Design And Development Of Small Wind Energy Systems Is A Soft Path For Power Generation And Environment Conservation For Off Grid Applications In India.

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ABSTRACT : **This paper describes the design a new evolving electrical power generation system with small wind turbine. Which offer solutions to meet local energy requirements of a specific location. Energy conservation decreases energy requirements, promotes energy efficiency and facilitates development of renewable. Wind energy dominates as an immediate viable cost effective option which promotes energy conservation and avoids equivalent utilization of fossil fuels and avoids million ton of green house gas emission causing ozone depletion and other environmental impacts like global warming. This paper gives an over view about the current status and a possible development for small wind turbines for off – grid applications in India.**

KEY WORDS: wind energy, wind power generation system, wind sensor, Energy resources, and wind energy conversion system.

I.   INTRODUCTION

The concept of wind energy dates back to nearly 7000 years ago [1]. Wind power technology dates back many centuries. The wind power data back beyond the time of the ancient Egypt ions [2]. Hero of Alexandria used a simple wind mill to power an organ whilst the Babylonian emperor, Hammurabi, used windmills for an ambitious irrigation projects early as the 17th century BC. The first wind powered electricity was produced by a Machine built by Charles F. Bob in Cleveland Ohio in the year 1888 [2]. Electricity can be generated in many ways. In each case a fuel is used to turn a turbine, which drives a generator. The turbines are designed to wind generated electricity: the wind is the fuel which drives the turbine, which generates electricity. It is free and clean. Wind power is one of the most mature Renewable energy technologies with over 74000 MW installed globally [3]. Wind drives turbine which generates power for energy use [3]. Electricity cannot be seen felt, tasted, smelled, heard or safely touched. In the late 1800 Dane developed the first wind turbines to produce commercial electricity [4].The green energy also called the regeneration energy.

Energy is the basic building block for socio-economic development of any country. Energy is one of the most important building blocks in human development, and, as such, acts as a key factor in determining the economic development of all countries. India has been a pioneer in the commercial use of wind energy in Asia since the 1990s. In the year 2013 India had the 5th largest installed wind capacity globally, during present year, India added installed capacity of 17644 MW as on June 2012 [5] [9]. It is a 14% annual growth rate and contributed 3.5% to the global wind market. India's total estimated potential is 48,561 MW [6] with Karnataka, Gujarat, and Andhra Pradesh as the leading states [7].The Indian energy sector has witnessed a rapid growth, areas liked the resource exploration and exploitation, capacity additions, and energy sector reforms have been revolutionized [8].
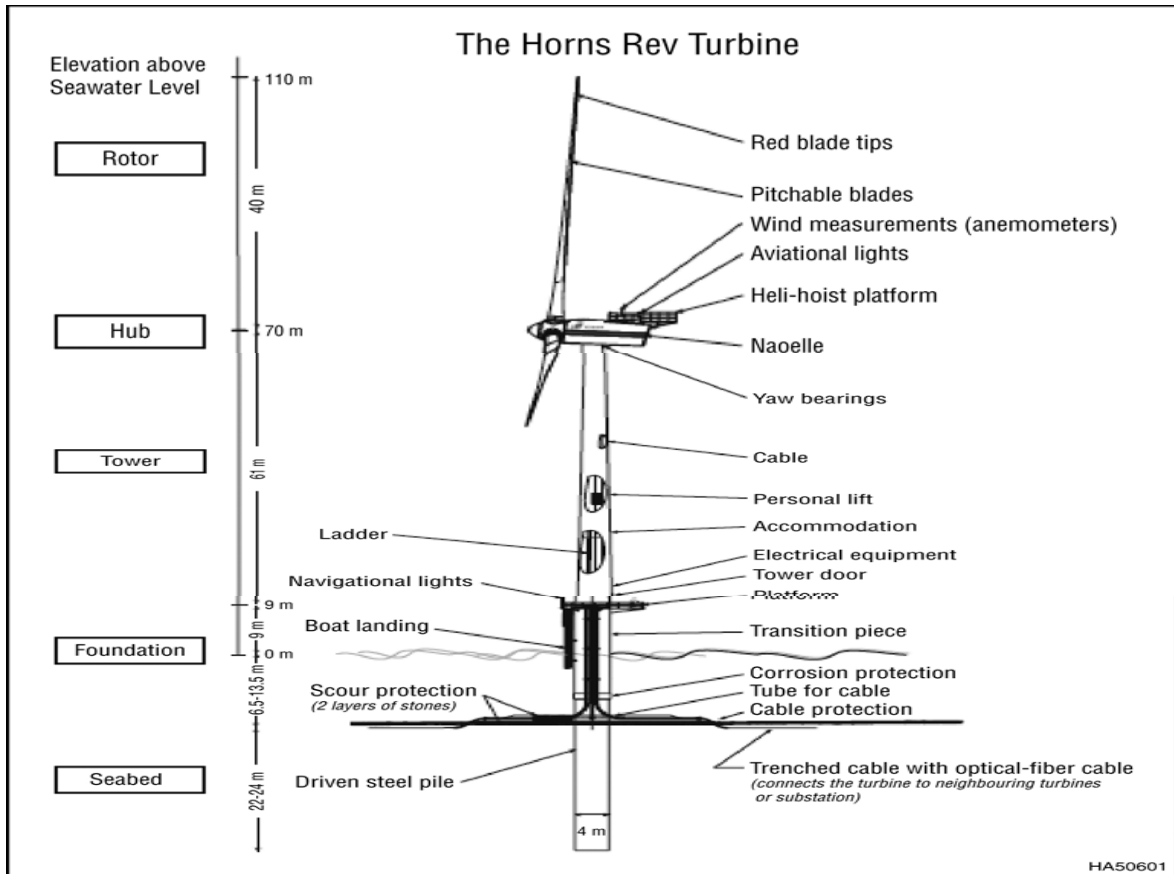
Fig1: schematic of typical wind turbine [14] (Primary components & Dimensions Of one of the 2-MW turbine). Source: Man well teals, 2001)
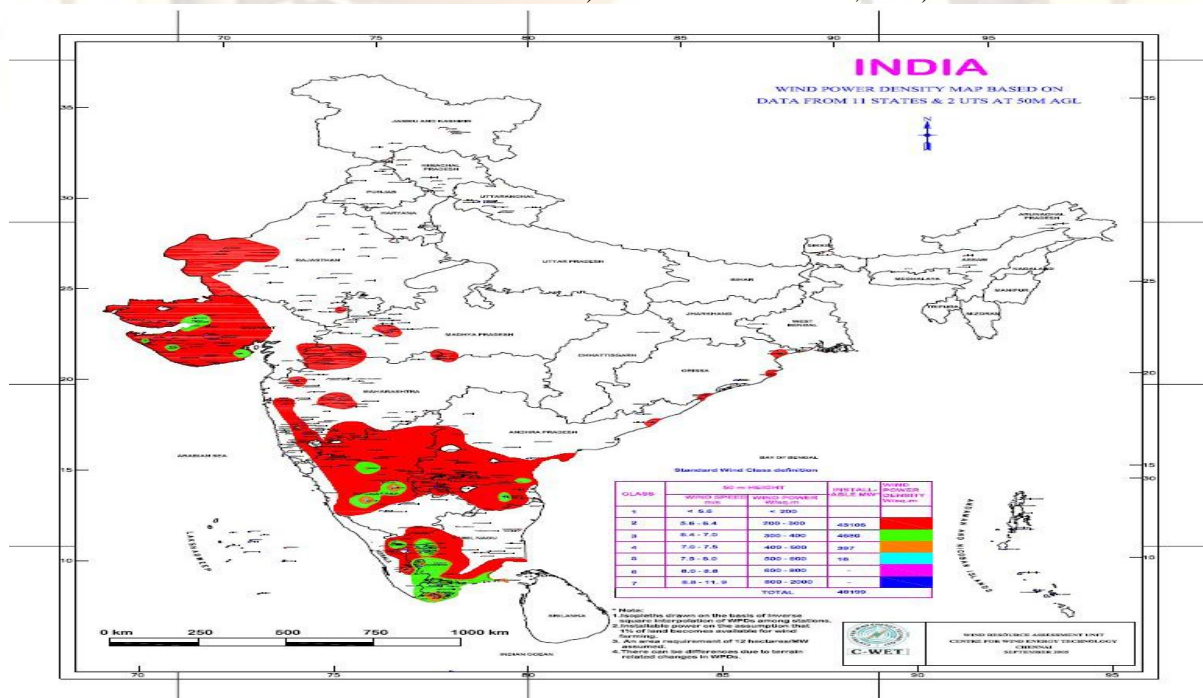

Fig2: wind power potential in India [12] (Source: C-WET), Government of India

India can become a potential world leader in the development and deployment of Renewable energy technologies and play a significant role in combating global climate change. The main policy incentives include a feed in tariff 80%. Accelerated depreciation, exemptions from excise duties, and tax exemptions for infrastructure related projects. In India wind energy has decreased by $12-18\%$. This sub sector grown an average 30% per annum, and wind mounting and mapping stations installed in 25 states and also in union territories. The maximum global wind resource is approximately 1.22×10^{15} KWh/yr. India estimates wind energy generation Capacity Quadruple to 89 GW by 2020 [15].

II.   Wind power generation system

Wind energy conversion system (WECS) converts the kinetic energy K.E of a renewable resource-wind- to mechanical energy ME. This energy can be used as electric power EE. The wind speed of 8 to 14 miles per hour (mph) at working site, wind speeds of above 4-5 m/s which makes small scale wind powered electricity generation an attractive option. The power in the wind is proportional to the area of wind mill being swept by the wind, the cube of the wind speed and the air density - which varies with altitude.

The power in the wind is calculated with [22]

$$Power = \frac{Density\ of\ air \times swept\ Area\ velocity\ cubes}{2}$$

$$P = \frac{1}{2} \rho\ A\ V^3 \qquad (1)$$

Where

P is power in watts (W).
A is swept rotor area in square miles (m^2).
V is wind speed in meters per second (m/s).
ρ is the air density in kilogram per cubic meter (Kg/m^3).

The fact that the power is proportional to the cube of the wind speed is very significant. The actual power depends on several factors such as the type of machine rotor, the sophistication of blade design friction losses etc. The wind mill can only possibly extract a mass of 59.3% of the power from the wind (this is known as the 'Batz limit'). The modified formula for 'power in the wind 'and the power which is produced by the wind machine can be given by [22].

$$P_M = \frac{1}{2} C_P\ \rho\ A\ V^2 \qquad (2)$$

Where

$P_{M\ is}$ power (in watts) available from the machine.

C_P is the coefficient of performance of the wind machine.
The output can be obtained from a wind machine [22].

$$P_A = 0.2\ A\ V^3 \qquad (3)$$

Where

P_A is the average power output in watts over the year.
V is the mean annual wind speed in m/s.
The gross annual CO_2 emissions reduced by a wind power project GCE wind can be estimated as [22].

$$GCE_{wind} = (8760\ PLF_{wind}\ P_{wind})\ CEF_e\ ) \qquad (4)$$

Where

P_{wind} (in fraction) − plant load factor of the wind power project.
CEF_e −   The emission factor of electricity.
8760   −   Annual amount of electricity saved by the wind power project.
Levelised cost of Electricity generation LCOE, the formula used for calculates the LOCE of renewable energy Technologies is [10].

$$LCOE\ =\ \sum_t^n = 1\ \ \frac{It + Mt + Ft}{\sum_t^n = 1 \quad Et\ /\ (1+r)2} \qquad (5)$$

Where

LCOE = the average life time levelised cost of electricity generation;
I_t =   Investment expenditures in the year t;
M_t =   operations and maintaince expenditures in the year t;
F_t = Fuel expenditures in the year t;
E_T = electricity generation in the year t;
r = discount rate and
n = Economic life of the system
Wind power technologies can be evaluated for modeling (or) policy development.

III.   Energy resources

Energy resources are classified in to two groups: primary non renewable and secondary-renewable resources, with respect to change in Quantitative [21].

A. **UN renewable energy resources:** Un renewable energy resources are the ones that decay partially or vanish with the time or needs decades for reuse, such as oil, coal and coal derivatives, natural gas wood and radioactive atoms (uranium).

B. **Renewable energy resources:** Renewable energy resources are the ones that are persistently, available and renewing itself with the time, industrialization and increasing world population has remarked the use of

renewable energy resources wind power, solar power, bio mass, tide, wave power, geothermal power is known ones.
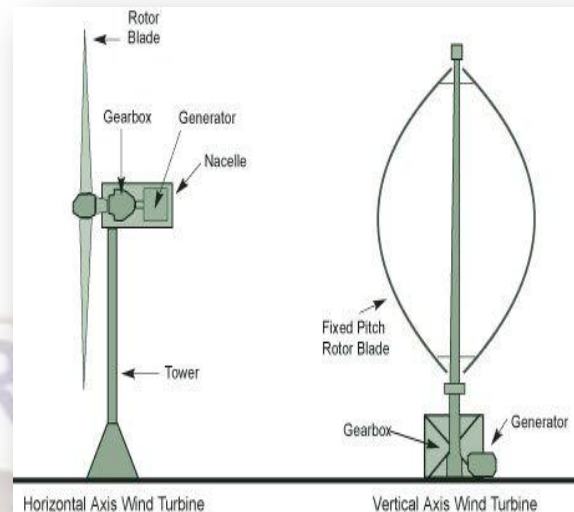
C.Wind power: The wind energy is a renewable source of energy .The energy available in the wind depends on the density and air velocity. Wind turbines are used to convert the wind power into electric power. Electric generator inside the turbine converts the mechanical power into electric power. Small wind turbine systems are available ranging from 50 W to 100 W. Any wind turbine having less than 30KW rated capacity can be termed as a small wind turbine Small wind turbines of different ratings from 50W, 400W, 1KW, 3KW, 5KW, 10KW up to 30KW are available in the global market [17].

Table1: The classification system for small wind turbine [22]

(Source: spear, 1994 and Gipe`, 1999)

Wind energy conversion system WECS convert the KE of a renewable resource – wind to mechanical energy. This can be uses as electrical power .We will need an average monthly wind speed 8 to 14 miles per hour (mph) at our site. An Anemometer is used to measure wind speed.

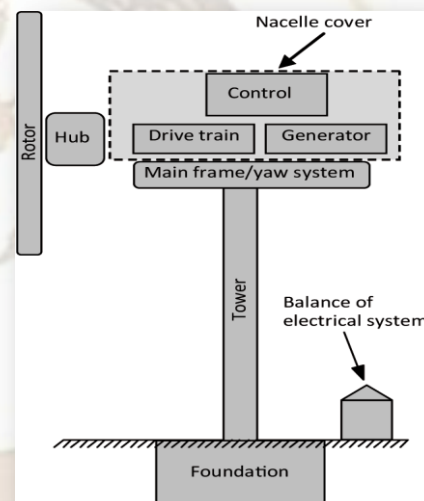| Scale	Rotor diameter	Power rating
Micro	Less than3m	50W to 2KW
Small	3m to 12m	2KW to 40KW
Medium	12m to45m	40KW 99KW
Large	66m and large	More than 1.0MW

Fig3: schematic of the horizontal and vertical axis wind turbine [11]   Fig4: schematic of typical wind turbine [13]

(Source: www.centreforenergy)
(Source: Man well et al, 2001

AC To DC: The electricity generated by a wind turbine Converted to alternating current AC and used without storage. Stored in batteries and later used as direct current DC or Alternating current [18].

D.Types of small wind turbines: Horizontal and Vertical axis wind turbines (HAVT & VAWT) came in variety of sizes and they are located on shore or off shore applications. The power generation of wind determined by the capacity of the turbine in kw or Mw, the wind speed, height and diameter of the rotor, 3 or 5 blade modern wind turbine rotating with horizontal axes, The turbine classification including, rotor, placement up wind or down wind, no of blades Output regulation system for the generators & gear box design, hub connection to the rotor. Small wind

turbines is defined as a turbine capacity of 100kw or less generally have higher capital cost and achieve lower capacity factor. It will be used for off- grid Electrification. It shares 14% global wind power market. It meet the electrical needs of homes, forms ,refuges, small communities, and wind energy play an important role in rural electrification science 1970's, trying to improve operating reliability and reduce noise concerns to acceptable level. Advanced airfoils, upper – magnet, generators smart power electronics, tall towers, low –noise factures will help improve performance and electricity generation from small wind turbines. UK & CANADA are the largest market for small wind. At the end of 2012 small wind turbines reached 540Mw from 656000 turbines [16] throughout the world.

IV.   WIND ENERGY SYSTEM DESIGN:

Converting energy in wind into a socially use full electrical or mechanical involves many processes.1st step the extraction of energy is converting the KE of wind to ME in a rotor via an aerodynamic lift. Rotor has 5 blades, are constructed primarily of composite material and its have horizontal axis rotation is also possible, rotor is provided by a yaw system. The gear box provides an increase in speed such that the speed of the gear box output is matched to the speed requirements of the generator. In step 2 the conversion of ME to EE, The shafts, gear box generated and associated equipment are contained a nacelle which located on top of a tower.

Electricity is carried down the tower with a drop cube. The electrical output of most turbines now days are directed into congenital electrical networks. In most sites considered for Wind energy development the average wind power density is in the range of 200-800 W/m^2 [19]. Speed measurements are typically averaged over ten minute intervals for use in performance and economic assessments. The average power from wind turbines is typically between 20% and 40% of this ratio maximum.
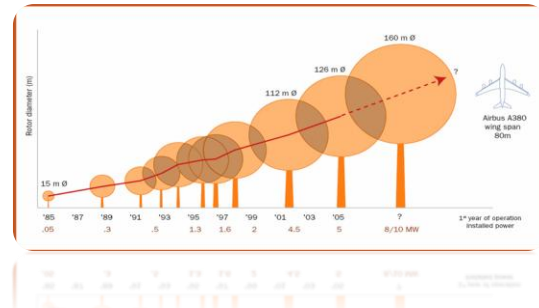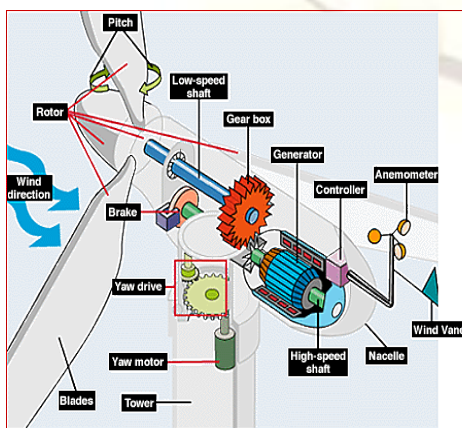

Fig 5: inside the wind turbine

Fig6: The future of up scaling of modern
(Source: India wind turbine manufacturers association)   electricity producing wind turbines. [10]

It is estimated that approximately 2% of the sunlight that falls on the earth is converted to wind energy. Wind energy is derived fundamentally from solar energy via a thermodynamic process. Sun light warms the ground causing air above it to raise the ensuring pressure differential caused air form elsewhere to move in resulting in air motion (Wind). Air motion is also affected by the earths' rotation. The total energy impinging an at the outer atmosphere, assuming a solar constant of 1, 367W/m2, is 1.53×10^{18} kWh/ per year. The Solar energy to wind has been estimated to occur at an efficiency 2% approximately 35% of this is in the lower boundary; layer where out could potentially be extracted by wind turbines. According to this estimate the Max global wind resource is approximately 1.22×10^{15} Kwh/yr.The onshore technical potential of wind is about 1.0×10^{14} Kwh/yr, and of shore wind energy resource at water, depletes up to 50 m is another 3.7×10^{13}KWh/hr. The global consumption of electricity at the present time is about 1.6×10^{13} Kwh/yr [20]. Modern turbines have evolved primarily from 'Danish concept'.

Main market Development in 2013

The Indian market is emerging as one of the major manufacture hubs for wind turbines in Asia; Nearly 17 manufacturers have annual production capacity of 7,500 MW. According to the wise, and the annual wind turbine manufacturing capacity in India is likely to exceed 17000 MW by 2013.

Policy support for wind power in India

In India still the 2003 Electricity Act is following, the Annual growth rate is 29.5% in the wind energy sector. The key financial incentives for wind power development, the possibility to claim up to 80% of the project cost. Within the first year of operation and the income tax holiday on all earnings generate from the project. In 2009 MNRE approved Generation based incentive GBI scheme for wind power projects, the incentive tariff of RS /- 0.50/Kwh

given to eligible projects for a max period of 10 years. It is valid for wind forms installed before 31st March 2012.

Benefits of wind energy: Wind energy is highly practical in places where the wind speed is 10mph. wind energy is used in large scale wind farms to provide electricity to rural areas and other far reaching locations [17].

- Wind energy is economically competitive.
- Unlike most other electricity generation sources, wind turbine do not consume water
- Wind energy is inexhaustible and infinitely renewable.
- Wind energy has many environmental benefits. Wind energy is clean energy that produce no emissions, which means it does not contribute to acid rain and now , global climate change, smog regional haze , mercury contamination , water withdrawal, and particulate-related health effects.
- Wind energy's "fuel" is free; it reduces the risk associated with volatile fossil fuel prices.

V. Small wind energy system development:

The Model 50.5 solid state wind sensor is used in this system sensor has high quality performance. This gives a bit output to a micro controller that could be controlled through A PRAPAN make power controller with Auto modes, no moving parts, digital and Analog out puts Tim proven design, sensor emulation. The battery bank has a nominal voltage of 120v.It is formed by 12 elements of 12v connected in series. Practically it is observed that 5 blade propeller about 35min diameter, in a 60km/hr wind pressure with a rotation wind speed of 47rpm produced a maximum power 12 MW.

Fig: 7 Actual wind turbine
Fig: 8 Battery systems.

Fig: 9 battery storage unit & controller.

VI.   Conclusion:

This wind energy power generation system will be highly effective in rural areas and other far reaching locations. India's rural areas and in reducing consumption of fossil fuels which is essential for future energy security of the country. It outlines the policies that have been followed to foster the growth of this sector and also indicates the targets and the future pathway. So there is a great need of wind energy source in India power sector remove GHG emission for the environment protection. In terms of wind energy security, environmental protection and economic efficiency for effective promotion of wind energy. Increased recognition of the contribution wind energy makes to rural development, lower health costs, energy independence, and climate change mitigation is shifting wind energy from the fringe to the mainstream of sustainable development. Therefore, it is the most reliable wind power or electricity resources with the least expenditure in the globe.

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