Site Modeling for Tidal Turbines

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Overview

- Tidal hydrokinetic energy is the placement of turbines in strong currents to capture kinetic energy and make clean, renewable energy
- High predictable
- Located in an area with a large population

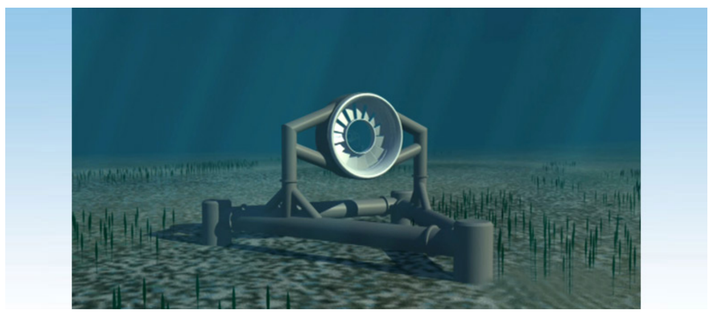

Figure 1: *Turbine Design for Pilot Project, Open Hydro [1]*

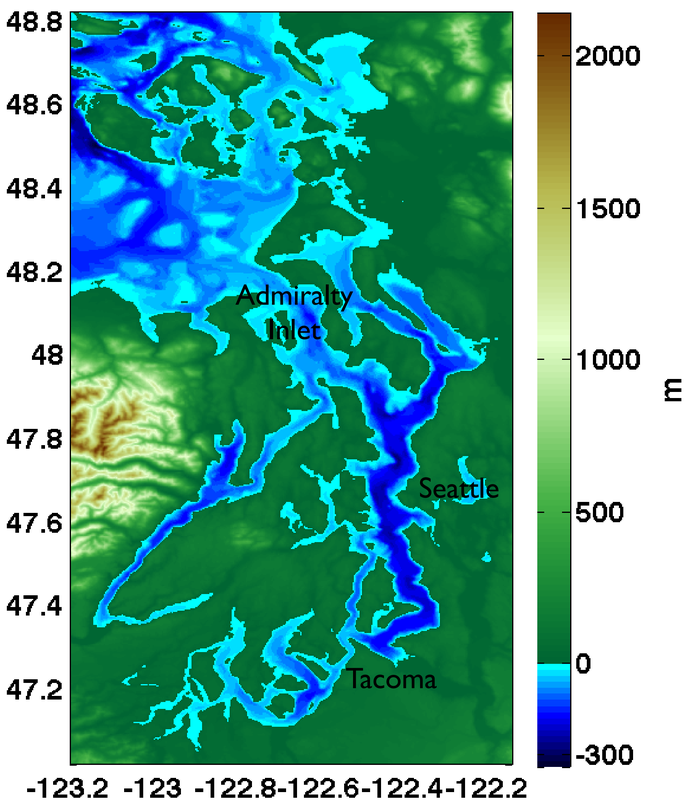

Figure 2: *Puget Sound*

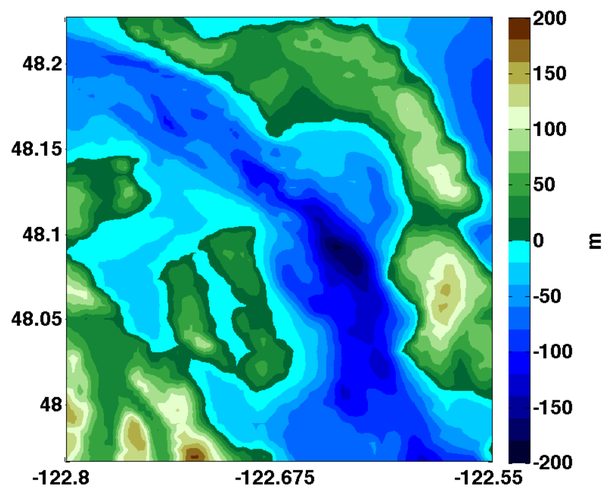

Figure 3: *Admiralty Inlet, Tidal Energy Development Area of Interest*

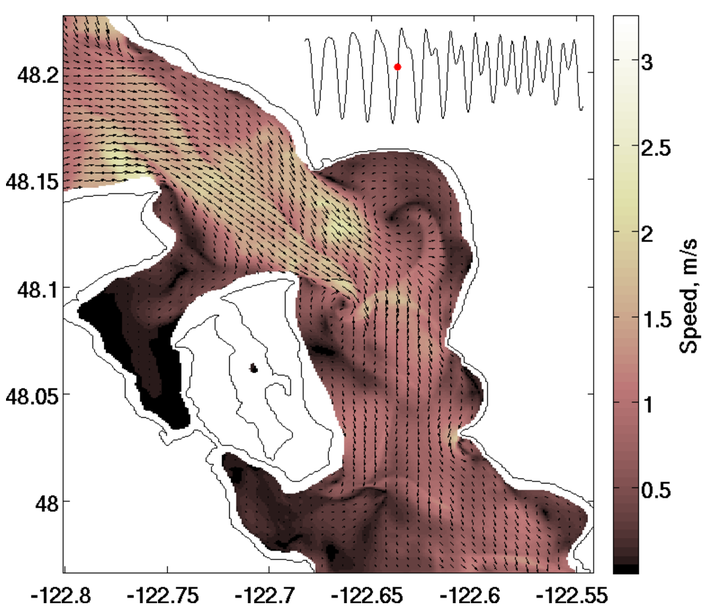

Figure 4: *Snapshot of Speed at Peak Flood*

Metrics and Results

- Summarize complex flow field information to inform turbine siting
- Building on previous work at the UW [2] [3]
- Look at metrics summarizing:
  - Quantification of resource
    - Mean speed
    - Mean kinetic power density
    - Turbine operation time
    - Power available given turbine properties
  - Qualification of resource
    - Bidirectionality
    - Power bias
  - Turbine survivability and efficiency
    - Vertical velocity
    - Shear
    - Turbulence

$\Rightarrow$ We want to know where these occur and why
$\Rightarrow$ Use a numerical model to help answer these questions

Mean Kinetic Power Density

MKPD $= \frac{1}{2}\rho s^3$, gives a measure of the available resource

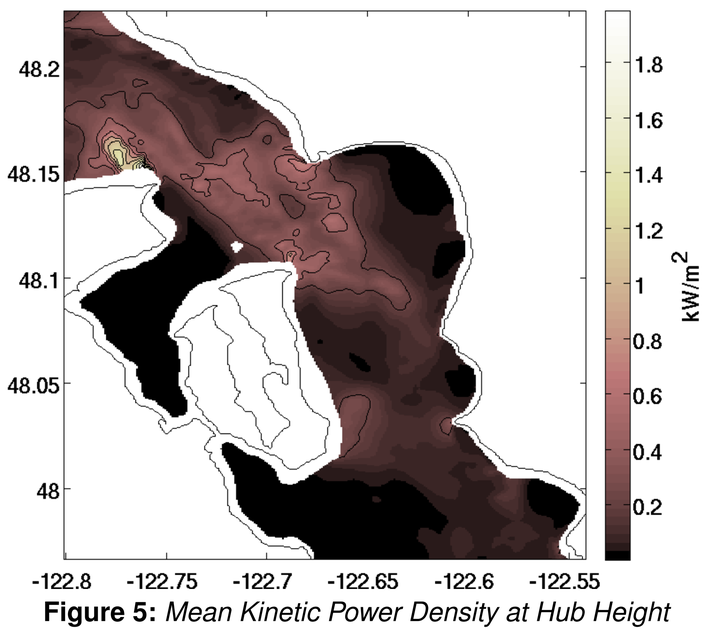

Figure 5: *Mean Kinetic Power Density at Hub Height*

Tidal Directionality

May matter for fixed-axis turbines that cannot turn with the tidal currents.

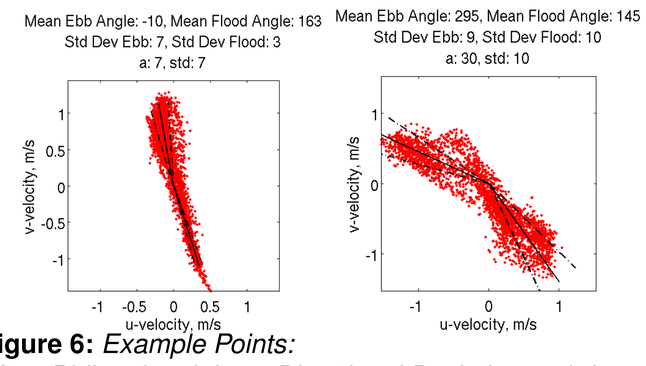

Figure 6: *Example Points: More Bidirectional, Less Directional Deviation on left; Less Bidirectional, More Directional Deviation on right*

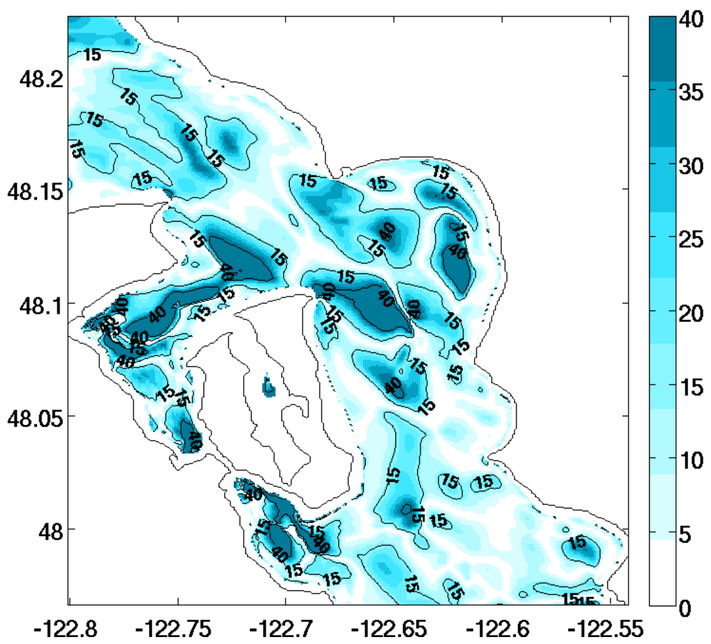

Figure 7: *Bidirectionality at Hub Height*

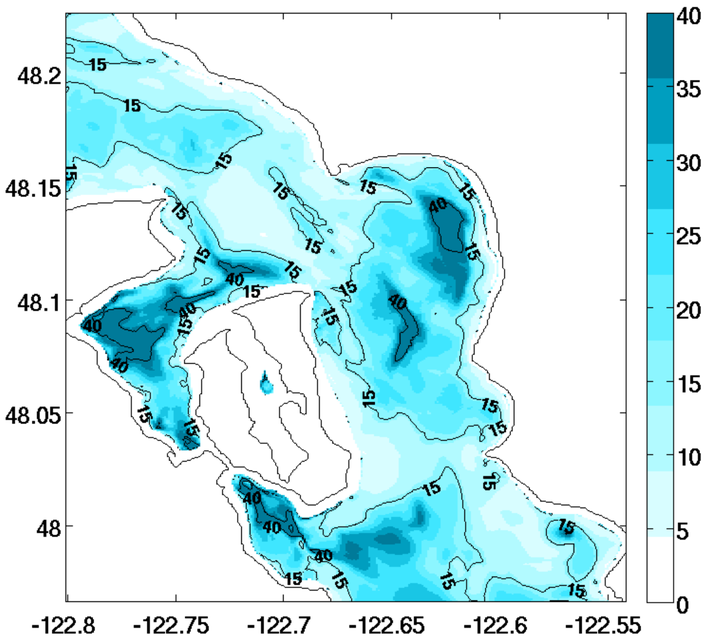

Figure 8: *Directional Deviation at Hub Height*

Mean Turbulent Kinetic Energy

A measure of small-scale, high energy flow motions that could fatigue turbines prematurely.

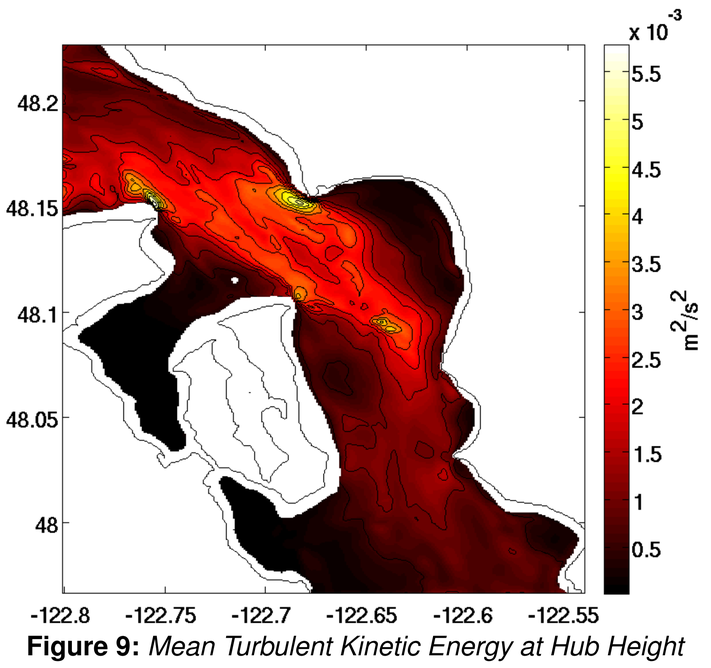

Figure 9: *Mean Turbulent Kinetic Energy at Hub Height*

Overlaid Metrics for Micrositing

Choose moderate values for each metric, then combine them all to find the resultant "best" turbine siting location.

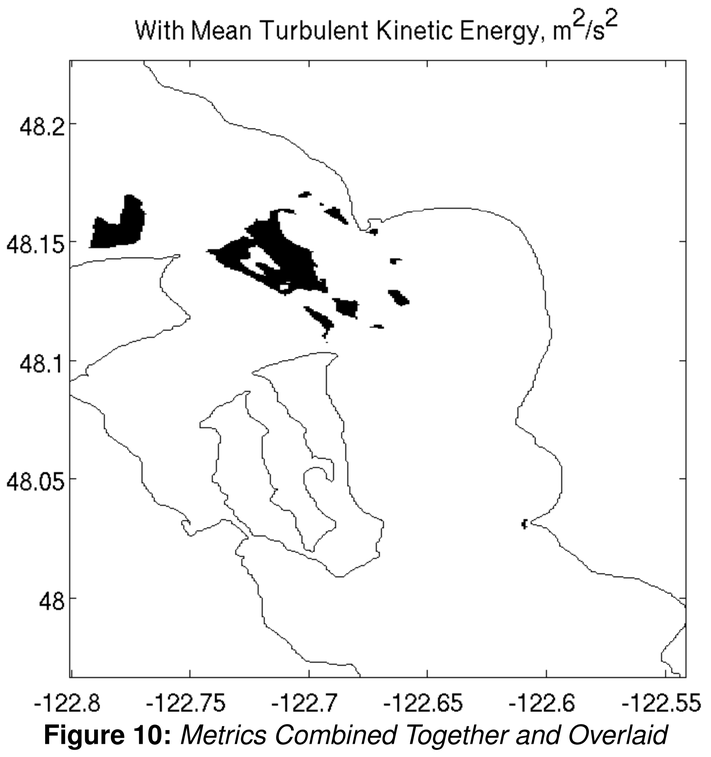

Figure 10: *Metrics Combined Together and Overlaid*

References

[1] Open Hydro. http://www.openhydro.com, October 2010.

[2] S. Gooch, J. Thomson, B. Polagye, and D. Meggitt. Site characterization for tidal power.

[3] B. Polagye. Tidal energy characterization for Admiralty Inlet, Puget Sound, US. *In preparation*, pages 1–15, Aug 2010.