly reduced through technological development or by properly sitting wind plants.

[8] Conclusion

Wind energy: a sustainable solution. It is evident that the use of wind energy as a permanent solution to the current global energy concerns could be sustainable. Even so, conditions to sustainability have been evaluated. As a result, even if the resource in its current state of technology is valuable enough to be able to support various developments in the business, achievements of vast technological opportunities could end up making the resource unlimited. At the monetary level, wind energy has proven to be not only environmentally but also socially profitable to financially reinforce wind industry while ceasing to cost competitive. Various governments are of the view that the wind industry is prepared to take up the opened business, with a green certificate market taking up all the favour. Nonetheless, in regards to a small market, there should be maintenance of a fixed price system. Socially, the actuality that the wind industry is participating to local development encourages for its sustainability. Additionally, its checked authentic influence on the native inhabitants could help in incapacitating the public unwillingness. Finally, it is important to push for further research concerning potential environmental research. It is, therefore, advisable to first reconsider results of studies and environmental impact evaluation when thinking of putting up a new wind farm or reconsidering an old one.

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