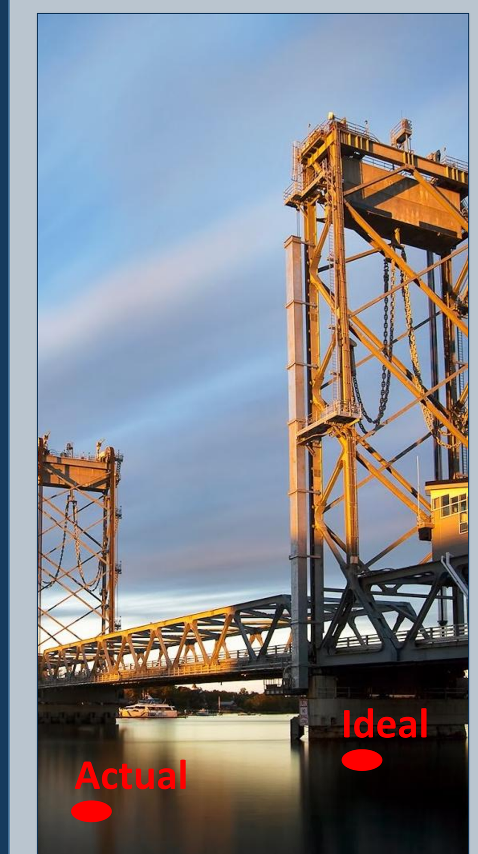
Memorial Bridge Hydrokinetic Power Generation

The Living Bridge: Bringing STEM to the Public

By: Hayden Hicks & Joel Griffith



1a. Data Acquisition

LOCATION: Ideally the data acquisition would occur directly on the NH side of the LB pier, but due to restrictions at time of equipment deployment, the actual assessment location was slightly further from the pier than desired. The ideal location vs. the Actual location is shown in the *figure to the left.*

EQUIPMENT:
- Acoustic Doppler Current Profiler (ADCP)
- Auxiliary Batteries
- Steel Frame
- 9 Lead bricks
- Gulf Challenger

ASSESMENT PERIOD:
Oct. 24th – Feb. 24th

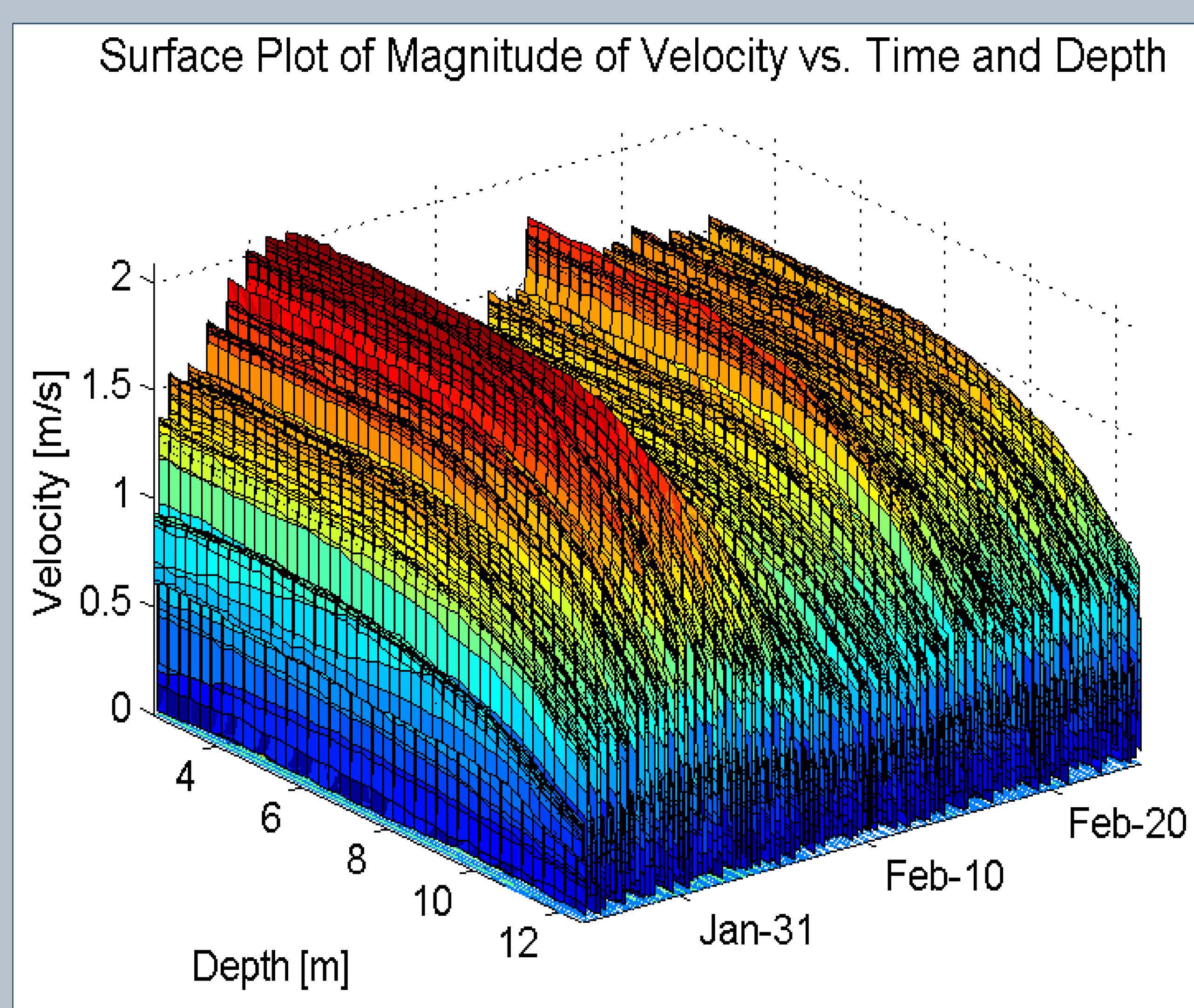
The ADCP is the device which acquires tidal current data.

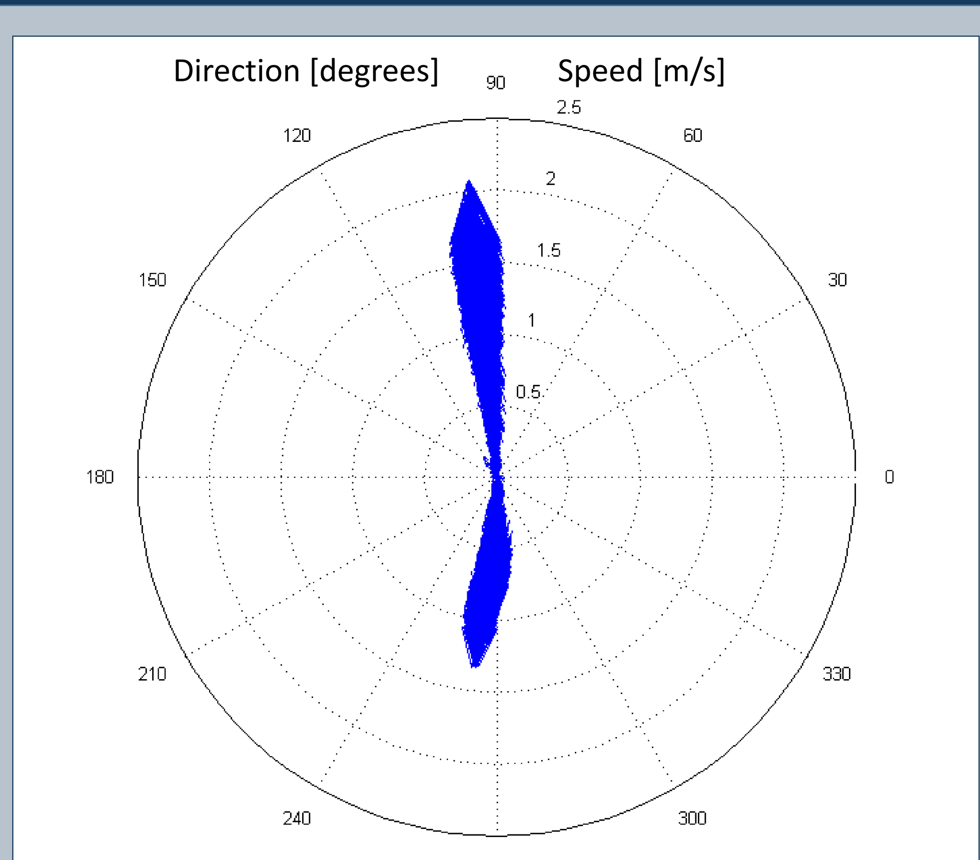
1b. Initial Data Analysis

Tidal current data is measured at 0.25 m increments for the depth of the assessment location. Measurements at each depth include:

- Tidal Current Velocity
- Flow Direction
- Temperature

The roll, pitch, and yaw of the ADCP are also recorded over the duration of the assessment. These are recorded to validate that the equipment is properly oriented and set-up to accurately acquire data.





1c. Flow Characteristics

At a representative depth of 7 meters from the bottom of the river, it is discovered that the speed of the tidal currents is larger for ebb tides than for flood tides. It is also discovered that the current does not switch direction by 180 degrees for ebb and flood tides. Which is dissimilar to the flow directions at the bottom of the river that have a 180 degree switch for the ebb and flood tides from 90 to 270 respectively.

PROJECT DESCRIPTION

A *detailed tidal resource assessment* is performed to investigate the tidal energy potential of the Piscataqua River at the Memorial Bridge located between New Hampshire and Maine. With an understanding of the *site-specific* tidal resource, an estimate will be made regarding the size and type of tidal turbine necessary to harness the clean, predictable, and renewable energy use in *powering sensors, systems, and lighting at the Memorial Bridge.*

PROJECT GOAL & OBJECTIVES

PROJECT GOAL: Perform a site-specific tidal resource assessment to aid in the selection of a hydrokinetic power generation device for the Living-Memorial Bridge (LB).

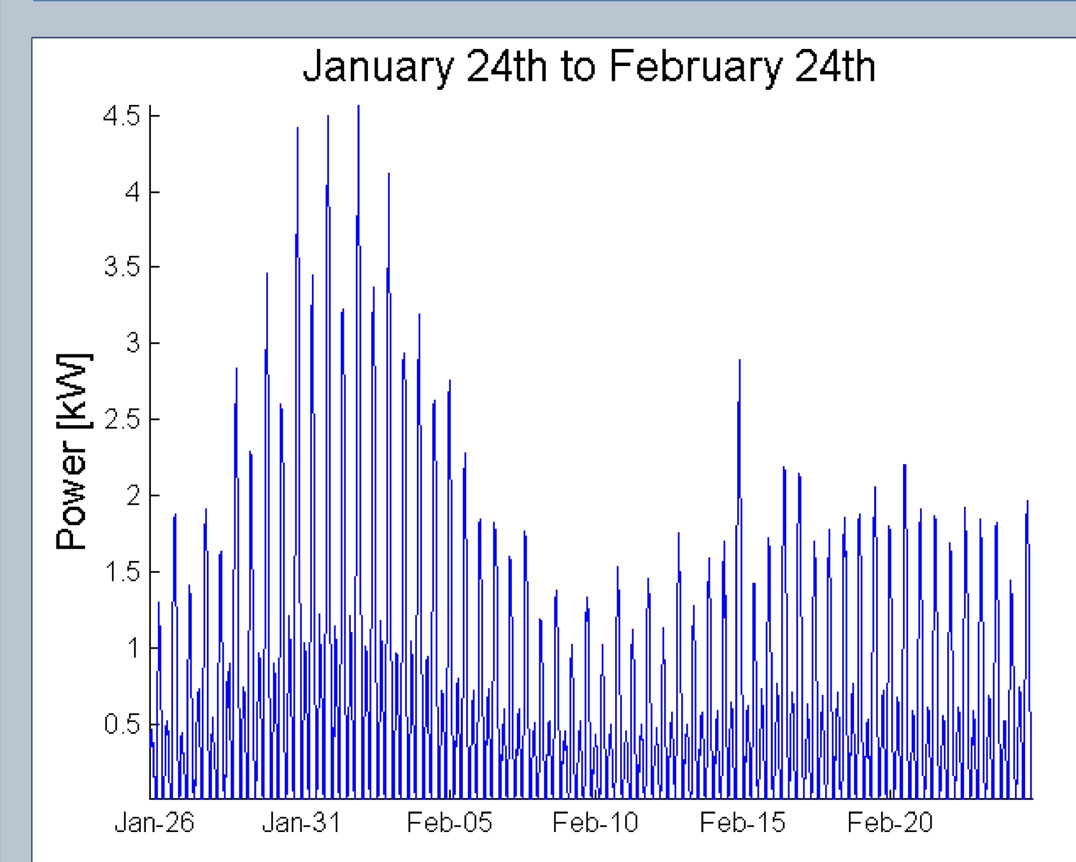
PROJECT OBJECTIVE:
1. Measure and analyze tidal current velocities
2. Calculate available hydrokinetic power from tidal resource
3. Estimate the power requirements of the Living Bridge
4. Develop site-specific design plot for aid in turbine selection
5. Investigate commercially available turbine solutions

2. Calculation of Power

The power is calculated from the magnitude of velocity of the Piscataqua River. Because velocity is cubed in the equation for power, a small increase in velocity results in a large increase in power.

$$P = \frac{1}{2}\rho A v^3$$

- P = Power
- ρ = River density
- A = Cross-section area
- v = Flow velocity

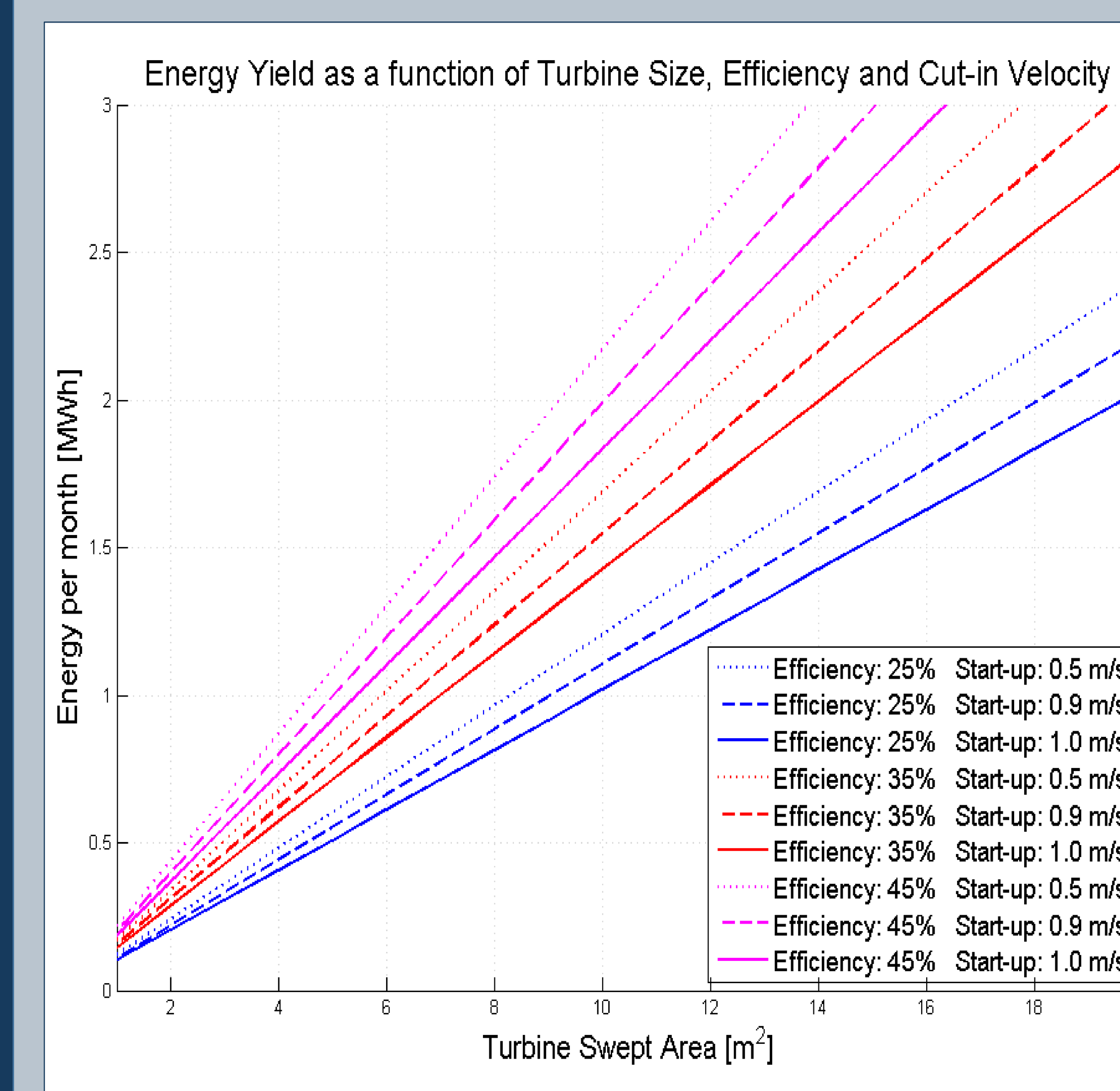


3. Bridge Power Requirements

The LB requires power for safety and aesthetic purposes, these energy requirements include:

- High-efficiency LED aesthetic lighting
- Traffic, aerial and marine navigation lighting
- Structural monitoring systems
- Performance monitoring
- Surveillance cameras
- Informational and educational display

Estimated energy (per month) to power LB:
0.9 MWh
Barry et all



4. Turbine Design Aid

Integration of power over the course of a month (February) results in the Energy available from the tidal resource. Theoretical turbines are analyzed by evaluating a range of turbine efficiencies, start-up velocities, and "swept" areas. See *figure to the left.*

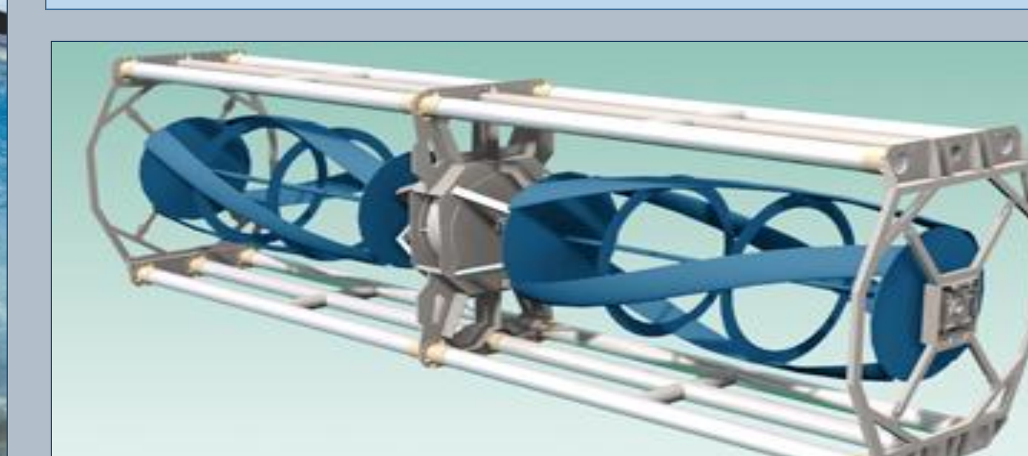
Knowing that the LB requires 0.9 MWh per month, a number of turbine solutions can be determined from the design aid by examining where the lines of constant efficiency and start-up velocity achieve the desired energy output.

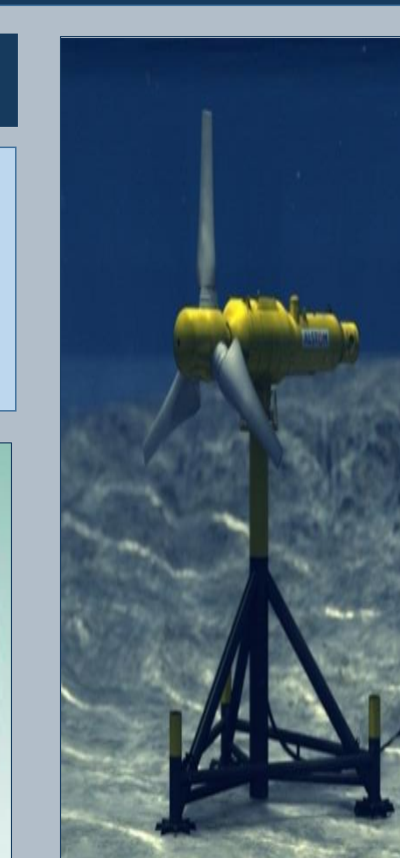
The turbine solutions that meet the energy demands of the LB, include the following parameters:

- Efficiency
- Start-up velocity
- Required turbine swept area

5. Tidal Turbine Investigation

Many different types of tidal turbines exist, including: Darrieus *(left)*, Gorlov *(below)*, and Axial Flow *(right)*. Each design has its own inherent start-up velocity and efficiency. Understanding of these existing parameters assist in the development of a turbine selection aid for the site-specific LB location.





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Ocean Engineering

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