Tidal Hydrokinetic Energy

Brian Polagye
Research Assistant Professor
University of Washington

SAMPE 2010
May 17-20, 2010
- Tidal Energy
- Northwest National Marine Renewable Energy Center
- Materials Suitability
Tidal Energy

Barrage
- Comparable to hydroelectric
- Very high cost and environmental footprint

Hydrokinetic
- Comparable to wind
- Potentially lower cost and environmental footprint
Tidal Hydrokinetic Devices
“Typical” Sites and Devices

- Gearbox-Generator
- Direct Drive Generator

- Rotor
  - 5-20 m
  - 10-20 rpm

- Drive Train
- Foundation

- 20-60 m

- Tension Leg
- Pile
- Gravity Base
- Chain Anchor

- 2-4 m/s

OSU W

NNMREC
Tidal Energy Projects in Puget Sound

- Race Rocks: Demonstration turbine
- Marrowstone Island: Demonstration array
- Admiralty Inlet: Pilot project

100-200 avg. MW practically recoverable
Local Drivers

- Initiative 937 obligations
  - 15% renewable energy by 2020
  - Excludes conventional hydropower

- Limited transmission capacity for new wind energy

- Tidal energy advantages
  - Predictable resource
  - No CO$_2$ emissions
  - No visual impact
  - Close to load
Tidal Energy Challenges

- Technology Readiness
- Economic Viability
- Societal Concerns
- Environmental Effects
- Tidal Energy
- Northwest National Marine Renewable Energy Center
- Materials Suitability
Northwest National Marine Renewable Energy Center (NNMREC)

UW-NNMREC
- Tidal Energy
- Resource and Site Assessment
- Device and Array Optimization
- Testing Facilities
- Environmental Effects

OSU-NNMREC
- Wave Energy
- Materials Suitability

8 Faculty members involved
6 Graduate student researchers supported
Resource and Site Assessment - Approach

Shipboard Survey
R/V Jack Robertson

Seabed Instrumentation
Measurement Tripod

Land Observation
AIS Ship Tracks

NNMREC
ROV Surveys

- **Seabed**
  - Cobbles (10-20cm)
  - Shell fragments
  - Sponges
  - Small slope
- **Less than 4m visibility**
  (with lighting)
Sea Spider Instrumentation Tripod

- **Acoustic release** (redundant recovery)
- **CTDO** (conductivity, temperature, depth, dissolved oxygen – partnership with WA Dept of Ecology)
- **ADCP** (Acoustic Doppler Current Profiler)
- **Fish Tag Recorder** (partnership with NMFS)
- **Hydrophone** (background noise)
- **T-Pod/C-Pod** (porpoise clicks)
- **Lead Weight** (650 lbs)

Programmed for 3 month deployments
Challenging Research Environment
Ferry Noise Study

Sea Spider
Device and Array Optimization

Numerical Simulations:
Parallel simulations of device and array performance

Wave-Current Flume:
Experimental studies of device wakes
Understanding Environmental Effects

- **Near-field Effects**
  - Pressure drop (model)
  - Sediment transport (model)
  - Noise (experiment)

- **Far-field Effects**
  - Tidal regime (model)
- Tidal Energy
- Northwest National Marine Renewable Energy Center
- Materials Suitability
Materials Suitability

- Hydrodynamic performance
- Structural performance
  - Metal corrosion
  - Composite aging
- Long maintenance intervals
  - 2-4 years for power train
  - 20+ years for foundation
Approaches to Minimize Biofouling

- **Biocides: “Anti-fouling”**
  - Effective
  - Toxic

- **Low friction: “Foul-release”**
  - Cost
  - Long-term effectiveness
Shallow Water Biofouling

Clean Current turbine: 6 months deployment

Before

After
Deep Water Biofouling
Damage: Composite Aging

- Water absorption, leading to loss of strength
- *In-situ* screening tests
  - 9 – 18 months exposure
  - Four composite material systems
Thank You!

More about Tidal Energy:
http://depts.washington.edu/nnmrec

More about Wave Energy:
http://nnmrec.oregonstate.edu/