Appendix C – Assessment of Tidal Energy Resources in Puget Sound and Wave Energy Resources in Grays Harbor, Washington

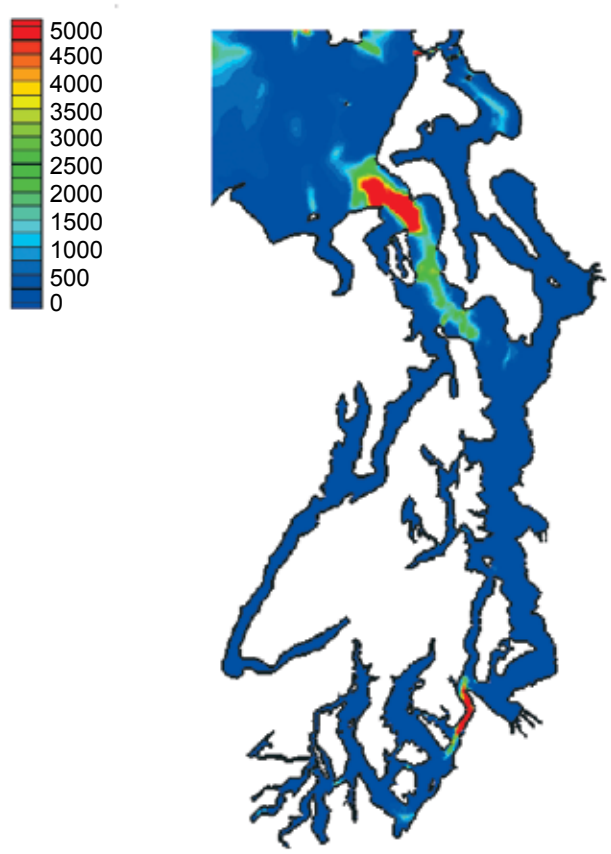
On behalf of Seattle City Light, Coast & Harbor Engineering (CHE) conducted a preliminarily assessment of available tidal energy power at specific sites in the Puget Sound area, and wave energy power at the open coast at Grays Harbor, Washington.

Tidal power estimates were conducted using results of preliminary numerical modeling and methodology developed for Tacoma PUD. Wave power estimates were conducted based on a compilation of data from NOAA buoys, processing of the data, statistical analysis, and limited numerical modeling.

Tidal Power Potential Sites

Potential sites for tidal power estimates were determined based on conceptual numerical modeling of tidal flow circulation in Puget Sound, using a 3-Dimensional SELFE tidal flow circulation model.

Based on numerical modeling results and using CHE methodology, computations of tidal energy density in the Puget Sound area were performed, based on depth-averaged velocities. Results of computed energy density in the Puget Sound area are shown below. The red color indicates an area with a higher density of tidal flow energy, while blue color indicates an area with a lower density.



Graph: Results of computed energy density in Puget Sound area

Modeling was conducted for a three-day period. Based on analysis of modeling results, seven areas with relatively high tidal flow energy were identified:

- Tacoma Narrows
- Admiralty Inlet
- Rosario Strait
- Deception Pass
- Port Washington Narrows
- Agate Passage
- Rich Passage

Federal Energy Regulatory Commission (FERC) licenses to Tacoma PUD and Snohomish County PUD cover most of the areas with high density tidal energy at five sites: Tacoma Narrows, Admiralty Inlet, Deception Pass, Agate Passage, and Rich Passage. The remaining two sites, Rosario Strait and Port Washington Narrows, were selected for further analysis and evaluation of tidal power:

Based on the previous Tacoma Narrows study it was found that maximum effectiveness of existing turbines does not exceed 20%. This study also has revealed that available turbine diameters are in the range of 3-7 meters. Assuming a 5.5-meter diameter turbine and effectiveness of 18%, total yearly power produced by this turbine in the most energetic area of Rosario Strait is estimated to be approximately 400,000 kWh/year. The same turbine, placed in the most energetic area of Tacoma Narrows, would produce energy equal to 430,000 kWh/year.

The Tacoma Narrows feasibility study included an economic analysis of deploying the turbine to extract tidal power. The study concluded that at present, there is no available technology that can economically extract tidal power for the Tacoma Narrows area. Power densities at Rosario Strait and Washington Narrows are smaller than in Tacoma Narrows, and conclusions from the Tacoma Narrows study likely apply to the Rosario Strait and Washington Narrows areas.

In summary, available tidal power in Rosario Straight and Washington Narrows is not sufficient for industrial production of energy using existing tidal power extraction technologies.

Wave Energy, Grays Harbor Estuary

Summarizing the analysis of wave energy at the entrance to the Grays Harbor estuary, the following is concluded:

- In general, offshore of the entrance to the Grays Harbor estuary is quite energetic. The annual average wave energy flux per linear meter of wave crest is estimated to be approximately 29 kW/m of wave crest at the 38-meter depth contour. This corresponds to energy of 254,900 kWh/year per linear meter of shoreline along the coastline.
- The wave energy is highly time variable. During low wave energy periods, wave energy flux does not exceed 2-5 kW/m. Periods of low wave energy may last for several months per year.
- For the deepwater areas and before wave breaking depth, wave energy is concentrated in the upper column of the water. At Grays Harbor entrance at depth 38 meters and deeper, most of the wave energy is concentrated in the upper 7-9 meters of water column. It is unlikely to be economical to extract the energy below this elevation.
- Wave energy is reduced by propagation toward the shoreline.

Selection and analysis of a wave energy extraction device was not in the scope of this current study. The following criteria are recommended to consider in evaluation of possible wave energy extraction devices in the future:

- The device should be capable effectively extracting wave energy from the upper column of the water. There are no benefits of device extending through the entire water column.
- The device shall extract wave energy from a large surface area. The area of the device should be compatible with typical wave length, 100-300 meters and larger.
- The device should operate at deepwater, at depths deeper than 30 meters.