WIND TURBINE SYSTEMS- REVIEW & RESEARCH PROPOSAL

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Objective:

The aim of the present research report is to provide a glimpse of the wind energy potential and introduce a research methodology to evaluate a best configuration of the wind turbine system for the given conditions of the wind resource and geographical conditions. The evaluation based assessment is purely based on statistical survey analysis and the results should be readily applicable or can be interpolated for the datum conditions.

Brief Introduction:

Increased usage of conventional fuels for the day to day requirements of the people resulting in escalating prices of conventional fuels. Apart from the scarcity and increased prices, fossil fuels also contributing to the increased pollution and other greenhouse effects. Day by day renewable energy resources are finding more and more popularity. However the selection of a particular renewable energy resource depends on the location under consideration as well other aspects like the trends and the magnitude of the energy demand. As a whole there is increased awareness towards the beneficial effects of the renewable energy and the national and international agencies are coming forward to encourage the renewable energy source based energy generations by way of subsidies and other incentive schemes. The present write-up introduces a research methodology to evaluate best wind energy solution for the given location and the wind availability configuration. The research is proposed to be based on statistical survey and assessment based on evaluation measurements.

Background for the dependency on wind energy:

Greenhouse gases emission and subsequent climatic change and global warming are some of the serious concerns of the global community. These are some of the main reasons that made the dependency on the conventional fuels to perish and the exploration for alternative energy resources gained momentum. Recent advances in the solar and wind technologies made number of countries to focus on for sustainable energy future and they are already involved in making explicit policies to encourage solar and wind energies usage. By way of subsidies as well as with growing awareness towards the renewable energy technologies, wind energy based power plants have grown at high pace in the recent times. The rated output, rotor diameter as well as average height of the wind turbines have steadily increased in the recent times worldwide. However the average size of the turbines as well as average capacity of the wind turbines varied from location to location across the globe. Apart from the prevailing policies there are several other factors like wind speed and the air movement in the region, stable environment, energy demand in the particular location etc are some of the key factors in deciding the rating of the selected wind turbine system in the region considered. Average turbine installed in 2013 was 1.93MW, while the average turbine installed worldwide is 1.34MW considering all the turbines installed so far. As per the expectation and assessments made by the Global energy agencies, the total installed wind turbine capacity can be 2000GW by 2030. Even though there are regional variation, generally speaking the installation costs of the wind turbine systems have decreased a lot in the recent times and still they are decreasing. One of the major reasons for the decrease in the wind turbine prices is the availability of more number of similar and same capacity turbines from several manufacturers. Also the supply of the wind turbines are growing a lot in the recent times which further reducing the cost of the wind turbines.

Wind energy in Europe:

In 2013, United Kingdom and Germany became the world's largest market places for the wind energy. 1883MW and 3238MW are the respective capacities of the Germany and Europe in the form of new installations. The wind energy industry is moving towards its target of supplying 14-16% of the total Europe energy demand by wind energy by way of installing newer wind energy generation devices throughout Europe. In 2013 alone, a total of 418 offshore turbines came into existence in Europe, with total wind capacity connected to the grid with a rise of about 34% over the previous year. By the end of 2013, Total offshore wind turbines in Europe are about 2080 across 69 wind farms installed and grid connected (Anon., n.d.).

Future Expectations & concerns & significance of wind energy research:

As per Global wind energy outlook report, it is possible that the global wind power can reach 2000GW by 2030. Also it is expected that about 17-19% of the total world's electricity will be met by the wind energy by 2000. It is expected based on the present growth rate as well as the anticipated growth rates that the total wind power could be anywhere about 25-30% of the global electricity by 2050 (Anon., n.d.).

At present Global wind energy industry is striving hard to bring down the total prices of the wind energy systems installations. Apart from the cost reduction aspects, other issues like effective support policies, innovative technologies as well as the industrialization of the supply chain are some of the several issues which the present global thought leaders of the wind energy industry are looking forward at (Anon., n.d.). Another equally significant domain is tapping of the offshore energy. Off shore wind energy do have large potential and is yet to get explored. Increasing the share of the offshore based wind turbine system is one of the strategies to reach the targets set before the global wind energy giants.

Wind turbines system is a key element in the overall energy tapping scenario. The cost and other performance parameters like capacity utilization do depend on the wind turbine system. The efficiency of the wind turbine system is a key issue in selection of the same. There are number of technical parameters playing a key role in the selection for the energy requirements of the future. The present part of the presentation do focus on the technical issues of the wind turbine system.

Wind turbine systems did existed prior to the grid connected electrical systems, later with the advancement in the grid supply infrastructures, wind energy systems usage is perished. However with the increase in the oil prices the wind energy systems again came into renaissance. From the mid 1980's there is dramatic increase in the installation of the wind turbine systems for power generation throughout the world. Principally wind turbine systems operate by receiving the wind and converting the energy contained in the wind to rotary energy by imparting it to the rotor and subsequently using the energy imparted to rotor for power generation in the generator. The energy generator in the generator can be optionally either can be converted to other form, can be stored or even can be grid connected. Even though the energy generation from wind energy is simple and the technology is used much compact, the uncertainty in the wind energy availability, macro and micro scale influences that affect the wind availability in a region all made the dependability only as an auxiliary source of energy.

Mostly the electrical energy generated from wind energy are used as an additional energy supply to the main resource of the thermal, nuclear energy generation sources etc.

Glimpse of wind turbine systems technologies:

Considering the underlying technologies of the wind turbine systems, the major variations existed in the wind turbine systems in terms of the generators used in. Direct drive generator type of wind turbine systems are found to be more common than the geared drive type of generator systems for electrical energy generation. The yield and the reliability of the direct drive type of the wind turbine systems is one of the major reasons for the consideration of the direct drive type of wind turbine systems to the geared wind turbine generator units. As far as maintenance problems are concerned the direct wind generation systems are more advantageous than the geared type of the wind turbine system. Apart from that other issues such as cost, size and even weight wise the geared generator systems is reported to be advantageous than the direct drive generator systems in the literature. That too in the direct drive type of the wind turbine systems permanent magnet type of the wind turbine systems are considered to be more popular and feasible than the other types. Rather than electrically excited system, the permanent magnet type of the generator systems are of less weight and are found to provide maximum energy yield.

Material for wind turbine systems: High strength fiber composite materials are now a days being used commonly in large and low cost blades of the wind turbine. With increased supply and advancement in the technologies, the cost of the power electronics used in the making of the wind turbines is coming down. Variable speed operation of the electrical generators is used to capture the maximum energy and thus optimization of the wind turbine systems resulting in increased use of the systems. The plant operations of the wind turbine have grown more to push the availability to as high as 95%. The improvement in the technology and the accumulation of the years of field experience is reducing the per unit cost of generation, increasing the sizes of the production systems as well contributing to the hike in the capacity factors.

Types of wind turbine systems:

There are number of factors used in to classify the wind turbine systems. Power of the wind turbine system as low power, medium power as well as high power. According to the rotational power as constant speed constant frequency, variable speed constant frequency, variable speed variable frequency, According to the orientation of the turbine as horizontal axis, vertical axis etc. DC generators, synchronous generators as well as induction generators are three different types of the generators commonly used in association with the wind turbine systems. The three key design philosophies employed in the design of the wind turbines are withstanding the loads, shedding or avoiding the loads, managing the loads mechanically and/or electrically. High availability and the low O&M costs are usually criteria used in to design the wind turbines. Even though minimization is the key concern, there is always need to reduce the overall O&M costs of the wind turbines along with the installations costs. The design of the other elements like tower costs should be considered and optimized accordingly in finalizing the total cost of the wind turbine (Anon., n.d.).

Reactive power control and the hybridization are the recent trends in the wind turbine power systems design. The recent trends in the making of the wind turbine systems include reactive power control for optimizing the power availability. Other developments include floating floor type of the offshore wind turbine systems, multi turbine hybrid wind turbine systems etc. Wind turbines with unconventional designs are being developed in the recent times. Spiral Magnus is another recently introduced type of wind turbine which incorporates spiral blades different from the conventional propeller type of wind mill blades. Wind turbine blades is another important component of the wind turbine undergone several changes in the recent times. Bladed undergone improvements by way of improved manufacturing methods, improved designs, improved materials as well as through advanced analysis and testing procedures. New planforms, aero foils and aero elastic tailoring are some of the few improvements In the making of wind turbine blades. Optimizing the performance by mitigating the fluctuations in the off shore wind energy output by other renewable energy systems like biogas, solar is fast catching up process presently.

Also contributing to the increased life and the performance of the wind turbine are the improved maintenance techniques of the wind turbines. The improved maintenance procedures and the usage of the improved methodologies for the Root cause analysis(RCA), Nondestructive testing (NDT) of the key components has enhanced the reliability and contributed to the migration of the higher power generation and for the construction of high risk turbine structures for power generation. As a whole the total wind turbine systems resulted in higher and improved power generation and resulted in several innovative designs and installations. Improved precision and accuracies in the estimation of the life of the key elements like bearings and other moving parts contributed to further enhancement of the wind turbine reliability and the life time. Savonious is another innovative turbine design. After all the choice of the wind turbine is mainly due to the environmental friendliness and is brought into use as an alternative to the conventional energy resources. However the technological improvements in the wind turbine are making the vision materialized and it is much likely that the set goals of the wind energy based power generation will be possible in short future. Turbine blades in the smaller turbines used in houses are made of solid carved wood and other wood laminates however aluminum steel and other wood veneer composites can be employed. However reinforced plastic composites became commonly used material in the large capacity wind turbines these days. Typical material consist of FRG, FRP, carbon fiber composites. They do possess higher strength to weight ratio compared with other materials. However as they are lightweight, strong and inexpensive they do have good fatigue characteristics and can be made in variety of production processes.

RESEARCH

Research hypothesis:

Wind energy installations and the utilization factors do depend more on the wind energy available as well as the type of the technologies available. The useful life and the performance characteristics of the wind turbine do depend more on the type of the wind turbine employed and its characteristics apart from the wind availability. The research proceed to identify the best wind turbines for a given location. Also the investigation tries to provide information on the best possible micro sitting configuration as well as the life time predictions of several types of the turbines in the given wind condition.

Other objectives tries to identify the best control of the wind turbine power control. As on date there are several types of wind turbine power control methods existing like blade pitch control, control of the generator through power electronics, control through smart rotor methodologies. A relative estimation of the efficacy of these systems calls for a thorough investigation of the control methodology and the performance characteristics as well as the life of the turbine model.

Research Methodology:

The basic technique of the research consist of thorough survey of the installed and operating wind turbines in the selected domain. Collecting the samples of the wind resource availability as well as the performance characteristics in that region. This will provide an exhaustive information of the wind turbine performance features for different types of configuration.

Research methodology consist of investigating the existing wind turbines with each of the above type of control procedure and the find the relative potential of each of the control method. The process consist of estimation of relative potential of each of the control method in terms of the active life measurement as well as performance features like capacity utilization, noise of operation etc. A cumulative understanding of the performance characteristic will provide a key introspection of the relative advantage and disadvantage of the wind turbine system control methodologies.

The key steps in the research methodology consists of the following steps:

(i) The basic information collection regarding the wind energy resource selection will be made from the geographic data, wind energy resource record values, NREL web site etc.

(ii) A thorough investigation of the existing wind mill systems in the area will collected.

(iii) Technical operational parameters like the height of the wind mill tower, capacity of the wind turbine, generator capacity, critical speed, type of control mechanisms, type of the wind turbine, tower height etc. will be collected for each of the wind turbine system in place.

(iv) A keen collection and investigation of the wind turbine system performance parameters like capacity utilization, down time details, maintenance history, working life, efficiency in operation, total cost of the installation, average operational and Maintenance cost, noise levels etc will be collected.

(v) A relative assessment of the issues like benefit cost analysis for the number of available models, Return on investment, Grid connectivity, available average power for grid, cost of power generation etc will be either gathered or will be computed from the given data conditions.

(vi) A comparison will be made for the range of the wind turbine types in the chosen area and an investigation will be made for the best type of wind turbine in terms of the optimum performance and benefit to cost assessment.

(vii) The output from the analysis performed will provide an input for the decision making process in selecting a new wind turbine.

(viii) The data gathered and analysis will yield true field data for the decision making process for the installation of the new wind turbines as well for the expansion projects.

(IX) The information also provide a relative estimation of the financial decision matrices in terms of the company of the wind turbine as well as their performance characteristics estimation.

(X)As a whole the success of the research will depend on the quantity of the data collected, precision in the data processing as well as the accuracy in the calculations.

Conclusion:

Present day wind turbine system performance depends much on the type of the technology used as well as other auxiliary works like the control configuration employed etc. The research proposed in the present work proposed to identify a right choice based on the performance, bottlenecks, costing (Net present value) of the turbines in the chosen location. Research is mainly focused on the power plants and hence other issues like micro sitting, networking configuration etc are equally considered in proposing a better solution in the given conditions of the wind resources. The methodology selected will be mostly through a physical as well as statistical survey of the performance and other technical features of the recorded parameters.

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