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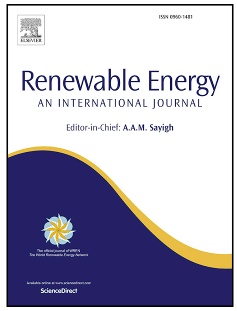

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Modeling of Complete Fault Ride-Through Processes for DFIG-Based Wind Turbines

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Abstract

Due to increasing penetration of wind power, post-fault power recovery behaviours of wind turbines could have significant effect on power system stability. To address this issue, a novel model representing the complete fault ride-through processes is proposed considering power recovery behaviours of doubly-fed induction generator wind turbines in this paper. The control strategies of active and reactive power during the fault ride-through are formulated, and controllers for grid- and rotor-side converters are designed. The proposed model is verified by simulation and field testing using wind turbines operating in wind farms.

Key words: Doubly-fed induction generator; wind turbines; dynamic model; fault ride-through; power recovery

Nomenclature

ρ	Air density (kg/m^3)	ξ, η	Coefficients
C_{p_opt}	Optimal power coefficient	k_q	Reactive current coefficients
R_w	Rotor radius (m)	$(\cdot)_e$	Electromagnetic
υ_w	Wind speed (m/s)	$(\cdot)^*$	Reference
ω_{rated}	Rated stator angular frequency (rad/s)	$(\cdot)_s$	Stator side
P_{rated}	Rated power of wind turbine (MW)	$(\cdot)_r$	Rotor and
P_{opt}	Optimal output power	$(\cdot)_g$	Grid side
i	Current	$(\cdot)_d$	d axis
u	Voltage	$(\cdot)_q$	q axis
P	Active power	$(\cdot)_{set}$	Pre-set value
Q	Reactive power	$(\cdot)_{fault}$	During the fault time
ψ	Flux	$(\cdot)_{clock}$	Current time
ω_1	Synchronous speed	$(\cdot)_{re}$	During the recovery time
R, L	Resistance and inductance	$(\cdot)_{normal}$	During the normal operation
C	Capacitance	$(\cdot)_Q$	Reactive power component
U_{dc}	DC-link voltage	$(\cdot)_{max}$	Maximum
k	Ramp rate	$(\cdot)_{min}$	Minimum
k_p	Proportional coefficients	$(\cdot)_n$	Norminal
k_i	Integral coefficients	$p(\cdot)$	Derivative to time
F	Error	$(\cdot)_{init}$	Initial

1. Introduction

With environmental concern of burning fossil fuels for power generation, renewable generation technologies have been significantly advanced worldwide. It is recognized that high penetration of grid-connected renewable energy sources such as wind power generators can have significant influence on security and stability of power grid. As a dominant type of wind turbines, doubly-fed induction generator (DFIG) wind turbines have been widely used in wind farms [1]. Therefore, developing effective DFIG-based wind turbine models is critical for power system dynamic studies [2-4].

During past few decades, modeling of DFIG-based wind turbines, particularly their control schemes, were reported [5-6]. Mathematical models of the induction generator, rotor- and grid-side converters using vector control algorithms were

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