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Introduction

The Living Bridge Project transforms the Memorial Bridge in Portsmouth, NH into a self-diagnosing, self-reporting, smart bridge. The project demonstrates that user-centered infrastructure combined with emerging renewable energy systems can lead to a more resilient, sustainable community. The structural health monitoring and environmental sensors installed on the bridge and in the river below are powered by a locally available renewable resource, tidal energy.

Bridges are a compelling location to deploy tidal turbines because:

- Constrictions where bridges are built create faster currents
- Permitting can be reduced by taking advantage of existing bridge permits
- Existing bridge structures can be used for mooring/foundations
- Power generated can be brought onto the grid via the bridge

Tidal Energy Conversion System

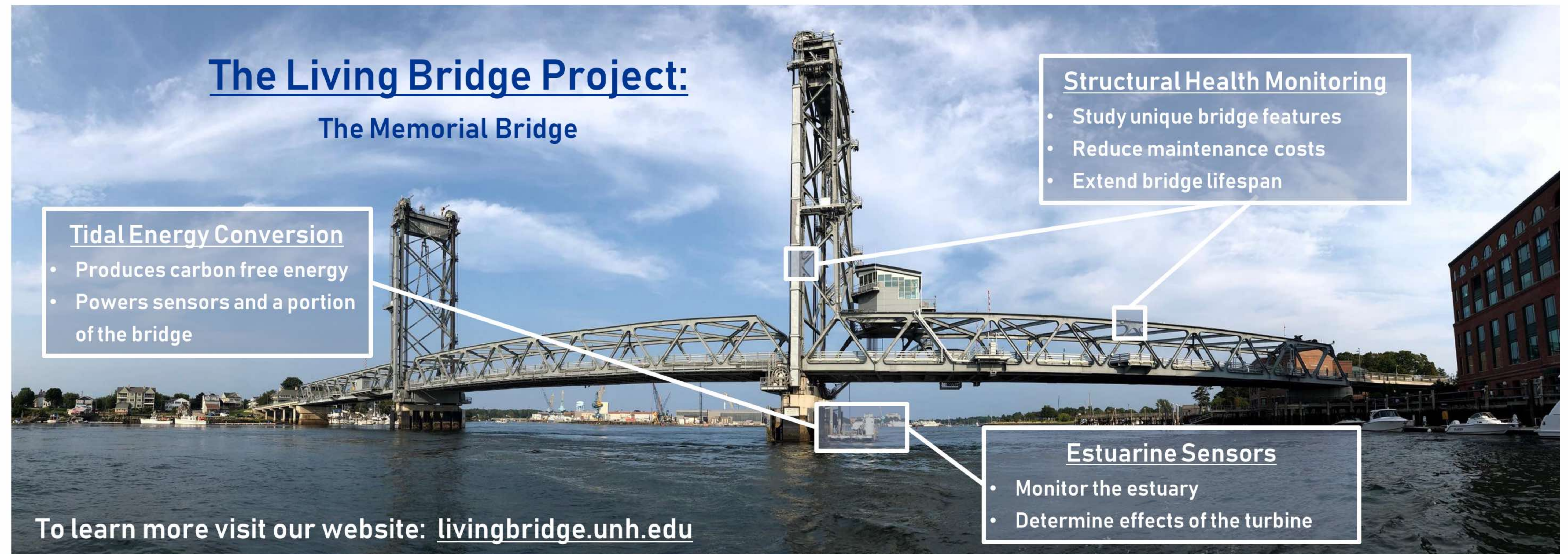
The tidal turbine deployment system consists of:

- 50ft x 20ft (15.2m x 6.1m) floating turbine deployment platform (TDP)
- Two 42in (1.07m) high density polyethylene (HDPE) foam filled pontoons
- Galvanized steel frame with moon pool
- Moored to the bridge pier with two 22ft (6.7m) tall vertical guide posts
- Capable of deploying up to a 9m² (97ft²) cross sectional area rotor



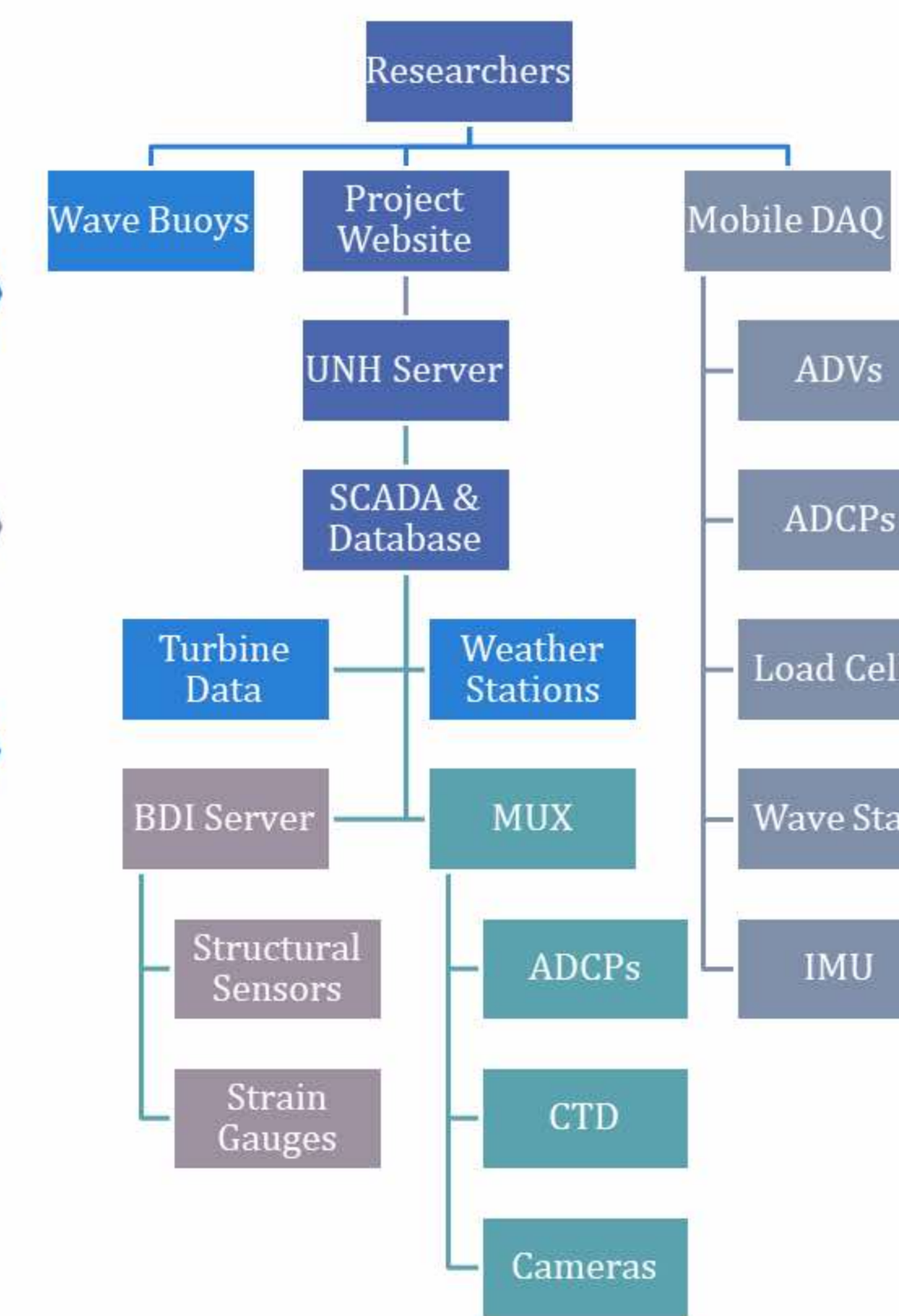
UNH has partnered with New Energy Corporation, who has provided their Envirogen 025 turbine for this project.

- First installation of turbine in tidal environment (previously at riverine sites)
- Direct drive permanent magnet generator located above the waterline
- Vertical axis crossflow turbine that uses a 4 bladed 3.2m (modified for this project, typically 3.4m) diameter and 1.7m tall rotor
- Can operate in grid tied (net-metered) and load bank configurations



Instrumentation

The tidal turbine deployment system at the Memorial Bridge includes environmental and tidal resource instruments and sensors. These sensors measure current velocity, mooring forces, rotor thrust forces, wave heights and periods, platform motion, wind speed, air temperature, water temperature, salinity, turbidity, chlorophyll levels, and visual information.



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Funding Sources



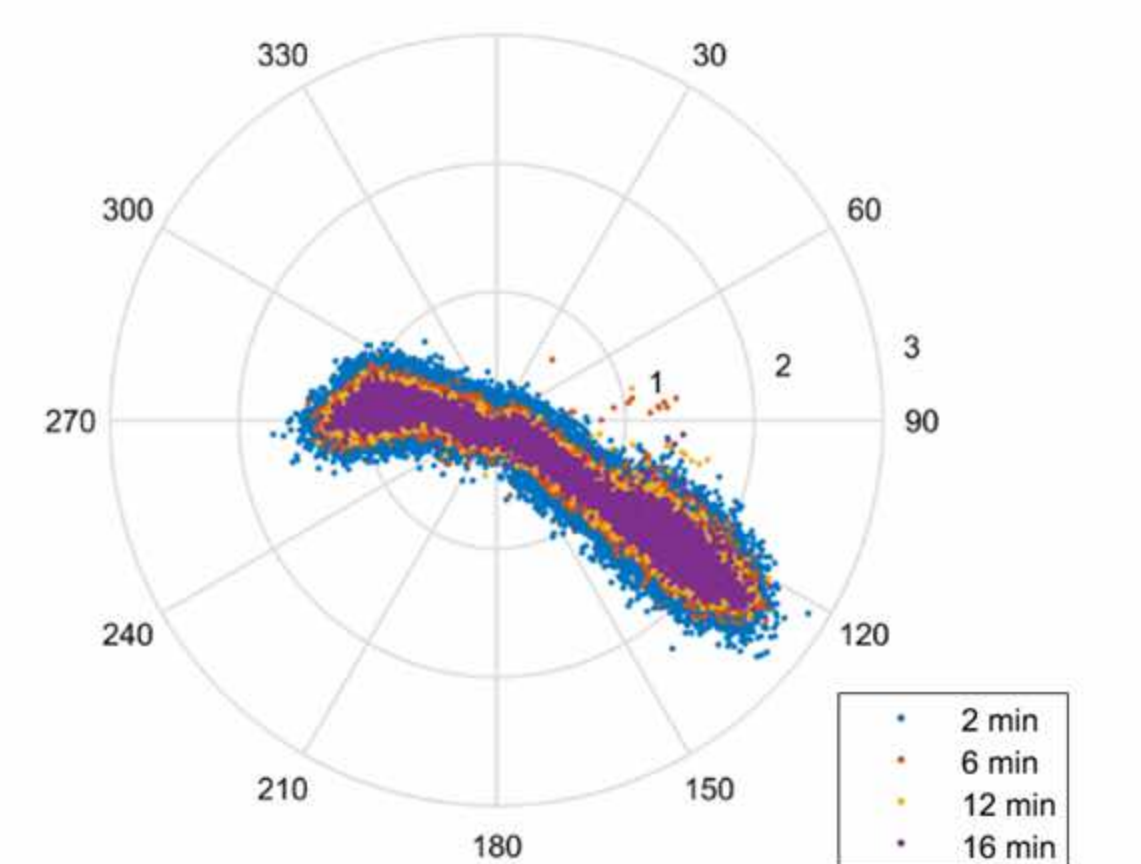
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Tidal Energy Measurements

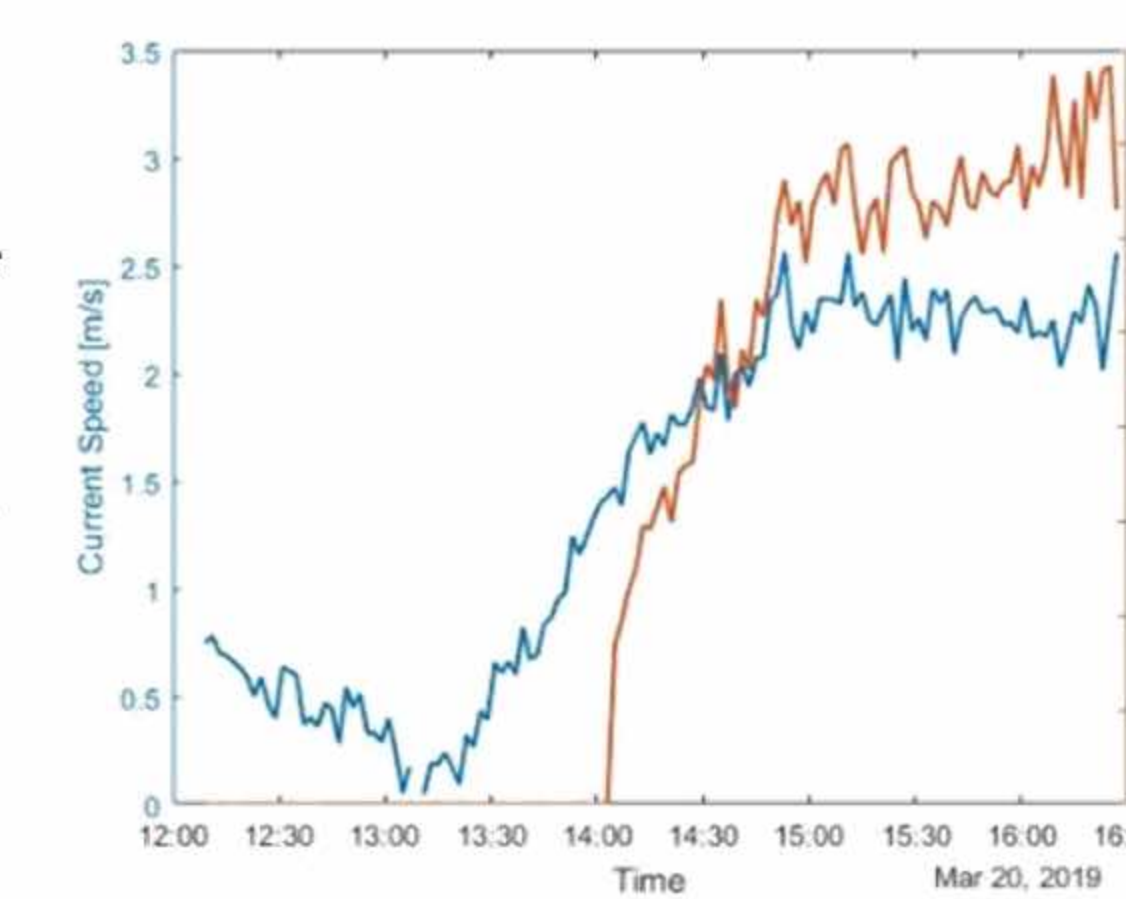
Data from Acoustic Doppler Current Profilers (ADCP's) on the TDP was collected with a two minute ensemble interval. The effect of the ensemble interval on the current speed and resource characterization metrics is shown in the polar plot and table using calculated values for higher ensemble intervals.

Ensemble Interval	2 min	6 min	12 min	16 min
Mean Kinetic Power Density [kW/m ²]	1.110	1.090	1.085	1.081
Mean Kinetic Power Asymmetry	6.77	6.91	6.94	6.96
Maximum Current [m/s]	2.85	2.61	2.50	2.48
Ebb/Flood Directional Asymmetry [deg]	-27.6	-30.9	-32.1	-33.0



An off-grid turbine test was conducted on the ramp up of an ebb tide (~ 4hrs) to produce a preliminary power curve.

In off-grid mode the power is dissipated to heat by a load bank of resistors. The current data was recorded using an ADCP and the power data is the load bank input as recorded by the rectifier.



Living Bridge 2017 – current speed [m/s] and direction at approximately 2m below surface (with varying ensemble intervals)

