New Energy’s Hydrokinetic River Turbine’s Power Generation During Turbulent Flows
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Objective
Use data from Tanana river test site in Alaska to determine the effect of turbulence on hydrokinetic river turbine energy production.

Introduction

Tanana River Test Site
Location accurately represents Alaska rivers due to:
• Large frequency of debris
• Sediment laden

ADCP Data Requirements:

Turbulence Tilt Corrections Equation:

\[ \theta = \tan^{-1} \left( \frac{w'}{u} \right) \]

\[ w' = -u \cdot \sin \theta + w \cdot \cos \theta \]

\[ u_h = u \cdot \sin \theta + w \cdot \cos \theta \]

\[ \varphi = \tan^{-1} \left( \frac{v'}{u_h} \right) \]

\[ v' = -u_h \cdot \sin \varphi + v \cdot \cos \varphi \]

\[ u_{tc} = u_h \cdot \sin \varphi + v \cdot \cos \varphi \]

\[ v' = u_{tc} \cdot \sin \varphi - v \cdot \cos \varphi \]

\[ \varphi = \tan^{-1} \left( \frac{v'}{u_{tc}} \right) \]

Kinetic Power

\[ \frac{p}{A} = \frac{1}{2} \rho V^3 \]

\[ V = \sqrt{u^2 + v^2 + w^2} \]

Experimental Setup

Computational Setup

Variable | Definition
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\( \theta \) | Horizontal tilt correction
\( u \) | North Velocity
\( w \) | East Velocity
\( v \) | Vertical Velocity
\( \varphi \) | Vertical tilt correction
\( p \) | Power
\( A \) | Area
\( \rho \) | Density of Water

Min: 0
Mean: 2494 W/m²
Max: 26922 W/m²

Min: 9.5 W/m²
Mean: 98.7 W/m²
Max: 7257 W/m²

On average 40% of fluid flow is turbulent contributing to 6% of the available power in the river.

Future Work
• Compare voltage/current data from the turbine to available power.
• Investigate the shear force produced by the turbulence.
• Compare the effect of different axes orientations on turbine efficiency.
• Calculate turbulence spectrum and analyze the turbine dynamics.
• Process the ADV data.
• Collect more voltage and structural health data on the turbines.

Acknowledgments/References
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Results

Prior Work

Test site is located between transects 440 and 800