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Overview of Existing Solutions for Fault Ride through Capability Improvement of DFIG used in Wind Turbines

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Abstract- ***The growing of wind generation gives arise for new challenges for its integration to the network tripping of large amount of wind power will lead to serious consequence to the grid . in this paper DFIG performance used in wind turbine during voltage dip due to fault. Wind turbines equipped with doubly-fed induction generators (DFIG) can regulate easily the reactive power generated in steady state. However, challenges appear when reactive power has to be generated during voltage dips. A survey of the problems associated with voltage dips and solutions for Ride Through operation of this type of system are given. an overview of different alternatives for Low Voltage Ride Through are presented in this paper.***

Keywords: Doubly-Fed induction Generator, Low Voltage Ride Trough, Voltage Dip.

I. INTRODUCTION

Wind power generation has experienced remarkable growth in the last decade .the concern about the environment has resulted in increasing interest in wind energy . In recent years, the total capacity of wind generation connected to the power system has been increased significantly due to its low environmental cost and low installation cost. In this situation, the sudden disconnection of wind power generation due to the power system disturbance may collapse power balance between the power supply and the power demand. In response to this problem, transmission system operators have revised grid codes in many countries, and they require Fault Ride-Through (FRT) capability . FRT is to keep connection of the wind power generator to the power system when power system disturbance Wind farms is contributing to grid frequency control by adapting reactive power control strategies . the most crucial demand for wind farms ,specially with dfig is the Fault Ride Through capability. There is a special emphasis on the Voltage Dip Ride Through capability in wind power systems based on doubly fed induction generators (DFIGs). In such a machine type , the voltage reduction in the stator windings, experienced during a voltage sag, creates an abrupt variation in the stator flux of the DFIG. As a consequence of this transient, the currents in the stator increases rapidly, experiencing an over current that is transmitted, because of the magnetic coupling of stator and rotor windings. These high transient currents, [8], which can cause a damage , especially for the semiconductors of the rotor-side converter (RSC), that can experience a thermal breakdown[6] [5].

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The E.ON (German transmission & Distribution utility Grid Codes) regulation will accordingly set the standard for tripping the generator from the grid. This insists that a wind turbine should continue to be stable and connected during the fault, even as voltage at the point of connection drops to 15% of nominal (i.e. a drop of 85%). Only in case the grid voltage dips below the curve, the turbine is allowed to get disconnected from the grid as can be seen in the above Fig.1

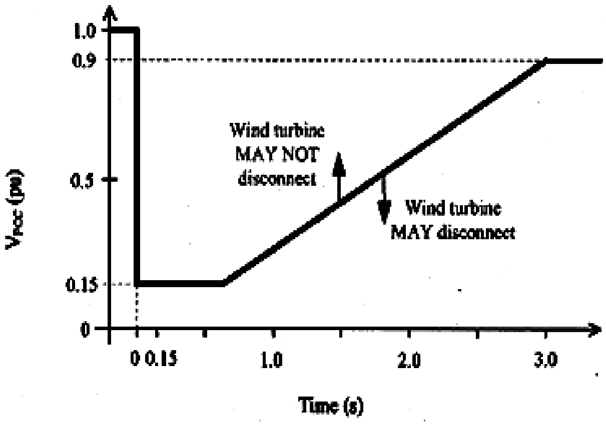

Figure 1. E.ON Fault Ride Through Voltage limiting curve

II. DFIG LOW VOLTAGE RIDE THROUGH PROBLEM DESCRIPTION

In wind farm, developers and research studies experience have illustrated that the wind farms are adversely affected by grid faults .grid faults can be classified as symmetrical and non-symmetrical faults. The grid codes requirement only determine symmetrical faults, as they have sever impacts on the grid stability , while non-symmetrical faults are more complex to deal with DFIG generators.

The stator flux of the DFIG machine is described by the following expression:

$$\psi_s = \psi_{s0} + \int_0^t (V_s - R_s I_s)\, dt \qquad (1)$$

In the occurance of voltge dip the stator flux of DFIG cannot follow the abrupt variation in stator voltage and dc component in the stator flux appears due to the fact that the integral term is decreased and the stator flux vector becomes nearly stationary, in the mean while rotor keep spinning and high slip is developed which will introduce overvoltage and over current in the rotor circuit .the excess current may destruct the power converter and the over-voltage may damage the rotor of the generator.

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In order to protect the power converter connected to the rotor from this over-voltage and over-currents a protection scheme is required .

III. SURVEY OF DFIG FAULT RIDE THROUGH SOLUTIONS

Common solution of the voltage dip problem is to connect a crowbar to the rotor of wind turbine The protection technique is to limit the high current and by providing a bypass of resistors set when a voltage dip is detected and the power converter connected to the rotor is protected [6]. Crowbar circuits may be antiparallel thyristor crowbar, diode bridge crowbar (Fig. 2). The diode bridge crowbar is more favorable than the antiparallel thyristor because it incorporates less thyristors and it is easier to control.
In either cases ,when the voltage at the DC bus reaches its limits or when the limit rotor current is exceeded , the crowbar is activated , and the rotor converter is disconnected from the rotor The crowbar stays s connected to the rotor until stator is disconnected from the grid and the rotor currents disappear because there is no control on the turning off of thyristors. This is no longer desirable under the developed grid codes. New grid codes require that the wind farm remains connected to the grid during the voltage dip

New solutions for Low Voltage Ride Through in Wind turbines with DFIG

1. Active Crowbar

In order to remove the crowbar as quickly as possible , the crowbar thyristors are replaced with fully controlable switches, called IGBTs [3]. The stator of the machine is not disconnected from the grid when the crowbar triggers and the crowbar action is disabled as soon as possible so as to retrieve control on the machine. During the crowbar actuation time, the rotor side converter is disabled and there is no control on the generator. When the crowbar is deactivated and the converter restors control, surge current transients may induce and sometimes the crowbar is reactivated.

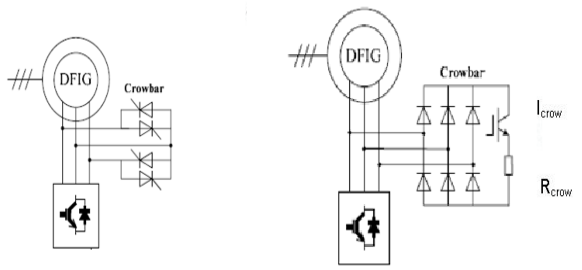

Figure 2. Typical Crowbar circuits. a) antiparallel thyristor crowbar b) diode bridge crowbar

2. Series antiparallel thyristors

In [7] a new LVRT system is suggested. The power rating of the IGBTs in the converter connected to the rotor are dimensioned for higher current ratings, and antiparallel thyristors are placed , like a conventional soft-starter. When high transient currents will as soon as appear in the stator, the grid voltage restors,. This high currents to be controlled with the anti-parallel thyristors by increasing the stator voltage. During normal operation the thyristors are kept on. The problem with this topology is that the efficiency reduces because of the conduction losses in the thyristors during normal operation. This could be avoided by bypassing the thyristors with commutators, with slow switching time of the commutators may , the system may not respond quick enough to a voltage dip. The higher ratings of the IGBT-s will result in increasing the cost of the power converter,

IV. STATIC SERIES COMPENSATOR (SSC)

The crucial solution for a DFIG wind turbine during a voltage dip would be that the wind turbine to be isolated from the voltage dip by a system .This can be done by using a Static Series Compensator (SSC) also called Dynamic Voltage Restorer (DVR) [1]. The SSC consistes of a voltage source converter connected in series on the connection between the grid and the load (in this case the wind turbine), whose voltage sums to the grid voltage to obtain the desired load voltage (Fig. 3). The load in the figure would be either an individual wind turbine or the whole wind farm. Based on the kind of control, the SSC may also mitigate voltage unbalance, regulate the voltage andeliminate low-order harmonics. This type of converter may be installed either individually for each wind turbine or a high power SSC may be installed at the connection of the wind farm to the grid.
The draw backs of this methods is that the additional cost of the incorporated power converters

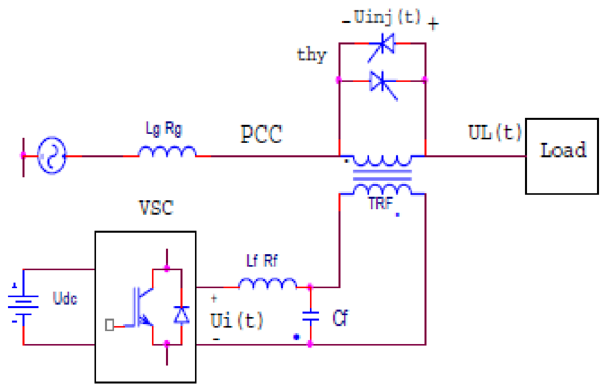

Figure 3. Static Series Compensator

V. STATCOM

There is the possibility of using the grid connected Voltage Source Inverter as a STATCOM. A STATCOM controls the reactive power in the point where it is connected, in order to control the voltage level. The low power rating of the Voltage Source Converter may not contribute to compensate the voltage dip at all, so this is not a viable solution. It could be effective to compensate for voltage unbalances under steady state operating conditions [8], but even then, the stator reactive power control capability is of more importance.

VI. CONCLUSIONS

Low Voltage Ride Through capability for Wind Turbines with DFIG is a problem that all manufacturers must solve. Consequently LVRT systems have already implemented by Most manufacturers while satisfying of the different grid codes has not been totally solved yet.

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New LVRT systems must meet grid codes requirements without compromising the system cost. The solution is the employment of low cost extra hardware (active crowbar) and adjustment of control strategies.

REFERENCES

1. ELTRA, "Specificatons for connecting wind farms to the transmission network", 2000.
2. E.on Netz, "Ergänzede netzansschlussregeln für windenergieanlagen". Technical report E.on Netz, 2001.
3. J. Matevosyan, T. Ackermann, S. Bolik, L.Söder "Comparison of International Regulations for Connection of Wind Turbines to the Network" Nordic Wind Power Conference, 1-2 march, 2004
4. C. Jauch, P. Sørensen, B. Bak-Jensen "International Review of Grid Connection Requirements for Wind Turbines" Nordic Wind Power Conference, 1-2 march, 2004
5. M.H.J. Bollen , G. Olguin, M. Martins, "Voltage Dips at the Terminals of Wind Power Installations" Nordic Wind Power Conference, march 1-2, 2004
6. J. Niiranen "Voltage Dip Ride Through of a doublyfed system" World Wide Energy Conference, 2004
7. T. Thiringer, A. Petersson, T. Petru, "Grid disturbance response of wind turbines equipped with induction generator and doubly-fed induction generator", Power engineering society annual meeting, Toronto, Canada july, 2003
8. J. M. Rodriguez, J. L Fernandez, D. Beato, R. Iturbe, J. Usaola, P. Ledesma, j. R. Wilhelmi, "Incidence on power system dynamics of high penetration of fixed speed and doubly fed wind energy systems: study of the Spanish case", IEEE Trans. in Power Systems., vol. 17,nº 4 pp. 1089–1095, November 2002.

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