

ABSTRACT

With the growing energy demand, conventional energy has limited sources. Researcher tends towards renewable energy resources. Solar, wind and biogas etc are different available renewable energy sources (RES). Among which wind energy is one of the fastest developing technology. It seems to be growing in the coming years. It will be play a predominant role and will have a bright future. The advantage of wind energy being it is clean, non-polluting and can be added to the grid. The wind power is generally developed in geographically suitable area. It is eco-friendly, clean energy sources and acts as a complementary energy sources. This paper provides a detailed description of India's wind energy industry and discusses several developments which accelerated its growth. The paper presents current status, major achievements and future of wind energy in India.

Keywords: Renewable energy, Wind energy Wind energy development, Wind energy potential, energy scenario

I. INTRODUCTION

Energy security is most important now a days. With the growing demand of energy, conventional energy resources like fossil fuels, coal, oil etc are limited sources. we are moving toward non-conventional sources like wind, solar, biogas, tide etc. Renewable energy is energy generated from renewable natural resources. The following major advantages: they are sustainable, never going to run out and non-polluting. Among all these sources, wind and solar energy sources have received the considerable attention and are widely used [3].

Since half a century, the generated power from wind energy is increased by 50%. With the growing energy demand renewable energy play a vital role in field of research. Wind energy is more suitable in remote place and it reduces the cost of transmission line. According to demand of electricity many wind turbines have been implemented.

Wind energy is one of the most suitable RES and it is inexhaustible source of energy. It is pollution free, and operational costs are nearly zero once a turbine is erected. Mass production and technology advances are making turbines cheaper, and many governments offer tax incentives to spur wind-energy development. In India 1980, the generation of electricity from wind has been started. From the last five years, wind energy becomes World's most power generated RES. In 2014, India generated 22,465 MW power from and as on 31 March 2015, wind capacity was 23,444 MW.

II. WIND ENERGY MECHANISM

1) Conversion of energy: A improve version of wind turbine is used in wind mill. The wind angles, wind blades are made to spin when the wind blows and then kinetic energy of wind is converted into mechanical energy. The strength and direction of wind are determined by the sensors on the turbine.

2) Conversion of mechanical energy to electrical energy: The rotor and generator are connected together with the help of shaft and gear box. Hence the generator rotates. The mechanical energy is converted into electrical energy in the electromagnetic field.

3) Conversion of electrical energy to high voltage:

Cables are used to transmit electrical energy into substation. A high voltage is obtained to combine the electrical energy generated by all the turbine.

4) Conversion of high voltage to usable level: Power lines are used by National Grid to transmit high voltage efficiently. The power is step-down from transmission level to voltage to distribution level voltage at substation. The power is then transmitted from substation to distribution wiring. At service location, power is again step-down to required voltage.



Fig- Wind energy power flow diagram

Mathematical modeling of wind energy system

Wind energy converts kinetic energy into electricity, change in power and change in efficiency can be seen at a different wind speed from the given equation. In the wind, turbine converts kinetic energy of water into mechanical energy and then generator converts this mechanical energy into electrical energy. Modeling the rotor using , turbine blade element theory has a number of limitations: an array of wind speed signals must be applied, detailed information about the rotor geometry should be available and computation becomes complicated and lengthy.

A wind turbine is modeled by studying its electrical behavior.

The kinetic energy of air and motion is called as Wind. Total wind energy flowing through an imaginary surface with area A during the time t is:

$$E = \frac{1}{2}mv^2 = \frac{1}{2}(Avt\rho)v^2 = \frac{1}{2}A\rho v^3,$$

where

$\rho = \text{density of air}$

$v = \text{wind speed}$

Avt is the volume of air passing through A (which is considered perpendicular to the direction of the wind); $Avt\rho$ is therefore the mass m passing through "A". Note that $\frac{1}{2}\rho v^2$ is the kinetic energy of the moving air per unit volume.

Power is energy per unit time, so the wind power incident on A (e.g. equal to the rotor area of a wind turbine) is:

$$P = \frac{E}{t} = \frac{1}{2}A\rho v^3$$

Wind power in an open air stream is thus proportional to the third power of the wind speed; the available power increases eightfold when the wind speed doubles. Wind turbines for grid electric power therefore need to be especially efficient at greater wind speeds.

III. TYPES OF WIND TURBINES

According to the rotation of rotor axis, wind turbine is two types: one is horizontal axis wind turbine (HAWT) and another is vertical axis wind turbine (VAWT). Power in a wind is directly proportional to the cube of wind speed: if the wind speed is doubled, there is eight times the available power.

Wind turbine has many applications as:

- Irrigation – for house and vegetable grades
- Stock water – sheep, cattle, horses
- Domestic applications – household water for drinking, sanitation, and washing
- Dewatering wet lands
- Filling dams, reservoirs, fish ponds, lakes
- Waste water removal
- Remote locations
- Sewage
- Water for small industry

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Selection of wind turbines is depends on the many factors like: location, water requirement, transportation, transmission and distribution level, source of water , wind condition, space, area, governing and pumping head. The overall condition depends upon the wind turbine and generator, both should be worked easily (about 10 km/h). This will also depend on the total pumping system.

In a rural areas, wind turbines are very useful for fulfill the demand and pumping the water for domestic supplies.

It can be an economical alternative where:

- The user requires environmentally clean power
- There is no other viable power source
- Unattended pumping is required for long periods
- Wind conditions are reliable

The principal advantages of using a wind turbine are outlined below:

- no energy costs
- suits isolated locations
- low maintenance
- run unattended for long periods

Some of their disadvantages are:

- requires auxiliary storage
- intermittent pumping in very light winds
- high capital costs

IV. STATUS OF WIND ENERGY

In last two decades, wind turbine is concerned in India when the demand of energy is increased and it can not be fulfill only by the conventional resources. Wind turbine is concerned in India during 1983-1984. Production of energy from wind was commercialization. The main purpose of this project is to aware the people about the development and production of energy form wind.

In this program various modification has been done like incentives, policies and schemes for wind energy from the side of ministry of Non Renewable (MNRE). At that time as compared to other country like USA or Denmark, India was relatively beginner. In 2011, at the fifth rank in the world, India generated largest capacity of energy through wind power. The worldwide installed capacity of wind power reached US (65,879 MW), China (114,763 MW), 370 GW by the end of 2014 and Germany (40,468 MW) are ahead of India in forth position in 2015 [5].

On 30 June 2013, the total installed power generated from wind power was 19,565 MW and now India is just behind Spain, China, USA and Germany. In past decades, Suzlon, an Indian-owned company, captured 8% of energy from wind power and shared it globally in 2006. In the present time, 45% market shared by, Suzlon which is currently the leading manufacturer of wind turbines Suzlon's success has made India the developing country leader in advanced wind turbine technology [5].

In last five years, demand of electricity is continuously increasing in India, despite a slowing global economy. In India 50% population has not connected with electricity due to cause of electricity shortage and they are unable to access modern energy system. The demand of energy is increasing continuously day by day from 2005. As per research, the total energy generated by wind is 350-360GW by 2022 according to our requirement. In 31st march, 2012 total generated energy fed to state electricity grid is 120 billion. According to plan 10th (2002-2007) and plan 11th (2007-2012) , we have achieved the target and often generated the exceeded power from wind. In the plan 10th the target was generated the power from wind is 1500 MW and whereas the total installation was 5,484 MW Similarly according to 11th Plan target was generated power from wind was 9,000 MW and the actual installations were much higher at 10,260 MW. With the growing demand wind energy developed 4-5% power to the country at present. In India total installed capacity of generated power from wind was 17,352 MW till March 31, which is 8.7% of total installed capacity.

V. ENERGY SCENARIO IN INDIA

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Demand side management energy conservation and some renewable energy technologies including, solar, hydro, biomass and wind are being promoted by Ministry of Natural Energy Sources(MNES) and Ministry of Power(MPO).MNES has been promoting various sources of renewable energy since 1990 [7]. The electricity sector in India had an e 2012, the world fifth largest. Thermal power plants constitute 61% of the installed capacity, hydroelectric about 15% and rest being a combination of wind, small hydro, biomass, waste-to-electricity, nuclear and etc. India generated 855BU (85500MU i.e. 855 TW) electricity during 2011-2015 fiscal. The wind mills and wind tuebines are used to harness electrical energy from the wind. The first wind form in India was set up in Ratnagiri, Okha, and Tuticorin. In the year 1996, with 55kw Vestas wind turbines. It is one of the most processing technology in the future. Recently these has been a step increase In the amount of energy produced by wind through wind, 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.

Wind power by state[4]

State	Total Capacity (MW)
Karnataka	3,082.45
Rajasthan	4,123.35
Kerala	43.50
Maharashtra	4,664.08
Tamil Nadu	7,684.31
Madhya Pradesh	1,866.35
Telangana	98.70
Gujarat	4,227.31
Others	4.30
Total	28,082.95

VI. DEVELOPMENT OF WIND ENERGY IN INDIA

As the increasing time the growth of wind energy increases constantly. According to the country's Cumulative Annual Growth Rate (CAGR), power generated by wind energy is 2.4% since 2002 at the same periods, this growth is same as globally . in the above table, it shows the installation of wind energy in different state according to their requirements. Among all the state , Tamil Nadu has always Tamil Nadu has always been as a head of all states. The total installed capacity from wind is 7276 MW , which is 34% of India's total generated power by wind. At the second number, Maharashtra is closely following Tamil Nadu with 4,098 MW of installed wind energy. Gujarat, Rajasthan and Karnataka as well handsomely contributed in increasing the share of wind energy in India. The generation of power from wind is more than 2000MW in all these states. According to the states, installation have been built all across the nation, from the hilly country to the plains and from the coastal region to sandy deserts . Hence, Indian government envisages, wind energy will greatly aid in attaining its mission of increasing share of renewable energy in total energy. wind energy has contributed more than 19,500 MW in the total installation since 2002. This is the reason, now government has increased target of annual capacity addition to 2500 MW.

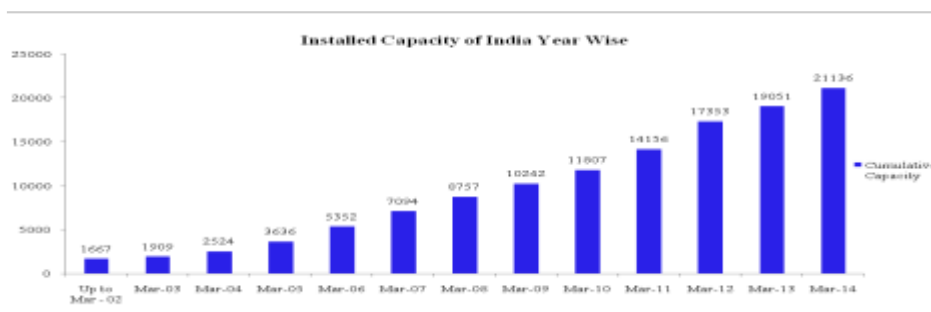


Figure: 2 Installed capacity of India year wise

VII. WIND ENERGY POLICY IN INDIA



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According to MNRE, as the demand of electricity is increasing day by day, wind energy is a friendly approach to adopt and investment in this sector. Wind energy is an alternative approach of conventional energy resources, but government does not invest directly into a wind energy project, but invest in R&D by putting up small demonstration projects at remote locations. These demonstration had put first projects in Tamil Nadu, then Gujarat and onwards Madhya Pradesh and Karnataka by the government with the help of Danish International Development Agency (DANIDA). Indian government has spent \$44.79 million, during 11th five year plan (2007-2012) on R&D in wind energy.

Considering high initial cost, government has decided to offer to individual investors for investing money in wind energy. Basket of incentives for this industry includes income tax holiday, accelerated depreciation, concessional excise and custom duty, provision of borrowing at low interest rates, etc. State governments also help investors by signing power purchase agreement for 20 years, allowing sale of energy to third parties and captive use of energy. Some state governments also provide subsidy for the initial investment in wind energy and sale tax benefits. The state governments of Tamil Nadu, Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Rajasthan, Haryana and West Bengal provide feed in tariff for purchasing wind energy. Feed in Tariff provides the minimum price at which wind energy based power must be sold to electricity distribution companies. This tariff is higher in comparison to the other conventional energy sources. Table 1 provides a brief overview of wind energy policies of various states.

VIII. CONCLUSION

In the traditional years, conventional energy was mostly used, but the increasing demand of electricity, it is difficult to fulfill by conventional resources. So researcher move toward the renewable energy resources to fulfill the demand of energy and also makes the environment healthy. The use of conventional energy resources increases the environmental pollution like noise pollution, skin problem, environment pollution. To overcome all these, renewable energy is used now-a-days. It is pollution free, inexhaustible, environmental friendly, free sources of energy etc. it is a green source of energy also known as "green electricity": renewable energy sources reduces the green house gasses. That is way we use the wind energy to pump water in a location that is remote from electricity grid and that is unattended for long periods.

This paper has made modest attempt to discuss the journey of wind energy in India since 1985 till date and highlighted the contribution of central government and various state governments in the development of this industry.

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