WIND INSTALLATION FOR WATER PUMPING, AUTONOMOUS AND GRID-CONNECTED POWER PRODUCTION

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Summary

Wind energy can be used for a large gamut of applications. The intermittent character of wind energy demands that in all cases energy storage or back-up facility should be used. Small wind mills with capacities less than 1 kW are mostly producing DC electricity and used to charge a battery, whereas the latter provide power for lighting, refrigeration, communication etc. Wind electric applications for agriculture require small wind systems ranging in size from 10 to 50 kW. In this case hybrid wind/diesel installations may be advantageous.

A special case represents wind energy use for water pumping. The lifted water from an underground well can be stored in a vessel at some elevation for the time interval when wind is insufficient.

Large wind machines in the range of 100 kW and more most probably should be grid-connected, the intermittent income of wind energy being compensated by the large capacity grid. For these installations economic considerations are of paramount

importance. First of all it means to rely on a representative data-base concerning the wind characteristics and choose for the wind mill deploying an optimum site. Recommended steps for site selection for a single wind mill and conditions for a wind-farm construction are described in this Article

1. Introduction

Wind turbine applications vary from large, megawatt-sized utility power plants to small wind turbines for home, farm or village use. Wind energy systems may be either grid-connected or stand-alone.

For utility-scale applications, wind turbines operate like utility power plants, feeding electricity into the grid for distribution to utility customers.

Wind turbines can supplement power delivered by utility lines. The owner of a grid-connected wind turbine buys and sells electricity from and to the utility. Electricity generated by the wind system is used on site, and any excess is fed through a meter into the utility grid. When a home or business requires more electricity than the wind turbine is generating, the demand is automatically met by power from the utility grid.

Wind turbine generators can meet electrical demand where there is no utility-supplied electricity. These stand-alone wind turbines are usually small, under 50 kW machines. Small turbines may operate alone or in hybrid configurations with batteries, diesel generators, and solar energy systems. For village power installations, mini-grids multiple wind turbines can supply power, often with diesel generator backup, to isolated communities. Developing countries provide the most promising markets for small turbines and hybrid systems.

Using wind power plants to supply electricity to utilities is a familiar concept in many countries of the world. There are large utility companies, which have contracted to buy significant amount of power from private wind power plant developers in these countries.

Economies of scale and simplified logistics favor the use of wind power farms or arrays for large utility applications, rather than dispersed individual turbines. Such wind power farms are connected to high-voltage transmission lines in much the same way as are conventional power plants, operating as part of the overall generation mix.

Unlike conventional generating sources, the wind is an intermittent resource. Such intermittence can cause the output of a wind power plant to fluctuate, often within minutes. Adjusting the output of other conventional generators feeding the grid must compensate for these changes in output. These effects can be magnified if wind power comprises a large proportion of the system's generating capacity. However, if the output fluctuations of a wind power plant are limited or can be anticipated, or if the wind power plant is coupled with versatile generating source, the effects of wind power fluctuations on the grid can be reduced significantly.

A modern wind power farm is a group of wind turbines interconnected through a system of transformers, transmission lines, and substations. Operation, control, and maintenance functions are often centralized through a network of computerized monitoring systems, supplemented by visual inspection and carefully performance monitoring.
The power that can be extracted from the wind varies with machine design and wind power plant location. Performance data can help the wind industry and potential users by identifying necessary modifications in machine design, demonstrating reliable operation, and providing information useful in the selection of a system to meet user needs. Such data usually include basic features of the machine such as design output, rotor configuration and operating wind speeds; characteristics and problems of the machine in operation; and result of specific tests of machine capabilities.

The performance of a wind turbine can be determined by actual power output measurements obtained through either long-term field testing or short-term wind tunnel testing. Otherwise, performance can be estimated or predicted through the use of models, especially computer models.

2. Agricultural Applications

Wind machines have been extracting mechanical energy from the wind to pump water for thousands of years. There is still a brisk commerce in mechanical water pumping windmills in some countries. These machines with ten or more blades are well suited to the low-speed, high-torque requirements of water pumps. Storage tanks are sized to keep water available when the wind is not blowing.

Wind electric generators, first introduced to farmsteads in the United States in the 1920s, can provide a greater variety of services for agriculture. Wind-generated electricity can be used for lighting, heating, pumping, refrigeration, running processing equipment, and producing hot water.

Most of these wind electric applications for agriculture require small wind systems ranging in size from 10 kW to 50 kW. Field tests have indicated that, in general, the wind system must be used throughout the year to be economical. However, some applications that include a storage system also may be viable.

3. Stand-alone and Wind/diesel Hybrid Systems

Wind energy has traditionally been a source of power for sites where no other power source is readily available. The most familiar of these traditional applications is the mechanical water pumping, which is still in use today. But in the first half of the 20th century, there were also many small (less than 1 kW) electricity-generating machines operating in countries.

The technology available for a small stand-alone installation has improved greatly since the 1940s, and today's modern small machines are used in thousands of installations worldwide. Very small direct current systems are used to charge batteries, while larger systems (up to 20 kW) are used as stand-alone, alternating current generators for agriculture and remote settlements.

The applications for stand-alone wind energy systems are almost unlimited. These applications are - low voltage lighting; telemetry equipment; educational aids; portable TV and radios; scientific field equipment; navigation aids; water pumps; weather station; small power tools; cattle-feeders; electric fence units; inverters; batteries chargers; TV repeaters and so on.

The typical users are: remote home owners; educational departments; explorers; caravan users (mobile & static); naval departments; scientific establishments; yacht and boat owners; nomadic tribes; harbor and port authorities; farmers; third world relief organizations; local water authorities; fish farmers.

Wind machines have also been used to provide power in Antarctic at the South Pole since the 1930s. Wind is supplying power at sites that would be costly to serve with conventional means or at sites so remote or harsh that other power systems might not work reliably over long periods.

Wind/diesel hybrid systems are becoming important in areas where it is advantageous to reduce conventional fuel use and decrease maintenance costs. In many of these hybrid systems, photo-voltaic (PV) panels that convert sunlight directly into electricity are also included. In the most common hybrid application, wind turbines and PV panels meet energy needs and charge batteries when the wind is blowing. If the batteries run low, the diesel engine-generator runs at full power until they are charged. In some systems, the diesel generator makes up the difference when electrical demand exceeds the combined output of wind turbines, PV, and batteries.

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Biographical Sketch

Professor Vladimir A. Dobrovolski, Ph.D. was born in Moscow, Russia in 1936. He graduated from

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1960-1963 - test engineer, the USSR Civil Aviation

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