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The Requirements and Technical Analysis of Low Voltage Ride Through for the Doubly-Fed Induction Wind Turbines

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Abstract

With the continuing rapid increase of the installed capacity of the wind farms and the construction of the large-scale wind farms, utilities in every country have proposed more strictly grid codes for the wind farms. This paper will make a detailed instruction of the low voltage ride through (LVRT) requirement for the wind farms, based on the rules for the wind farms accessing to the power system. It will also make a comprehensive analysis and comparisons of the technologies to meet the LVRT requirements for the doubly-fed induction generator (DFIG), which is used universally. In the end, it will make an improvement of the technologies and come up with the future research direction.

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1. Introduction

In the past 10 years, the installed capacity of the global wind power maintained a rapid growth momentum. Based on the current trend of accelerated growth, the World Wind Energy Committee have made a prediction: by the end of 2020, the total global installed capacity will be at least 1, 900, 000MW, at the same time, the world's electricity consumption will be 12% from wind power^[1].

As the penetration level increases, grid operators in all regions have put forward higher standards in connecting the wind power with the power system^[2-6], related to active and reactive power capability, voltage operating ranges, low voltage ride through (LVRT), and other aspects of control. The LVRT is considered to be the biggest challenge in wind turbines' design and manufacturing technology^[7]. To enhance the capacity of wind farms' LVRT will definitely increase the cost of wind farm projects. Thus, according to the wind turbines' type, putting forward specific requirement of LVRT in the planning stage

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of wind farm construction has great economic significance [8].

The more common wind turbine implementations are variable speed, for it has the advantages of higher energy capture, less mechanical stress, constant energy output and lower noise, compared with the constant speed turbines. So the mainstream model is based on variable speed constant frequency(VSCF) doubly fed induction control technology wind turbines(DFIG)^[9], This paper will consider such model, according domestic and foreign researches, to discuss its LVRT requirements and technical measures.

2. Grid Codes

All around the world, the grid codes vary in scope and specific details from one jurisdiction to another. In order to regulate wind farms, all areas have developed specifications according to their relevant technical situations. The literatures [5, 6] have given Wind Power grid specifications in Europe and the Americas. The State Grid Corporation of China have established Wind Power System technical requirements(revised) in February, 2009. The main requirements are summarized below:

(i) Active power. It provides a clear requirement that wind farms must have the ability to regulate the active power, and to control their active power output in accordance with the dispatching department directives.

(ii) Reactive power. The wind farms are required, in any way, to guarantee a certain amount of reactive power regulation capacity. The power factor range is typically between 0.9(lag) to 0.98(lead).

(iii) Voltage range. When the voltage of the point of common connecting deviation between -10%+10%, the wind turbines should be able to work properly. The wind farms should be able to control the point's voltage between -3%+7%, within its capacity.

(iv) Frequency operating range. The wind turbines are expected to operate within typical grid frequency variations which the system frequency varies from 49.5 to 50.5HZ.

(v) Low Voltage Ride Through (LVRT). In the event of a voltage drop, the turbines are required to remain connected for a specific amount of time before being allowed to disconnect. This requirement is to ensure that there is no loss of generation for normally cleared faults. Disconnecting a wind generator too quickly could have a negative impact on the grid, particularly with large wind farms.

3. LVRT Requirements

The most representative LVRT requirement was proposed in Europe in 2003 by E. On, (Fig.1). Since then, many jurisdictions have proposed their own version of the LVRT curve, the one applied in China is illustrated in Fig.2.

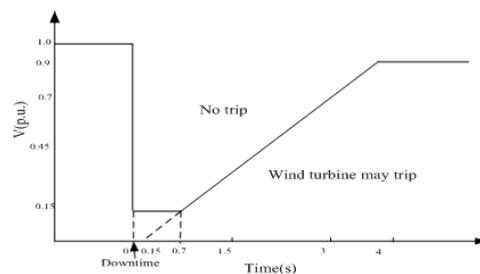


Fig. 1. E.On low voltage ride through requirement

The key basis for putting forward the LVRT requirement is the specific characteristics and configurations of the grid, which is the wind farms connecting with. In addition, the capacity of wind

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