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COMMON APPROACHES OF SMALL WIND TURBINE APLICATION

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***Abstract* - the basic problems of application and a number of proposal for small wind turbine project development was shown.**

***Key words:* small wind turbine, hybrid systems, standalone systems,grid connected systems.**

Problem formulation. The global Small Wind Turbine (SWT) market has been on the upswing in the five years. The main drivers of this growth are the demand-supply gap in energy, increasing fossil fuel prices, improved small wind turbine technology and the diverse application to which it can be put to—both “grid- tied” and “stand-alone”. [1]

Small wind turbines find application in isolated or standalone systems, mainly rural electrification, commercial applications (telecommunication towers) etc. Most of the existing systems come under this category (standalone). Hybrid systems constitute a major share of these isolated systems, as they combine two or more sources of renewable energy to ensure continuity of supply. Grid connected small wind turbines are becoming popular in the countries like USA, Canada, European countries; the grid connected machine feeds power to the grid via a net metering system and the consumer is allowed to export or import power.[1]

*Recent research analysis.*As per IEC 61400-2, wind turbines with rotor swept area less than 200 sq.m and is capable of generating 1000 V AC or 1500 VDC are classified as small wind turbines. Several sub-divisions may exist within this classification based on the rating of the machine, swept area of the rotor, axis of rotation, direction in which wind approaches the rotor and kind of force used by the machine to create torque.[4]

Table 1 shows a categorization of commercial SWTs on the basis of rated power.

Also small wind turbines are increasingly being recognized as a technology symbiotic to pure photovoltaic systems. In 2008, the total number of installations in the SWT spectrum was almost 19,000 units, amounting to 33.6 MW of SWT installations. The United States of America is the leader in SWT applications. The cumulative installed small wind capacity in USA has now reached a whopping 80 MW.

Table 1 - Small wind turbine categories

Category	Rated power, kW	Rotor swept area, m^2
Pico wind	<1	<4.9
Micro-wind	1-7	<40
Mini-wind	7-50	<200

Globally, the trend has been to set up grid-interactive SWT or SWT hybrid systems. Almost 77.5% of all the installations in 2008 were for grid connectivity. Net metering and feed-in tariffs are driving the entire SWT industry and have also been responsible for harnessing it mostly for grid connectivity. Grid connectivity, usually results in increased system costs but due to the recent surge in sales worldwide, equipment manufacturers were able to reduce their prices considerably, further fuelling the prospects of on-grid installations.

The high cost of energy generated has historically been the most significant barrier to the growth of SWT and hybrid system market globally. Most of the SWT and hybrid systems installed are in the ‘off-grid mode’. Lowering of the cost of generation can be achieved through technology improvements and production scale-up as well as policy support.

*Article purpose formulation.*To show the basic approaches of the SWT application, including SWT in hybrid systemsand to offer a number of proposal for SWT project development.

*Hard core.*Standalone systems are designed to produce and store DC power. The output of the wind turbine is converted to DC power from where it goes to the load through the inverter. The battery charger is a DC-DC buck boost converter. The power in excess of the load goes to the battery. If excess power is available after fully charging the battery, it is shunted in the dump load. When no input power is available, the battery discharges through the inverter to provide the load. [1]

Small wind turbines use permanent magnet alternators, which are designed to match the characteristics of the wind turbine. There are two possible schemes of variable speed operation.

Conveniently most turbines operate efficiently on a constant tip speed ratio (TSR). The TSR is defined as the ratio of the tower blade tip speed to that of wind speed [2]

$$TSR = \Omega R / V \quad (1)$$

where ω is rotational speed

R is radius of turbine

V is wind velocity.

The optimal TSR is physical characteristics provided by the manufacturers after based on pre-production testing. Though, TSR remains constant throughout the design life but slightly changes as the blade bows bends, pickup dust and debris.

The system design for a constant TSR operating scheme is shown in Fig. 1 below. By measuring the wind speeds locally the optimal rotor speed is computed using reference speed ratio. This optimal speed is compared to the actual rotor speed and electrical loading adjusted to correct the difference. [2]

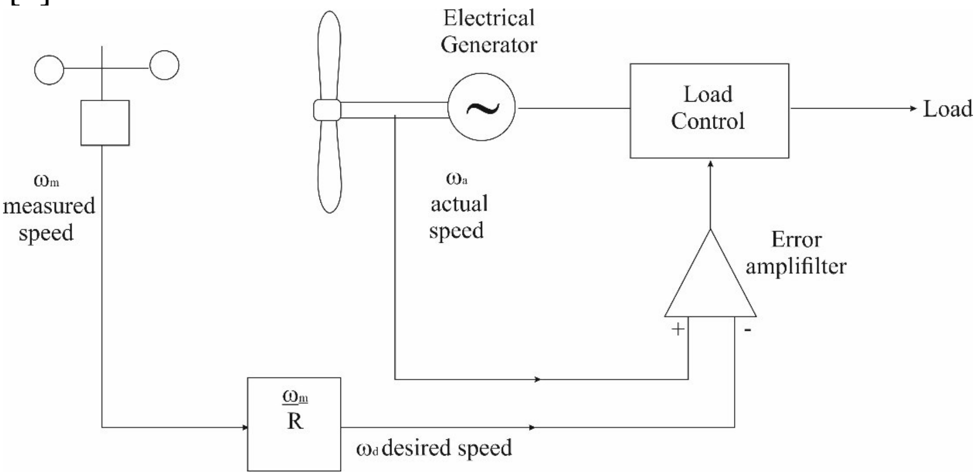

Figure1 - Maximum power extraction using the constant tip speed ratio scheme.

The power Vs rotor speed curve shown in Fig. 2 below as well defined peaks and the following expression provides the condition of maximum power point i.e.

$$dP/d\omega=0 \qquad (2)$$

Therefore by incrementally varying the rotor speed by small amounts and evaluating dP/dω the peak power tracking scheme continuously tracks the optimal operating point and adjusts rotor speed accordingly.

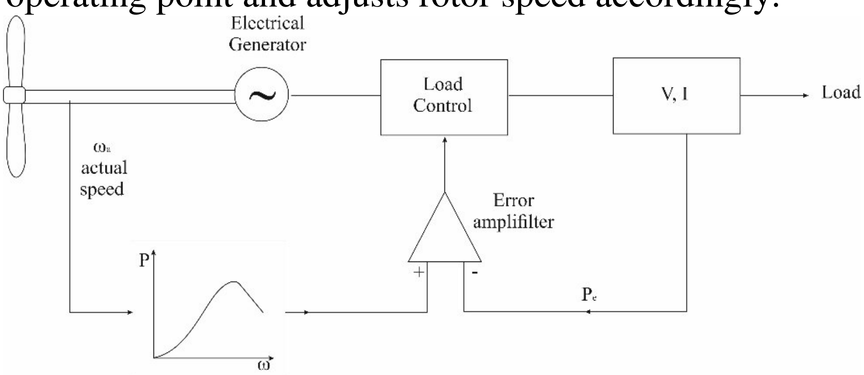

Figure2 - Maximum power extraction using the peak point extraction scheme.

Grid connection of wind power systems helps in riding over the temporary excessor shortfalls in the generated renewable energy. This improves the overall economy. The grid supplies power to the load when needed, or absorbs excess power when available. Fig. 3indicates schematic of such grid connected systems. [2]

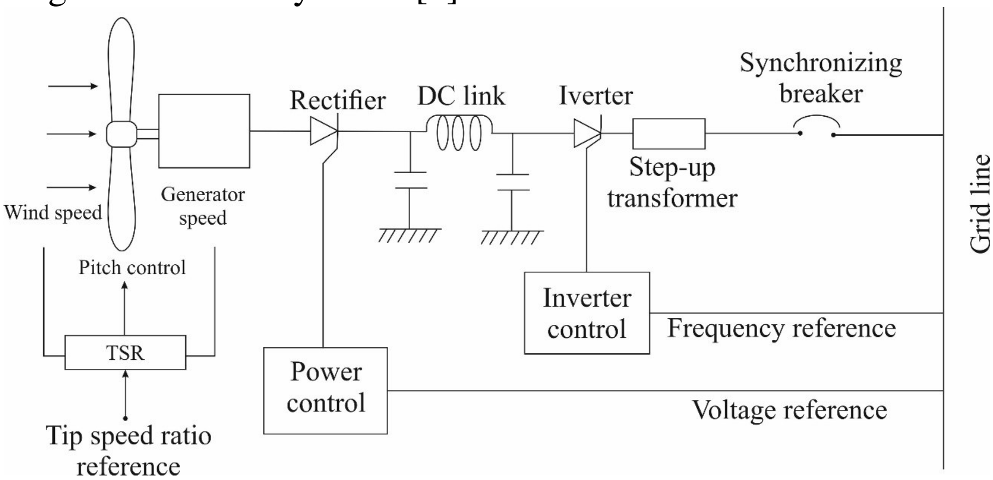

Figure3 - Grid connected wind system.

The renewable energy systems interface through the breaker at the output end of the inverter. The power flows in either direction depending on the site voltage at the breaker terminals.

The fundamental requirements on the site voltage for interfacing with the grid are as follows: [2]

• The voltage magnitude and phase must equal to that required for the desired magnitude direction of the power flow. The voltage is controlled by the transformer turns ratio and/or the rectifier/inverter firing angle in a closed-loop control system.

• The frequency must be exactly equal to that of the grid, or else the system will not work. Meet the frequency requirement; the only effective means is to use the utility frequency as reference for the inverter switching frequency.

Testing of small wind turbines with an objective to verify its engineering integrity is safety philosophy and quality assurance. The idea is to ensure the performance and operation of the small wind turbines are as predicted in the design. Owing to the large number of players coming up in the field there was a dire need to establish testing facility: for small wind turbines so as to streamline the manufacturers based on the performance of their machines for necessary empanelment. [3, 4, 5, 6]

The present testing program focuses on the following tests of the Small Wind turbines.

- Power Performance measurement
- Duration Test
- Safety and function test

Conclusions. Traditional power production of electricity is insufficient today because of exponential industrial growth and higher living standards. Small generation which includes technologies small wind turbinesis both a serious form of clean energy production and a cultural movement, which is gathering momentum worldwide.Therefore focus on a program to expand the market for SWTs and hybrid systems by industry stabilization through mass production, (both stand alone and grid interactive systems), diverse product portfolio, standardization of products, product testing, and product certification, improved operation and maintenance service network, business model restructuring, innovative policy and regulatory framework and capacity building.

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ОСНОВНІ ПІДХОДИ ДО ВИКОРИСТАННЯ МАЛИХ ВІТРОВИХ ТУРБІН

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