HYBRID POWER GENERATION WITH MINI WIND MILL AND SOLAR PANEL "A FUTURE ENERGY SOLUTION FOR DOMESTIC POWER REQUIREMENT"

Brijesh M. Garala
Head of Department,
Department of Mechanical Engineering
Om Engineering College
Junagadh, Gujarat, India
bmgarala@omeducation.edu.in , bmgarala21@gmail.com
+91 90 99 44 79 75

ABSTRACT

Energy is the primary and most universal measure of all kinds of work by human beings and nature. Everything what happens in the world is the expression of flow of energy in one of its forms. Energy is an important input in all sectors of any country's economy. The standard of living of a given country can be directly related to per capita energy consumption. Energy crises are due to the two reasons; firstly the population of world has increased rapidly and secondly the standard of living of human beings has increased. To fulfill the increasing demand of energy, conventional energy source is not sufficient. That's why now a days it is more important to fulfill the energy demand with the help of non conventional energy sources. In this paper an attempt is made to study the design and development parameters for mini wind mill used in domestic applications like generate small capacity power for buildings, households, commercials, small industry etc. effectively.

INTRODUCTION

Current scenario for energy generation with the help of not conventional energy source is the prime important concept in the world. This energy is generated by so many ways like solar energy, wind energy, bio gas, geothermal energy, tidal energy etc. Solar and wind are the prime resources of available energy. Solar energy is not available throughout day while wind energy is available. As the velocity of wind in terms of kinetic energy is converted into the rotation of rotor in terms of mechanical energy and this mechanical energy in terms of rotation of shaft rotates electrical generator which produce power in terms of electrical energy. Finally kinetic energy is converted into electrical energy by some means of loss of energy. Basically wind turbines are classified into two categories like horizontal axis machine and vertical axis machine. With the help of horizontal axis machine power generation is more like in terms of MW which is widely used in wind farm. These types of aero machines (wind turbines) are larger in size and hard to install and maintain with very high cost. While vertical axis machines are smaller in size and quite low in cost as well as small in size. The major limitation for vertical axis machine is less power generation in terms of KW.

BASIC SOURCE OF ENERGY

Basic energy sources are divided in to two categories like conventional energy source and non conventional energy source. As all we know energy produced by the conventional energy source is not sufficient for the requirement of power demand. To satisfy the energy requirements prime important objective is to develop some renewable energy source.

Basic source of non conventional energy is solar energy. As we know that non conventional energy sources like wind energy, geothermal energy, tide energy, wave energy, biomass energy etc are one or another form of the solar energy. For biogas, geothermal, tide, wave etc energies have no resources available each and every place. Solar energy is available everywhere but major limitation of solar energy is availability of energy is only 12 hrs per day.

As wind energy is easily available source of energy throughout day and year, there are better opportunities available to do some research work in the direction of wind turbines especially vertical axis machines for

domestic application which can fulfill the small household requirements. If we can develop hybrid system work based on wind energy and solar energy it would be more beneficial and economical for small power generation.

REQUIREMENTS OF ENERGY GENERATION THROUGH WIND ENERGY SOURCE

1. Installed generation capacity in India: 157,229 MW (Feb 2010)
2. Renewable energy contributes: 15,789 MW (as of Jan 31 2010)
3. Additional capacity over next 10 years: 92,000 MW
4. Power demand growth rate: 8% annually
5. Current per capita electrical energy consumption: 500W
6. Targeted per capita consumption: 1,000W (by 2010)
7. Renewable energy potential capacity: 90,000 MW
8. Potential Wind Power generation capacity: 48,561 MW
9. Installed wind power generation capacity: 10,464 MW
10. Capacity addition: 15,000 MW (Eleventh Plan, 2007~2012)
11. Wind power: 10,500 MW (70%)
12. Small hydro: 1,400 MW (9.3%)
13. Wind will continue to be the main new source until 2030
14. By current standards, urbanization alone will need 215GW of additional power generation capacity by 2025
15. By 2025, India will add 215 million heads to its urban population
16. By 2025, India will add 89 million urban households
17. Cities with 1 million+ population will grow from 42 (in 2008) to 68 (in 2030)
18. By 2030, India will need to build 700 ~ 900 square miles of residential and commercial space
19. The Government of India is targeting to increase per capita generation capacity from 500W to 1,000W (by 2010)
20. Assuming 1kW of Wind Power per household of 5 persons Each from renewable resources 43,000MW of additional Wind Power will be needed for urban India by 2025 (assuming 1kW of Wind Power per household) much of this can be delivered using small wind turbines

Power generation with the help of wind energy is one of the interesting R&D criteria. Basically wind turbines are divided in to two basic types like

1 Horizontal axis machine
2 Vertical axis machines

As we know that horizontal axis machines are larger in size and generate electric power more than 500 KW per machine. Installation cost of such machines is quite high as well as initial cost of such machine is also very high. As we know space utilization for the installment of such horizontal axis machine is very large and it need proper open space for working. Such kind of machines are typically installed where large open space available like sea sour or any small mountain where there is no obstacle in wind and proper constant wind velocity is available.

Regarding the vertical axis machine size of machine is comparatively small and it produces 0.2 KW to 10 KW power. Height of machine will be very and starts from 4 ft depend upon the installation capacity. Initial cost of machine and installation cost is also comparatively low. Installation is very easy and can be installed on buildings or gardens or any space. Most advantageous things of such machine is the working at very low wind velocity 1.3 m/sec.

DESIGN CONSIDERATION

Various types of vertical axis machines are designed based on drag forces to turn rotors of different shapes. These include plates, cups or turbines blades as a drag device, as well as the Savonius--- S shaped cross section rotors which actually provide some lift force, but are still predominantly drag devices. Such devices have relatively high starting torques compared to lift devices because of their higher solidity, but have relatively low tip to wind speed and lower power outputs per given rotor size, weight and cost.

In vertical axis machine drag on a cup is greater when its concave side faces the wind which caused the device to rotate. Life also plays a small part: the cup crossing the wind experience a small lift because their convex surface deflect the wind and causes a pressure reduction. The main virtue of the cup is that in tends to rotate within a narrow range of TSRS under all conditions, so its rotational speed is closely proportional to wind speed.

DESIGN PREREQUISITE

While designing such vertical axis machine we must consider certain parameters like

1 Requirement of energy
2 Data of wind velocity
3 Installation capacity
4 Location of installation
5 Energy storage system
6 Installation structure

1 REQUIREMENT OF ENERGY

As we know vertical axis machine has capacity of low power generation, we must design such machine for low power requirements like, household requirements, small scale industrial requirements, small scale commercial requirements etc.
Such kind of small power generation machines can be installed in more numbers to fulfill large number of commercial requirements or industrial requirements.

2 DATA OF WIND VELOCITY

Such vertical axis machine should be design according to availability of wind velocity data like how much maximum and minimum wind velocity available, how much change occurs during month and day, what is the intensity of wind velocity etc.

3 INSTALLATION CAPACITY

According to the energy requirement it should be conformed that installation capacity of such machine is possible or not. If the machine is installed upon terrace of building then we must consider vibration occurred and failure of machine with force acting on machine. If the machine is installed upon ground then we must consider types of soil available on the ground.

4 LOCATION OF INSTALLATION

Site selection is the most important criteria for the power generation. Power generation depends upon at which the machine is installed. If the average velocity of wind is higher than power generation is higher and capacity of machine is larger or higher and vice versa.

5 ENERGY STORAGE SYSTEM

As we know wind velocity fluctuates continuously and power generation will also fluctuate. But for the requirement all equipments work under constant load. So there should be some system between power generation and power requirement. There must be some energy storage system developed according to the requirement of power. For constant power supply each and every machine must have separate energy storage system.

6 INSTALLATION STRUCTURE

During installation we must consider what the base of installation is. According to the base of installation, infrastructure of installation must be design. Also structure depends upon the power generation capacity, wind

velocity, consistency in velocity, height of machine, installation height etc.

At the time of installation we must consider mechanical aspects such as vibration due to wind velocity, noise generation during rotor movement, alignment of machine components, static and dynamic failure of machine due to wind velocity etc.

DESIGN CRITERIA

1 PERFORMANCE

Machine performance should be independent from the change in wind velocity. With the change in wind velocity speed of rotor changes which effect the power generation. So there should not be any change in performance of power generation with the changing effect of wind velocity.

As we know in vertical axis machine there is pitch control and yawn control is not possible. So the machine should be design according to major constrains like pitch and yawn control. Also power must be generated with very low velocity (1.3 m/sec) without any external input and can sustain for high wind velocity.

2 SIZE OF MACHINE

This type of machines are installed either on terrace or garden size of machine is most important due to limited availability of space. For vertical axis machine the blade size can be varied from 1 m (0.2 KW power) to 2.5 m (1 KW power) to match desired capacity. According to blade size variation total size of machine is also variable. Also availability of installation size is more important to avoid interference. To avoid interference distance between two machines should be 5*D to 7*D.

3 MATERIAL OF MACHINE

Selection of material for vertical axis machine should follow below criteria.

1 Can withstand pressure generated due to wind velocity
2 Can be low in weight
3 Can easily available
4 Can easily manufacture
5 High resistance to corrosion, wear and atmospheric conditions
6 Weight to strength ratio is as high as possible

Mostly mounting structures of machines are designed from steel while column of machine and blades are designed from low weight materials like aluminum or aluminum alloy, industrial plastics or fiber glass composite material which can withstand high load and weight of machine should be as minimum possible.

Also during selection of material we must consider manufacturing process through which components of machine is to be made.

4 GENERATOR INSTALLATION

Generator of vertical axis system is mounted on horizontal surface either on the top of buildings or on the ground. It is very easy to install but the main criteria is availability of space for the installation of generator. Also maintenance of such system is comparatively easier then horizontal axis machine. Other power generating system related with generator is also mounted on horizontal surface on ground or on terrace of building.

6 POSSIBILITY FOR HYBRID POWER

Wind energy is not constant for each time due to change in wind velocity. Our power requirement for each place is constant for each and every time. For the supply of constant power at the time of design such machine we must consider the possibility of hybrid power system like combination of wind power and solar power. As we know solar is easily available energy throughout everywhere, we can provide separate photovoltaic plate attached with the column of machine and more power generation is possible. This power can be stored along

with common storage system. Such hybrid system can be useful where sufficient wind velocity is not available for some time and requirement of power cross the limit of power generation. With the help of such system it is easy to fulfill power requirement during day hours. A typical hybrid system is shown in figure 3.

7 MAINTENANCE OF SYSTEM

During design of any system maintenance is the most important criteria. As vertical axis machine has lower height compare to horizontal axis machine, maintenance of vertical axis machine is much lesser and cheaper then horizontal axis machine. During design we must consider noise occurred due to wind velocity, vibration of machine due to height of machine, mountings of machine, foundation of machine etc. factors harmful for human life.

Figure 1 Typical installation on ground with storage system

Figure 2 Typical installations on building terrace with special foundation design

Figure 3 Typical installations for hybrid power generation

Figure 4 Typical installation on road

ADVANTAGES OF SYSTEM

- As we know the vertical axis machine size is smaller to horizontal axis machine, it is easy to install more number of machines with very low power requirements.
- This design is that the rotor blades can accept the wind from any compass.
- Since the machine has vertical axis symmetry, it eliminates yaw control requirement for its rotor to capture wind energy. A dual purpose and relatively simple shaft axis support is anticipated as well as ground level power output delivery due to presence of vertical shaft.
- Aerofoil rotor fabrication costs are expected to be reduced over conventional rotor blade costs.
- The absence of pitch control requirements for synchronous operation may yield additional cost savings.
- Energy generation through wind energy is free from pollution and comparatively cheaper.
- As the initial cost of installation is higher this can be covered within few years.
- System should be designed generally for 5 years of breakeven point. After reaching breakeven point energy available will be at very negligible cost of maintenance. Regarding tax benefit 80% to 100% depreciation is allowed on wind equipments.
- State Electricity Boards are mandated to purchase 10% of their power needs from Renewable generation-based incentive of Rs 0.5 per kWh sold
- Income tax waiver on power sold to utilities
- Sales tax exemption / deferment for investments in Wind Power project
- Unrestricted levels of FDI, including BOO models
- Soft loans are available through IREDA
- Low import tariff for capital equipment and most other materials
- 10-year tax holiday
- Carbon credit
- Very less maintenance

General benefits anticipated by the corporate sector from environmental sustainability:

1	reputation building	55%
2	identify growth opportunities	39%
3	cost savings	53%
4	risk avoidance	29%
5	employee attraction retention & productivity	26%
6	foster custom loyalty	29%
7	other indirect benefits	29%

For particular application of vertical axis machine on building below specific benefits will be available as an environmental impacts.

Sr	Description	%
1	Reduce operating cost	8% - 9%
2	Reduction of total energy use	30% - 50%
3	Reduction of carbon dioxide emission	35%
4	Savings on waste output	70%
5	Reduction of water use	40%
6	Improve R O I by	6%
7	Increase the value of building by	7%
8	Increase the rent ratio by	3% - 5%
9	Increase the occupancy ratio by	3%

Table 1 % saving in cost by applying wind machine at building

DISADVANTAGES OF SYSTEM

- Initial cost of installation is higher compare to available energy.
- This type of machine is too solid, having so much metal or other material surface compared with the amount of wind intercepted. This not only leads to excessive weight for a large installation but also leaves the machine of the mercy of severe storm, since there is no way to reduce the effective area.
- It is not useful for very tall installation because a long drive shaft problems and also the bracing of the topmost bearing above the rotor of a very tall vertical axis machine is awkward,, requiring very long guy wires.
- To maintain storage system for generated power.
- As the velocity of wind is continuously fluctuated, power generation is not constant. But for our household power requirement is constant. In this case we must develop and maintain certain power storage system which can handle all equipments.

INITIAL AND INSTALLATION COST

Initially project installation cost is somehow higher. Basic installation cost is 5 lacks Rs for any kind of vertical axis machine. For generation of 1KW power approximately 1.5 Lacks Rs required. Initially the project is newer, very less development is done in this direction and very less production is started in this direction. As R&D work done in this area, initial installation cost and installation cost can be reduced.

FUTURE SCOPE

1. India plans to establish 60 “solar cities” that would reduce energy demand by 10 percent with renewable
2. India recently proposed to augment cooking, lighting, and motive power with renewable in 600,000 villages by 2032, starting with 10,000 remote UN-electrified villages by 2012

3. India's new feed-in tariff was capped at 50 MW through 2009, although a second policy phase may increase the program cap to 1,000 MW.
4. The tariff provides up to 12 Rupees per kWh for Solar PV projects promising a 10-year commitment with a cap of 50 MW

As per survey availability of wind farmable sites in India is listed as below. States or union territories in India which have following number of stations can generate 200 W/m^2 average power at a height of 50 meters.

Sr no.	State/Union Territory	Stations
1	Andaman & Nicobar	2
2	Andhra Pradesh	32
3	Arunachal Pradesh	0
4	Assam	0
5	Gujarat	40
6	Haryana	0
7	Himachal Pradesh	0
8	Jammu & Kashmir	1
9	Karnataka	26
10	Kerala	17
11	Lakshadweep	8
12	Madhya Pradesh	7
13	Chhattisgarh	0
14	Maharashtra	39
15	Orissa	6
1	Punjab	0
17	Pondicherry	0
18	Rajasthan	8
19	Tamil Nadu	45
20	Uttarakhand	1
21	West Bengal	1
	TOTAL	233

Table 2 No of station available per state/union territory

CONCLUSION

Since power prices are forever increasing, we should really consider green power as a method to cut prices. We can gather the power of wind for our home with a mini windmill. Now a day's power demand increases rapidly there must be some alternative source of energy which can fulfill the requirements of power. In this case renewable energy source especially wind energy is the most easily available renewable source of energy; it will be beneficial to develop certain system work based on wind energy for domestic purpose. Development of mini wind mill (vertical axis machine) is the most suitable option for domestic applications. As the machine size is small, cost of machine is comparatively lower then horizontal axis machine and can easily installed where the power requirement is small like on the terrace of building, gardens, commercial buildings, small industries etc.

Initial cost of machine as well as installation cost of machine is higher compare to available energy but it can be recovered within few years with very less maintenance cost. Energy generated after breakeven point is very cheaper compare to available energy.

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