Reference Model #1 – Tidal Energy: Resource

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Introduction

Reference Model #1 is a tidal turbine operating in a narrow, tidal channel. The site is a generalized version of Tacoma Narrows, Puget Sound, Washington. The resource is a mixed, mainly semidiurnal tidal regime with two ebbs and floods each day of unequal strength (i.e., a diurnal inequality in which a strong ebb/flood exchange is followed by a weak exchange). The diurnal inequalities provide extended windows of weak currents for device installation and maintenance activities relative to a purely semidiurnal tidal regime, though at the expense of reduced generation potential for equivalent peak currents.

Doppler profiler data from Puget Sound are used to construct a reference tidal resource (i.e., a generic mixed, mainly semidiurnal tidal regime). After Polagye and Thomson (*submitted*), currents measured by a Doppler profiler ($\boldsymbol{U}_{sample}$) may be conceptually partitioned into deterministic ($\boldsymbol{U}_{\mathbf{det}}$), meteorological ($\boldsymbol{U}_{\mathbf{met}}$), and turbulent ($\boldsymbol{U}_{\mathbf{turb}}$) components, as well as Doppler uncertainty (n_{sample}) (Brumley et al. 1991).

$$U_{\mathbf{sample}} = U_{\mathrm{det}} + U_{\mathbf{met}} + U_{\mathbf{turb}} \pm n_{\mathbf{sample}}. \quad (1.1)$$

each of which are further subdivided. The deterministic currents include harmonic currents, described by harmonic constituents, as well as the aharmonic response to these currents induced by local topography and bathymetry. Aharmonic currents are not described by tidal constituents, but are repeatable, site-specific flow features. Meteorological currents include wave- and wind-induced motion, residual currents associated with estuarine stratification, and storm surges. Turbulent currents include large-scale, horizontal eddies and small-scale, isotropic turbulence.

In order to evaluate device performance, a generalized probability distribution and vertical profile for current speeds in a mixed, mainly semidiurnal tidal regime is required. Once the distribution of velocities is known, leading-order device performance may be evaluated based on the device operating parameters at each point on the distribution. These parameters include cut-in speed, rated speed, and power conversion efficiency.