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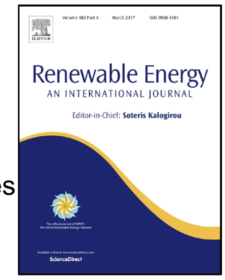

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THE INFLUENCE OF TURBULENCE MODEL AND TWO AND THREE-DIMENSIONAL DOMAIN SELECTION ON THE SIMULATED PERFORMANCE CHARACTERISTICS OF VERTICAL AXIS TIDAL TURBINES

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ABSTRACT: The influence of Computational Fluid Dynamics (CFD) modeling techniques on the accuracy of fixed pitch vertical axis turbine power output predictions was investigated. Using Two-Dimensional (2D) and Three-Dimensional (3D) models, as well as the Baseline-Reynolds Stress Models (BSL-RSM) model and the *k-ω* Shear Stress Transport (*k-ω* SST) model in its fully turbulent and laminar-to-turbulent formulation, differences in power output modeling accuracy were evaluated against experimental results from literature. The highest correlation was found using a 3D domain model that fully resolved the boundary layer combined with the *k-ω* SST laminar-to-turbulent model. The turbulent 3D fully resolved boundary layer *k-ω* SST model also accurately predicted power output for most rotational rates, at a significantly reduced computational cost when compared to its laminar-to-turbulent formulation. The 3D fully resolved BSL-RSM model and 3D wall function boundary layer *k-ω* SST model were found to poorly simulate power output. Poor output predictions were also obtained using 2D domain *k-ω* SST models, as they were unable to account for blade tip and strut effects. The authors suggest that 3D domain fully turbulent *k-ω* SST models with fully resolved boundary layer meshes are used for predicting turbine power output given their accuracy and computational efficiency.

Keywords: Vertical Axis Turbine, Computational Fluid Dynamics, Turbulence Model, Computational Domain, Laminar-to-Turbulent Transition

Highlights:

- 2D CFD models cannot capture blade tip and strut effects resulting in poor power output simulation accuracy
- 3D CFD models can now accurately capture turbine power output without excessive computation requirements
- The *k-ω* SST turbulence models provide the closest agreement with experimental results
- Transition flow modeling is computationally demanding and only increases simulation accuracy at high rotational rates when compared to fully turbulent models
- BSL-RSM and *k-ω* SST Wall Function models poorly simulate power output