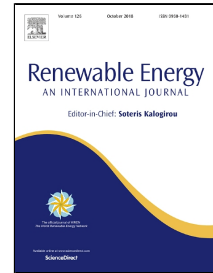


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Active Control of Wind Turbines Through Varying Blade Tip Sweep

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ABSTRACT

In this research work an introduction to the concept of an actively controlled horizontal axis wind turbine through varying blade tip sweep, is presented. The concept refers to variable tip swept rotor blades, that have the ability to pivot collectively aft, about an axis located at the blade tips. Quantities to be controlled are power production and blade loads. The investigation is carried out with a modified Blade Element Momentum (BEM) model that takes into account variable tip swept rotor blades and the modifications are based on results from a lifting line theory based model. The simulations refer to the 5MW NREL reference wind turbine that incorporates a suitable controller and preliminary results show beneficial behaviour in all of the investigated areas.

Keywords – Active Control, Swept Blades, Unsteady Lifting Line Theory, Blade Element Momentum Theory

Abbreviations:

AEP: Annual Energy Production

AOA: Angle Of Attack

BEM: Blade Element Momentum (Theory)

CFD: Computational Fluid Dynamics

CUDA: Compute Unified Device Architecture

DEL: Damage Equivalent Load

DU_SWAMP: Delft University Smart Wind turbine Aeroelastic Modular Processing (model)

ECN: Energy research Centre of the Netherlands

EOG: Extreme Operating Gust

IEC: International Electrotechnical Commission

MW: Megawatt

NREL: National Renewable Energy Laboratory

STAR: Swept Twist Adaptive Rotor

TE: Trailing Edge

TurbSim: Turbulence Simulator

ULL: Unsteady Lifting Line (Theory)

List of Symbols:

A: cross section area – rotor swept area

$A_{mp(x)_s}$: amplitude of a wind turbine parameter due to the harmonic sweeping motion of the blade tip

ai: axial induction factor

C_L : Lift coefficient

C_{Lsw} : Lift coefficient of a swept wing

C_p : power coefficient

$Circ_{diff}$: bound circulation difference between adjacent blade elements

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