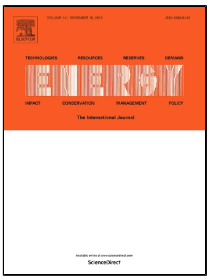
Accepted Manuscript



An Experimental Study on the Aerodynamic Performances and Wake Characteristics of an Innovative Dual-Rotor Wind Turbine

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PII:	S0360-5442(18)30020-3
DOI:	10.1016/j.energy.2018.01.020
Reference:	EGY 12132
To appear in:	*Energy*
Received Date:	14 September 2017
Revised Date:	01 December 2017
Accepted Date:	02 January 2018

Please cite this article as: Zhenyu Wang, Ahmet Ozbay, Wei Tian, Hui Hu, An Experimental Study on the Aerodynamic Performances and Wake Characteristics of an Innovative Dual-Rotor Wind Turbine, *Energy* (2018), doi: 10.1016/j.energy.2018.01.020

A revised manuscript submitted to "Energy" for publication (Ms. Ref. No.: EGY-D-17-04717R1)

An Experimental Study on the Aerodynamic Performances and Wake Characteristics of an Innovative Dual-Rotor Wind Turbine

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Highlights:

- Dual-Rotor Wind Turbine concept is developed to reduce root losses and wake losses
- Power outputs increased by 7.2% and 1.8% for CR-DRWT and CO-DRWT designs
- Downstream turbines in the CR-DRWT wake has 15.4% power increase by reducing wake loss.

Abstract

A novel dual-rotor wind turbine (DRWT) concept with an auxiliary upwind rotor and a bigger downwind rotor was introduced for improved turbine performance. An experimental study was performed in an Atmospheric Boundary Layer (ABL) wind tunnel with scaled turbine models to investigate the aerodynamic performances and wake characteristics of DRWTs in either co-rotating or counter-rotating configuration (i.e., CR-DRWT or CO-DRWT), in comparison to those of a conventional single-rotor wind turbine (SRWT). In additional to measuring the aerodynamic forces and power outputs, the wake flow characteristics behind DRWTs and SRWT were also quantified by using a high-resolution Particle Velocimetry (PIV) system. In comparison to those of SRWT, while the aerodynamic force acting on the CR-DRWT was found to increase 13.3%, the power coefficient of the CR-DRWT design was improved by 7.2%. Faster wake recovery behind the DRWT designs was confirmed from both the measured power outputs of the same turbine model sited in the turbine wakes and the measured flow velocity at various downstream locations. The wake flow measurements were corelated with the aerodynamic force and power output data to elucidate underlying physics for the higher efficiency of DRWT designs in either isolation or wind farm settings.

Keywords: **Horizontal-axis wind turbine (HAWT), Dual-rotor wind turbine (DRWT), Wake characteristics, Particle image velocimetry (PIV) measurements, Aerodynamics forces, Power outputs**

Nomenclature

A	=	Area of blade rotational disk [m^2]
C_M	=	Bending moment coefficient [-]
C_P	=	Power coefficient [-]
C_T	=	Thrust coefficient [-]
d	=	Diameter of the auxiliary rotor [m]
D	=	Diameter of the main rotor [m]
H	=	Turbine hub height [m]
I_u	=	Turbulence intensity [-]
P	=	Power output [W]
TSR	=	Tip-speed-ratio [-]
U_H	=	Freestream velocity at turbine hub height [m/s]

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