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Numerical Simulations and Experimental Measurements of Scale-Model Horizontal Axis Hydrokinetic Turbines (HAHT) Arrays[1] TEYMOUR JAVAHERCHI, NICK STELZENMULLER, University of Washington, JOSEPH SEYDEL, Boeing, ALBERTO ALISEDA, University of Washington —
The performance, turbulent wake evolution and interaction of multiple Horizontal Axis Hydrokinetic Turbines (HAHT) is analyzed in a 45:1 scale model setup. We combine experimental measurements with different RANS-based computational simulations that model the turbines with sliding-mesh, rotating reference frame and blame element theory strategies. The influence of array spacing and Tip Speed Ratio on performance and wake velocity structure is investigated in three different array configurations: Two coaxial turbines at different downstream spacing (5d to 14d), Three coaxial turbines with 5d and 7d downstream spacing, and Three turbines with lateral offset (0.5d) and downstream spacing (5d & 7d). Comparison with experimental measurements provides insights into the dynamics of HAHT arrays, and by extension to closely packed HAWT arrays. The experimental validation process also highlights the influence of the closure model used (k-ω SST and k-ϵ) and the flow Reynolds number (Re=40,000 to 100,000) on the computational predictions of devices' performance and characteristics of the flow field inside the above-mentioned arrays, establishing the strengths and limitations of existing numerical models for use in industrially-relevant settings (computational cost and time).

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