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Improving low voltage ride-through capabilities for grid connected wind turbine generator

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Abstract

Low Voltage Ride-Through (LVRT) is one of the most dominant grid connection requirements to be met by Wind Energy Conversion Systems (WECS). In presence of grid voltage dips, a mismatch is produced between the generated active power and the active power delivered to the grid. Low voltage ride through requirement demands management of this mismatch, which is a challenge for the WECS. In this paper, LVRT requirements provided by Wind Grid Codes have been reviewed. This paper discusses the standards for interconnection of wind generators to local grid during healthy and fault conditions. As per LVRT requirement, during dip occurrence, the wind power generation plant must remain connected to the grid and in addition, it has to deliver reactive power into the grid to aid the utility to hold the grid voltage. Voltage sag proves to be the most prominent power quality issue and the effect of voltage sag on different wind generator topologies has been investigated. Several methods for LVRT fulfillment have been explored and the LVRT scheme has been validated based on MATLAB-SIMULINK simulation.

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1. Introduction

With increasing wind power penetration, the simultaneous disconnection of a significant percentage of generating capacity can have a profound effect on the stability of the grid. As the wind power plants increase in size, they are required to stay operational and not disconnect from the grid; supporting the grid with reactive power during voltage

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sags. Such requirements are known as Fault Ride-Through (FRT) or Low Voltage Ride-Through (LVRT) capability[1].

Nomenclature

DFIG	doubly fed induction generator
ESS	energy storage system
FRT	fault ride through
HCS	hill climb search
IWGC	Indian wind grid code
LVRT	low voltage ride through
PMSG	permanent magnet synchronous generator
PCC	point of common coupling
SCC	short circuit capacity
SCIG	squirrel cage induction generator
SCR	short circuit ratio
TSR	tip speed ratio
WECS	wind energy conversion system
WTG	wind turbine generator

LVRT fulfillment is required by the wind generators when the voltage in the grid is temporarily reduced due to a fault or large load change in the grid. The required LVRT behavior is defined in grid codes issued by the grid operators in order to maintain system stability, thereby reducing the risk of voltage collapse. The grid codes were originally developed considering the synchronous generator generally used in conventional power plants, whereas Wind Turbine Generators (WTG) have different characteristics as compared to conventional power plants. As per Indian Wind Grid Code (IWGC), wind farms connected to 66kV and above shall have the operating region as shown in figure during system faults. Wind farms can be disconnected if the operating point falls below the line in Fig. 1.

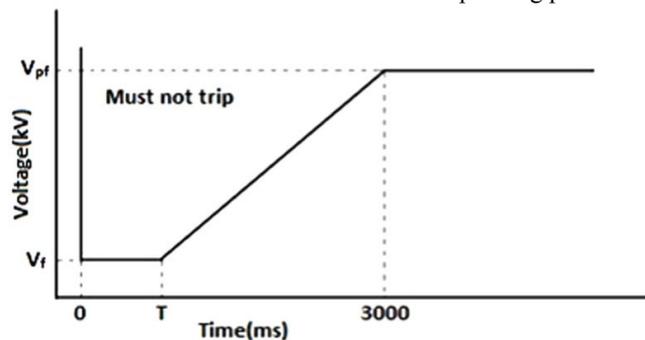


Fig. 1. Fault ride through characteristics.

Where,

V_f is 15% of nominal system voltage,

V_{pf} is minimum voltage mentioned in IWGC[2].

When a grid voltage dip appears, LVRT requirements demand the following conditions from power-generation plant:

- To remain connected to the grid, if line voltage is above the limit curve in Fig. 1 and
- To support the system during fault condition by injecting reactive power.

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