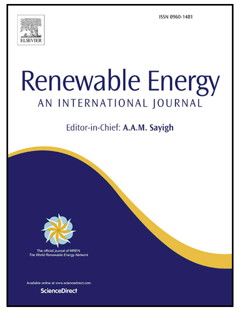

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High Efficiency Control Strategy in a Wind Energy Conversion System with Doubly Fed Induction Generator

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***Abstract*--This paper presents a high efficiency control strategy for a wind energy conversion system (WECS) with doubly fed induction generator (DFIG). The proposed control scheme provides power loss reduction for the DFIG and maximum power point tracking (MPPT) for the wind turbine. Therefore, increased electric energy production from the same wind energy potential can be attained. Moreover, the cut-in wind speed is reduced and thereby, extension of the exploitable wind speed region is accomplished. The high efficiency in the DFIG is attained through the stator frequency and magnetic-flux weakening control, and the maximum harvesting in the turbine is accomplished by properly controlling the turbine speed. The proposed control system can be easily implemented, since the controller parameters are determined experimentally and thus, the knowledge of the wind system model is not required. Moreover, for the implementation of the proposed control scheme, a converter system of low power requirements is used, as holds in the conventional system, and thus, this advantage of the WECS with DFIG against other electrical generator types is still valid. The efficiency improvement of the proposed control scheme has been experimentally validated in a laboratory low power scaling emulation WECS with DFIG.**

***Index Terms*-- Wind system, wind energy, high efficiency, doubly fed induction generator, loss reduction.**

NOMENCLATURE

i_{ds} , i_{qs}	*d*- and *q*-axis components of the DFIG stator current, respectively,
i_s , i_G	stator and grid current, respectively,
i_{dr} , i_{rs}	*d*- and *q*-axis components of the DFIG rotor current, respectively,
u_{ds} , u_{qs}	*d*- and *q*-axis components of the DFIG stator voltage, respectively,
i_{dc_r} , u_{dc_r}	dc-link current and voltage at the DFIG rotor side, respectively,
L_m	magnetizing inductance of the DFIG,
R_s , R_r	stator and rotor resistances of the DFIG, respectively,
ψ_m	air-gap flux-linkage of the DFIG,
ψ_{ds} , ψ_{qs}	*d*- and *q*-axis components of stator flux-linkage of the DFIG, respectively,
ψ_{dr} , ψ_{qr}	*d*- and *q*-axis components of rotor flux-linkage of the DFIG, respectively,
p	number of pole pairs,
P_l	DFIG power loss,
P_s , P_r	power provided by the stator and rotor side of the DFIG, respectively,
P_G	electrical power injected to the grid,
Q_s , Q_r	stator and rotor reactive power of the DFIG, respectively,
P_w	wind power,
C_p	wind turbine power coefficient,
λ	tip-speed ratio of the wind turbine,
u	wind speed in m/s,
n	gear ratio,
R	turbine blades radius,
ω_e	stator frequency of the DFIG (in rad/s),
ω_G	grid frequency (in rad/s)
ω_r	electrical rotor angular velocity of the DFIG,
ω_{wt}	turbine shaft angular velocity,
ω_m	mechanical angular velocity of the DFIG,
T_{wt}	torque produced by the wind turbine,
T_m	torque at the generator shaft,
T_{m_l}	mechanical loss torque,

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