Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 3, Issue 11, November-2016

INVESTIGATE SYSTEM SOLUTION FOR WIND ENERGY SECTOR IN INDIA

Namra Joshi[1], H.P. Dishoriya[2], Jaya Sharma[3]

[1]*Assistant Professor, Department of Electrical Engineering, Sanghavi College of Engineering, Nashik*
[2]*Senior Lecturer, Department of Electrical Engineering, Shri Vaishnav Polytechnic College, Indore*
[3]*Assistant Professor, Department of Electrical Engineering, Shri Vaishnav Vidhyapeeth Vishwavidyalaya, Indore*

Abstract —Wind power generation is being deployed rapidly and massively, but will be limited to the regions of uninterrupted wind availability. Winds are generated by complex mechanisms involving the rotation of the earth, heat energy from the sun, the cooling effects of the oceans and polar ice caps, temperature gradients between land and sea and the physical effects of mountains and other obstacles. Wind turbines convert the kinetic energy of the wind into electricity. This paper covers various system solution requirements for wind energy sector in India & their technology enabled solutions.

Keywords-Pitch Control, Ultra capacitors; Overhead Insulation; Reactive Power Compensation; Low Voltage ride through.

I. INTRODUCTION

Wind Energy penetration in India has seen robust growth over the past decade & stands 5th in the world. Armed with the necessary experience, the finer aspects related to its deployment and performances are now gaining visibility & attention. Electrical pitch control for normal duty as well as emergency duty using batteries suffers from low battery life and difficult repair & replacements. Ultra capacitors based electrical pitch controls can provide long life & reliable pitch control more effectively. Meeting existing & emerging grid code requirements using conventional reactive power compensation mechanisms are proving challenging. Dynamic reactive power compensation using distributed static compensation technique are capable of low voltage/ fault ride through and fine reactive power control under a wide range of operating conditions. Traditional Switchgear configurations have been generically extended for use in the electrical infrastructure for wind sector. Unitized substations with adaptations in such as load break switches instead of conventional breakers can provide a cost effective and project facilitating approach for meeting the electrical infrastructure requirements. Overhead insulation of transmission line can save many an outage on account of bird faults, tree faults in wind farms. Installation friendly insulation sleeves can provide the necessary relief to repetitive fault incidents.[3]

II. PITCH CONTROL APPLICATION USING ULTRACAPACITOR

A. Background

Pitch Control Systems control the rotor blades to optimize the power output & ensure performance within operating limits. Electrical pitch control systems conventionally use batteries as their power source & sized using the peak power requirements in mind. During the various pitch control measures, the batteries are subject to cycling with fluctuating duties. Further, wide temperature fluctuations & inherent life cycle limitations result in typical battery life of 1-2 years. Since the batteries are installed at a height, maintenance & replacement of batteries is not convenient.

B. What is an Ultra capacitor?

Ultra capacitors based on nanotechnology have high specific power but low specific energy which makes them useful in pulse power requirement. An Ultracapacitor is an electrochemical device consisting of two porous activated carbon electrodes immersed in an electrolyte solution that stores charge electro-statically. The key feature of the ultracapacitor is that its liquid electrolytic structure & porous electrodes gives it a very high effective surface area compared to a conventional plate structure. It also ensures a minimal distance between the plates. These two factors lead to a very high capacitance compared to a conventional electrolytic capacitor. Ultracapacitors can have 100 to 1000 times the capacitance per unit volume compared to a conventional electrolytic capacitor.

Typical cell voltage ranges from about 0.8 volts per cell up to over 2 volts per cell depending on the materials used in the cell of ultra capacitor. An ultra capacitor module consists of several such cells connected in series & parallel depending upon the rating of the module. Ultracapacitor share some of the chemistry of batteries but the approach is to operate them at a cell voltage range that leads to only electrostatic storage of charge. If they charged too high, then chemical reactions begin to occur and the cell may behave more like a battery.[1]

C. Comparison Between Lead Acid Battery and Ultracapacitor

Table I depicts that ultra capacitor have major advantage of operating temperature range, fast charge discharge, high specific power and long life cycle. Batteries on the other hand have high specific energy but low specific power. Further, there are different kinds of ultra capacitor with varying characteristics based on the individual design, construction and materials employed for their electrodes and electrolytes. Within these choices, aqueous ultra capacitor which use aqueous KOH as their electrolyte are environment friendly, which is easy to dispose as compared to lead acid batteries or other ultra capacitor types with organic electrolytes which are hazardous and inflammable. Moreover, unlike batteries that suffer in their performance under low operating temperature due to increase in ESR, ultra capacitor are not as significantly affected by low temperature conditions.

TABLE I

ULTRACAPACITOR VERSUS BATTERY

S.No.	Characteristics	Ultracapacitor	Battery
1	**Charge-discharge cycles**	More than 500000	1000
2	**Expected Life (in years)**	More than 20	1 to 3
3	**Power density (kw/kg)**	2-10	0.1-0.5
4	**Energy density (Wh/kg)**	3 to 5	8 to 100
5	**Ability to discharge Completely**	Yes	No
6	**Self Discharge Rate**	High	Low
7	**Temperature Range**	-50 to +55° C	-10 to +50° C
8	**Environmentally Friendly**	Yes	No

D. Use of Capacitors for Pitch Control

Use of ultra capacitor for pitch control has been gaining momentum over the years due to the obvious suitability of its application over batteries due to long life. The downtime, risk and effort associated with maintenance/replacement at heights are also correspondingly avoided. Several manufactures worldwide have adopted these systems as standard.

There are some valid concerns about performance under high ambient temperature condition which operational experience can support. There are also several technological choices pertaining to the choice of the ultra capacitor types, including its construction, electrolyte etc. that can be customized to make them more amenable to specific operational considerations.

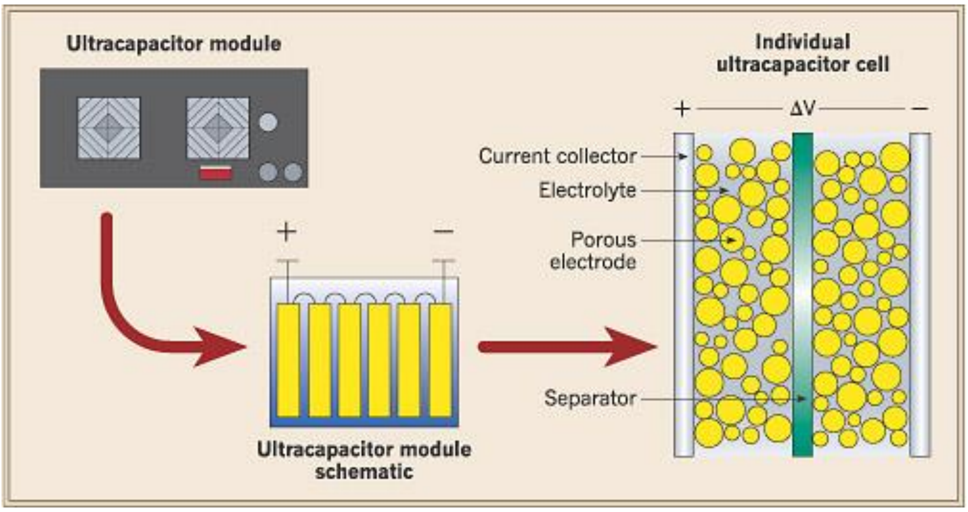

Fig. 1 *Ultracapacitor Module*

III. DISTRIBUTED STATIC COMPENSATION FOR DYANAMIC REACTIVE POWER COMPENSATION

A. Background

Reactive power compensation requirements in a wind farm are essential for the operation of the wind generator and vary with the fluctuating wind speed conditions. Further, grid connectivity imposes increasingly demanding power factor constraints at the point of common coupling (PCC). During faults on the grid. Which results in a low voltage condition; it is desirable for a wind farm to maintain its feed to the grid and support the grid during such disturbances. However, a depressed voltage essentially starves the WEG from reactive power and hence a short term reactive power support with magnitude of multiple of nominal's levels becomes essential to provide low voltage ride through/fault ride through capabilities.

B. Challenges in Reactive Power Compensation

Convectional switched capacitor compensation need to constantly adjust to varying reactive power requirements in a windfarm.This switching duty causes considerable loss of life in the electromechanical elements. Further they are incapable of giving momentary burst of reactive power on demand. The static VAR compensator (SVC's) which employee combination of thyristor switch capacitors /reactors can avoid electromechanical duty due to constant switching. However, transient stability by short term peak reactive power support is not readily available with such system.

C. Dynamic Reactive Power Compensation

IGBT based FACTs devices called STATCOM (Static Compensators) are fast acting compensating reactive power sources. They provide real time voltage control and improve both power factor as well as transient system voltage stability. STATCOM use solid state DC to AC inverters to provide reactive current and can supplement conventional voltages and VAR control devices by using them as base level support systems. STATCOMs can react quickly to fast changing situations and provide dynamic LAG/Lead VARs in less than $1/4^{th}$ Cycle. They will also reduce over voltage cause by capacitor banks or line switching. Smaller rated distributed STATCOMs or DSTATCOMs can be use at multiple locations throughout the wind farm provide more effective reactive management. A proven DSTATCOM solution are commercially available for multi-MVAR banks in modular versions of +/- 1.5MVAR and occupies substantially lesser footprints compare to SVCs. During transient situation in grid, they can provide 264% of rated outputs for up to 2 sec, thus rapidly restoring transmission system voltage.

IV. UNITIZED SUBSTATIONS WITH OPTIMIZED SWITCHGEAR CONFRIGURATIONS

A. Background

Wind farm projects are located in terrains that are not necessarily conductive to ease of transportation, installation, operation and maintenance. The electrical switch gear necessary for interfacing the output of each wind turbine to the network of underground/overhead transmission lines include various components such as transformer, LV/MV breaker /load brake switch arrangements, lighting arrestors, metering devices etc. Some of these components may be integrated inside the wind turbine structure as well base on manufacture designs.[4]

B. Unitized Substations

From a project perspective, it is desirable to have a skid mounted unitized substation that houses on all electrical interface equipment's within one shipping module. This can conveniently serve much shorter installation, commissioning, repair, maintenance and replacements and the logistics of handling various diverse components at site can be effectively eliminated.

In India, while this concept is not entirely new, the widespread use of this choice has not yet been experienced. Relatively modest increases in capital costs need to be weighed against the well identified benefits as mentioned above.

C. Load Break Switches instead of Breakers

Conventionally, MV breaker is employed at each wind turbine end. However, it is worth nothing that typically, this breaker does not serve to operate under faults conditions. For faults on the LV side The LV breaker trips to isolate the fault. Similarly, for faults under transmission line, the upstream breaker at the customers substation is expected to operate and clear the fault.

Typically, the use of MV breaker is typically recommended and endorsed by most utilities as per their standards. However, one can easily accomplish the functional requirements by way of a cost effective load break switch with manual controls. Since none of the electrical safety consideration are being violated, the regulatory bodies/utilities should consider favorable acceptance for providing load break switches instead of breakers in their electrical switch gear infrastructure.

V. OVERHEAD INSULATIONS FOR TRANSMISSION LINES

A. Background

Typically, wind farm installations in India have follow the practice of using overhead non insulated trans. Lines instead of underground cables in the interest of economy. However, when such lines are located close to trees that may quickly grow within striking distance, faults may result that can cause system wide outage/islanding in the wind farm. Also, recent experiences have also identified the need to protect wind form towers from presence of animals/birds with wide spans/tails (E.g. Peacocks)who can radially result in phase earth fault(S) and loss of life to the incumbent animal/bird which may not be acceptable, especially if indicative of high number/repetitive trends.

B. Overhead Transmission Line Insulation Sleeves

Insulation sleeves that can be conveniently install on a transmission line which are expose to potential fault situation on account of nearby outgrowth of trees, animals, birds etc. provide a ready solution to the problems explain above. Care should be taken that the sleeve has the necessary insulation requirements and require minimal time and high degree of convenience to enable its quick installation on trans. Lines that minimize risk in installation at height as well as downtime on account of maintenance activity during installation. It is observed that when peacocks use to fly up to the transmission line tower and inadvertently short the phase to another phase/earth due to their long tail. Since peacock is India's national bird, and is part of India's cultural and religious heritage, special attention is deserve to insure that such risk are effectively mitigated.[3]

CONCLUSION

Based on the aforesaid discussion and data this can be concluding that by incorporating aforesaid System solution for a variety of real problem areas in wind energy sector. While each such solution road map demand further due to diligence in Indian context, these have been already tested and validated in many countries abroad.

REFERENCES

[1] Miller, John R., Conway, Brian E., 'Fundamentals and Applications of Electrochemical Capacitors, 'An electrochemical short course, May 1997.

[2] John R. Miller, Fundamental and Applications of Electrochemical Capacitors, Technology Tutorial, January 3, 2002, pp 876-880.

[3] www.windworldindia.com

[4] www.mnre.gov.in

[5] www.suzlon.com