METAP NNMREC

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The Northwest National Marine Renewable Energy Center (NNMREC)

- A partnership between Oregon State University & the University of Washington, funded by the U.S. Department of Energy
- Develop a full range of capabilities to support wave and tidal energy development
- Center activities are structured to:
  - facilitate device development,
  - inform regulatory and policy decisions,
  - close key gaps in understanding.

Funding for NNMREC is provided by DOE, OSU, UW and multiple partners

NNMREC is a virtual center focused on evaluation of marine renewable energy

Environmental

Sediment Transport

Electromagnetic Fields

Benthic Ecosystems

Acoustics

Technical

Testing/Demonstration

Wave Forecasting

Survivability/Reliability

Anti-fouling / Corrosion

Device/Array Optimization

Social

Fisheries/Crabbing

Outreach/Engagement

Existing Ocean Users

Local/Oregon Economy

NNMREC Scaling, Development and Evaluation Resources

Phase 1: Model Validation at OSU Facilities

Ph. 1a - 20kW Wave Energy Linear Test Bed (WESRF), 2m stroke
Ph. 1b – Tank Testing in Regular and Irregular Waves (HWRL)

Scale (λ); 1:30-100

Phase 2: Advanced Model Validation at OSU Facilities

Ph. 2 - Tank Testing in Regular and Irregular Waves (HWRL)

Scale (λ); 1:15-50

Phase 3: Field Testing (Intermediate Scale)

Yaquina Bay, OR: Wind Waves: 0-0.2m in 7.6m water depth
Puget Sound, WA: Wind Waves: 0-1m in 16m water depth

Scale (λ); 1:1-15

Phase 4: Full Scale Individual Device Testing & Demonstration

Newport, OR: Water depth 40-50m

Scale (λ); 1:1

Examples of Testing at NNMREC

- Linear Test Bed – L-10 (20kW scale)
- Creates the relative linear motion between a center “spar” and a surrounding “float” (active components)
- Enables dynamic testing, using captured wave profiles, while simulating the hydrodynamic force of ocean waves
- Specifications:
- 2m relative motion/stroke (6.5 feet)
- 14ft tall x 10.5ft wide x 8.5ft deep

Examples of Testing at NNMREC

- 3-D Basin – 1/33 scale CPT test (2009)
- PhaseSpace optical motion tracking system (LED markers and cameras allows the motion of the components to be tracked and recorded with sub-millimeter resolution at a 480Hz sample rate.)

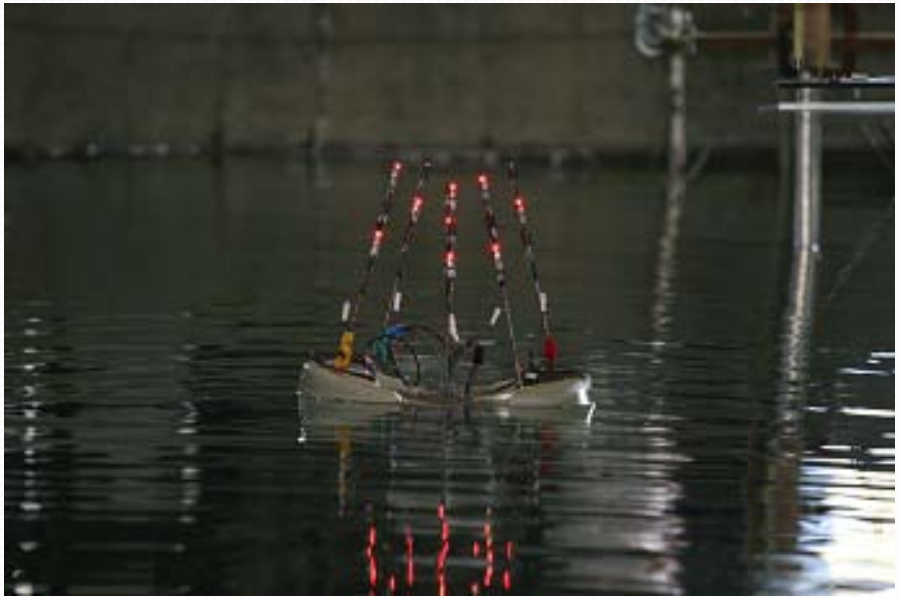
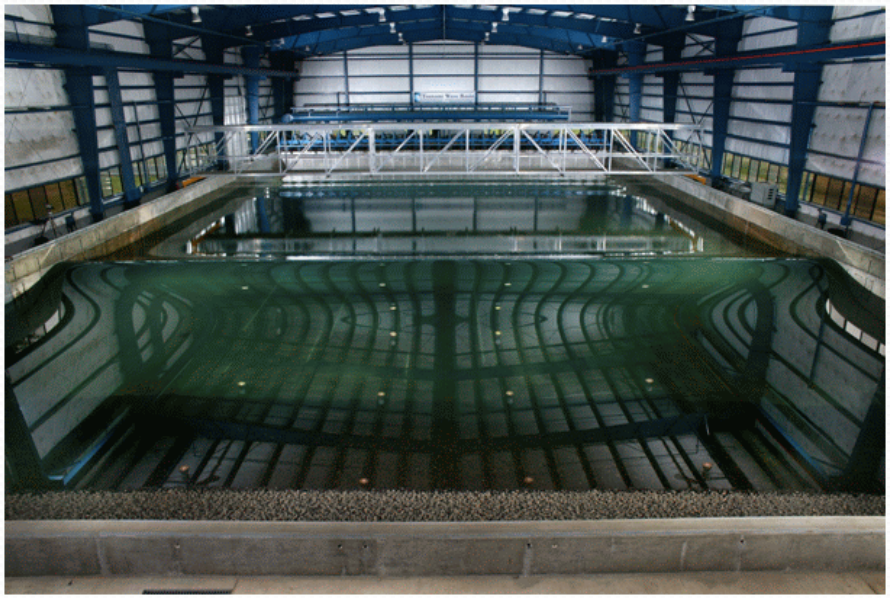


Photo courtesy Columbia Power Technology

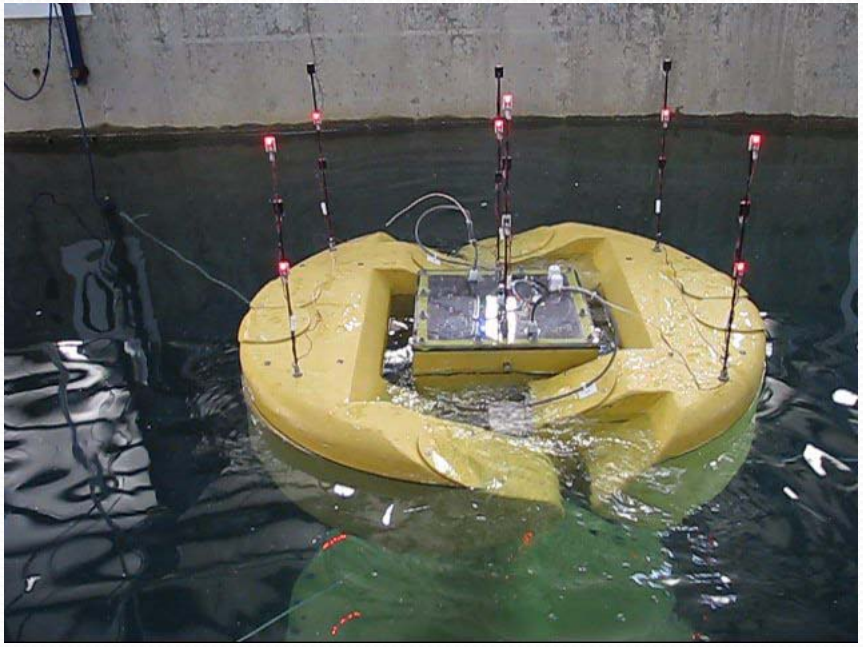


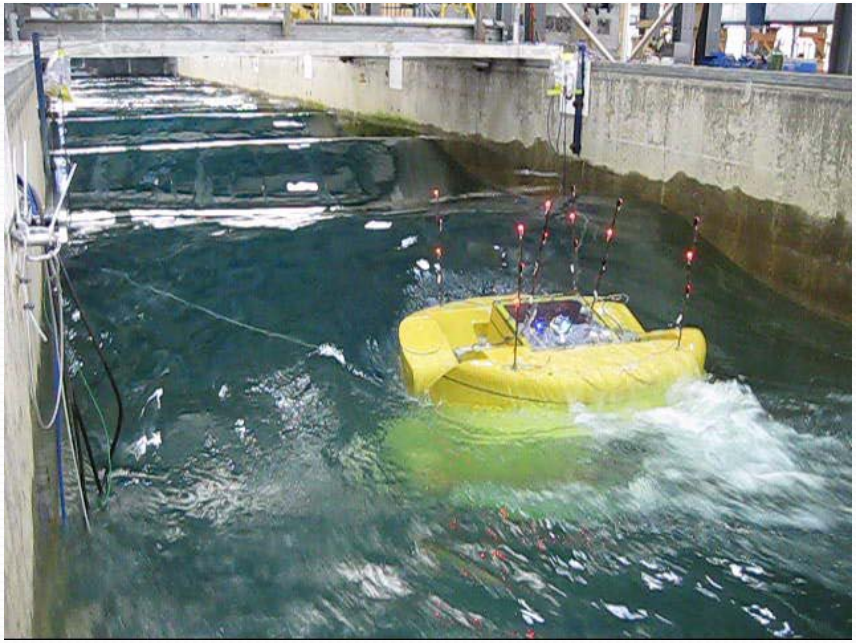
OSU Tsunami Basin

Examples of Testing

- Long wave flume – 1/15 scale CPT test 2010 with PhaseSpace system

OSU's Long Wave Flume





Photos courtesy Columbia Power Technology

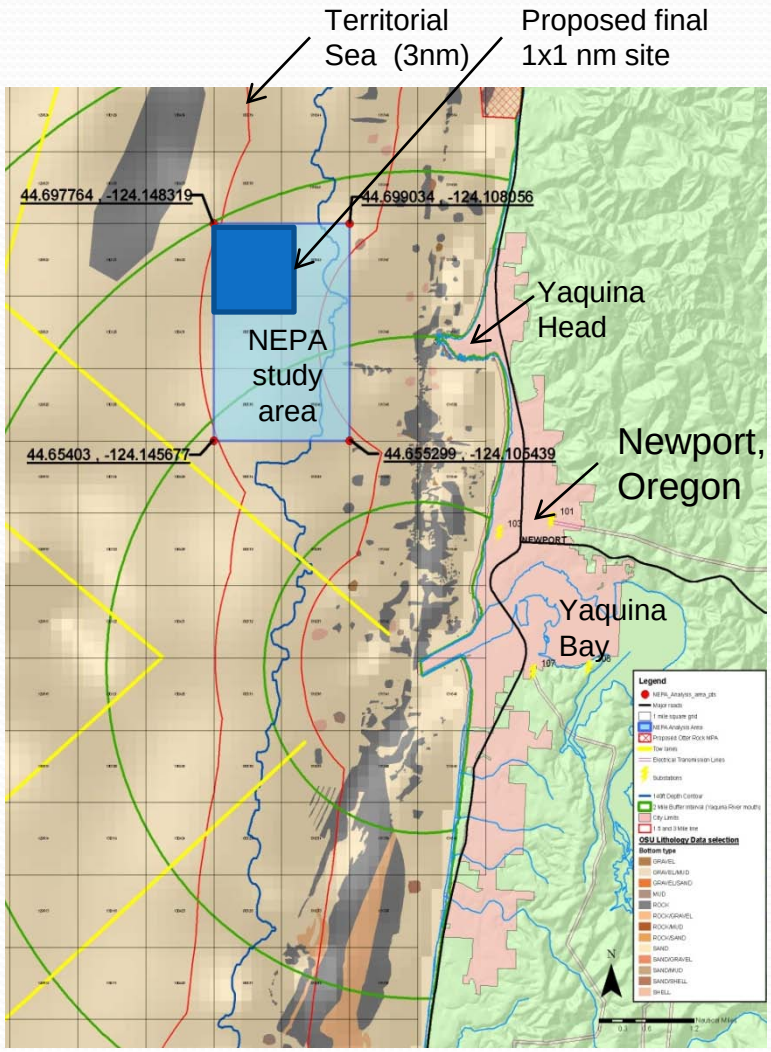
L-10 Deployment & Testing, Newport OR, September 2008

Proposed Testing at NNMREC

- Proposed this fall – 3-D basin – 1/33 scale five device array
- Proposed May 2012 – Full-scale ocean test with Mobile Ocean Test Berth (MOTB)
  - Ocean-deployable, re-locatable capability to precisely test the electrical output of wave energy converters (WECs)
  - Evaluates WEC performance under real-world conditions in a permitted site
    - One nautical mile square off the coast of Newport, Oregon
    - Supporting systems monitor and collect WEC performance data
  - Mobility enables WEC evaluation at alternate sites

Mobile Ocean Test Berth

- Mobility
  - Newport site
  - Alternate sites
- Independent of grid
  - Avoids shore cable expense and significant installation
- Ocean deployable
  - Mooring adaptable to site
- Standard interface
  - Mates with WEC via submarine cable
- Data telemetry
  - Monitors, records, and transmits WEC power generated
- Standard test protocols
  - Under development (NREL)

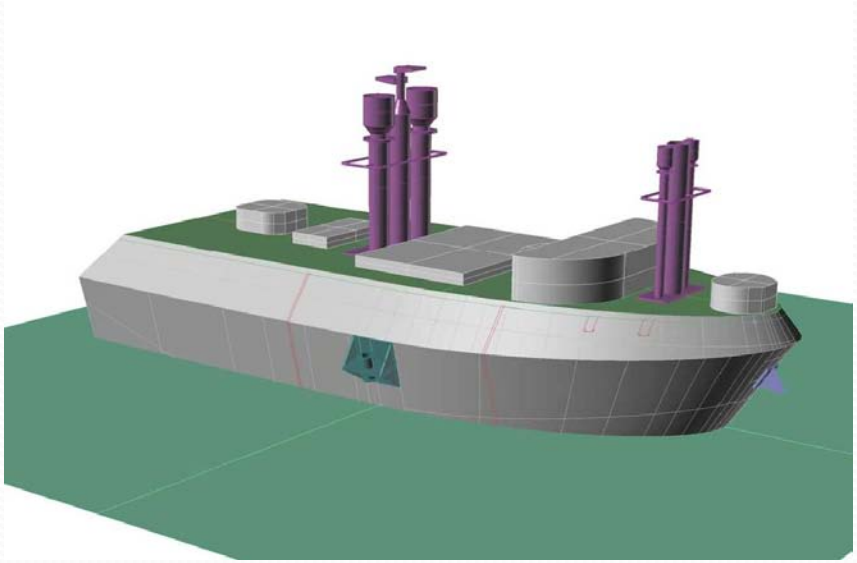


MOTB Top-level Requirements

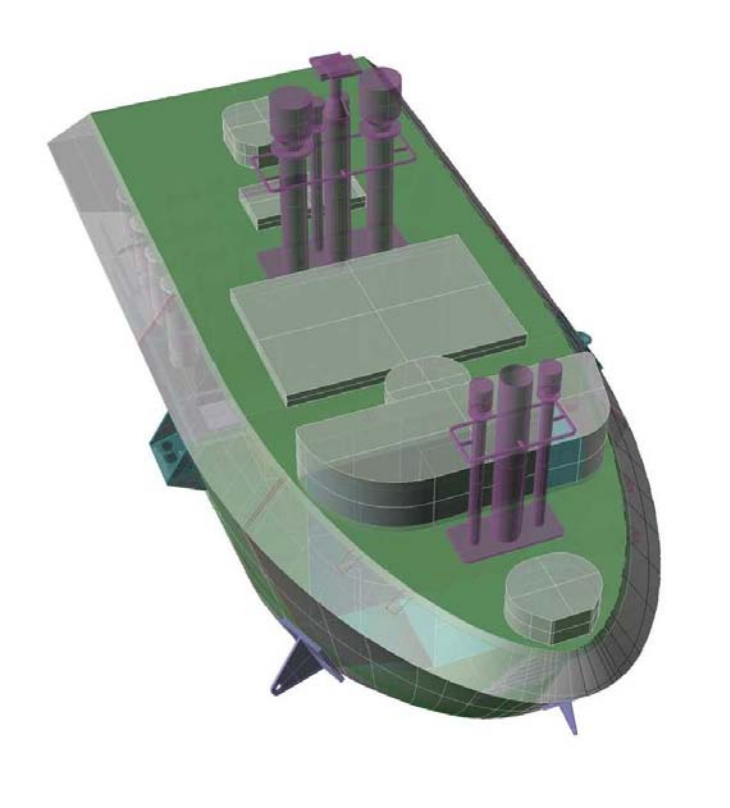
- 1 MW power dissipation capacity
  - Three-phase and single-phase AC
- Robust hull design based on a proven hull shape
- Reliable mooring system
  - Designed to withstand 50-year storm
- Unattended operation with remote monitoring and control
- Significant emphasis on electrical safety
  - Personnel and equipment protection
- Redundant telemetry communications and data backup
- U.S. Coast Guard marking and lights for navigation safety

MOTB Preliminary Profiles

- Waterline Profile

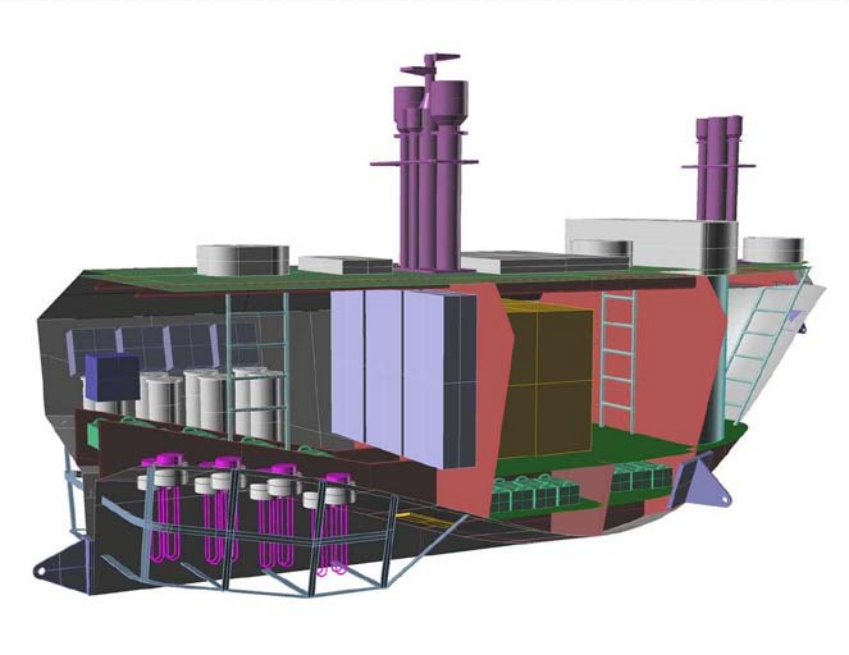


- Topside Arrangement

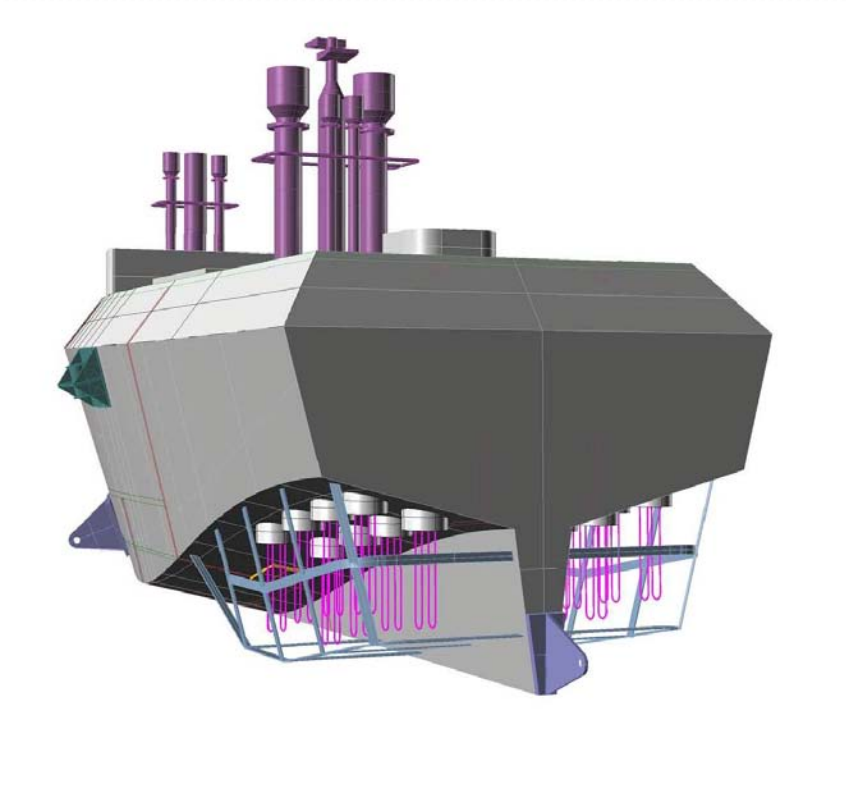


MOTB Preliminary Arrangements

- Interior Compartments



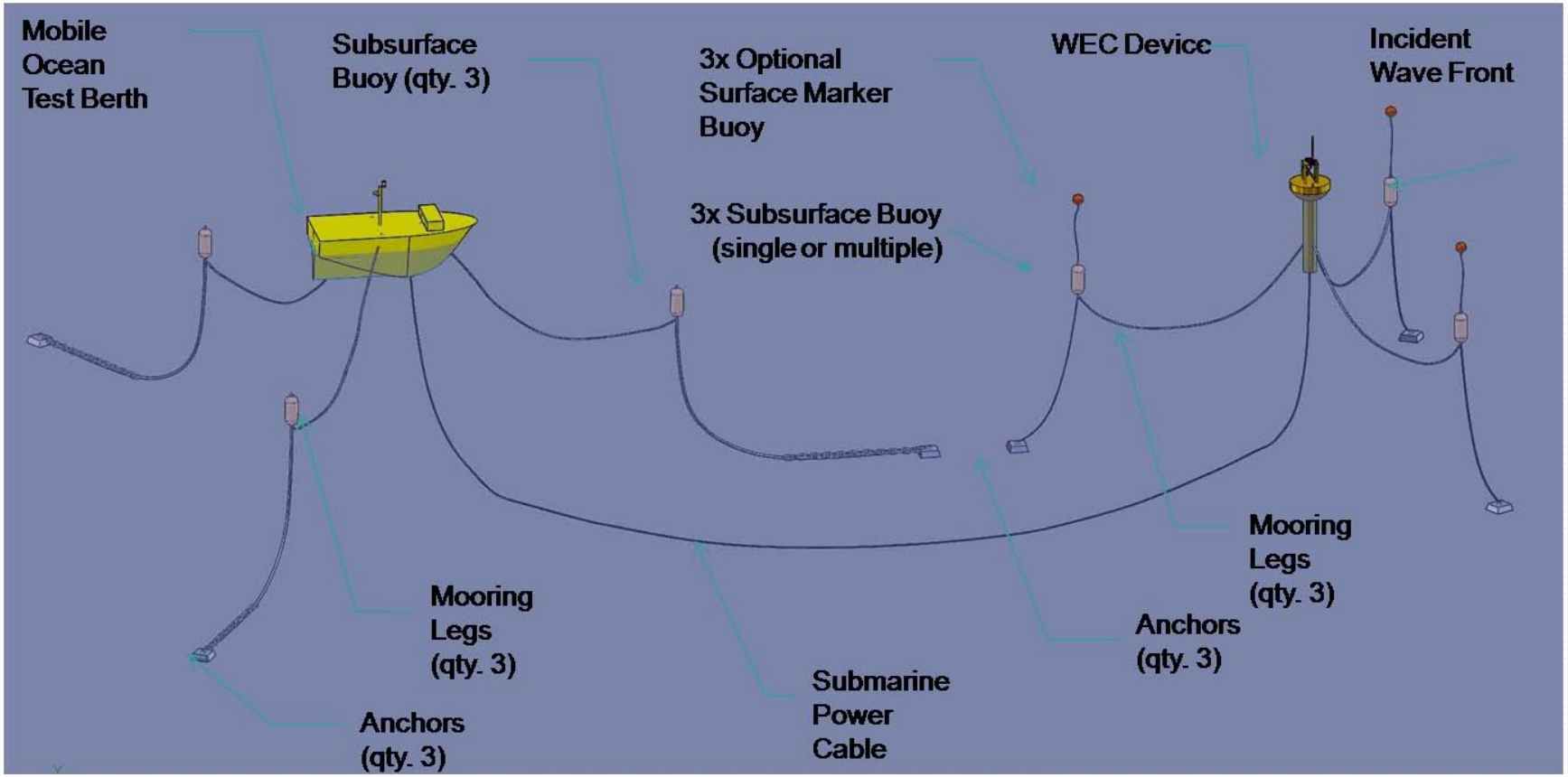
- Load Elements



Test Berth Concept of Operations

- MOTB deploys in mooring at the permitted site
- Developer installs WEC and connects submarine power cable to the berth interconnect point
- MOTB transmits data from internal and WEC health sensors
- MOTB dissipates power through load elements cooled by surrounding seawater
- MOTB to provide limited grid emulation
- Collected output data viewable over secure Internet
  - Credentials restrict sensitive, encrypted data to those authorized
  - Redundant telemetry communications and data storage
- WEC power output correlated with wave measurements
- MOTB functions controlled remotely
  - Minimal on-water interactions when MOTB and WEC are deployed

MOTB – WEC Deployed Layout



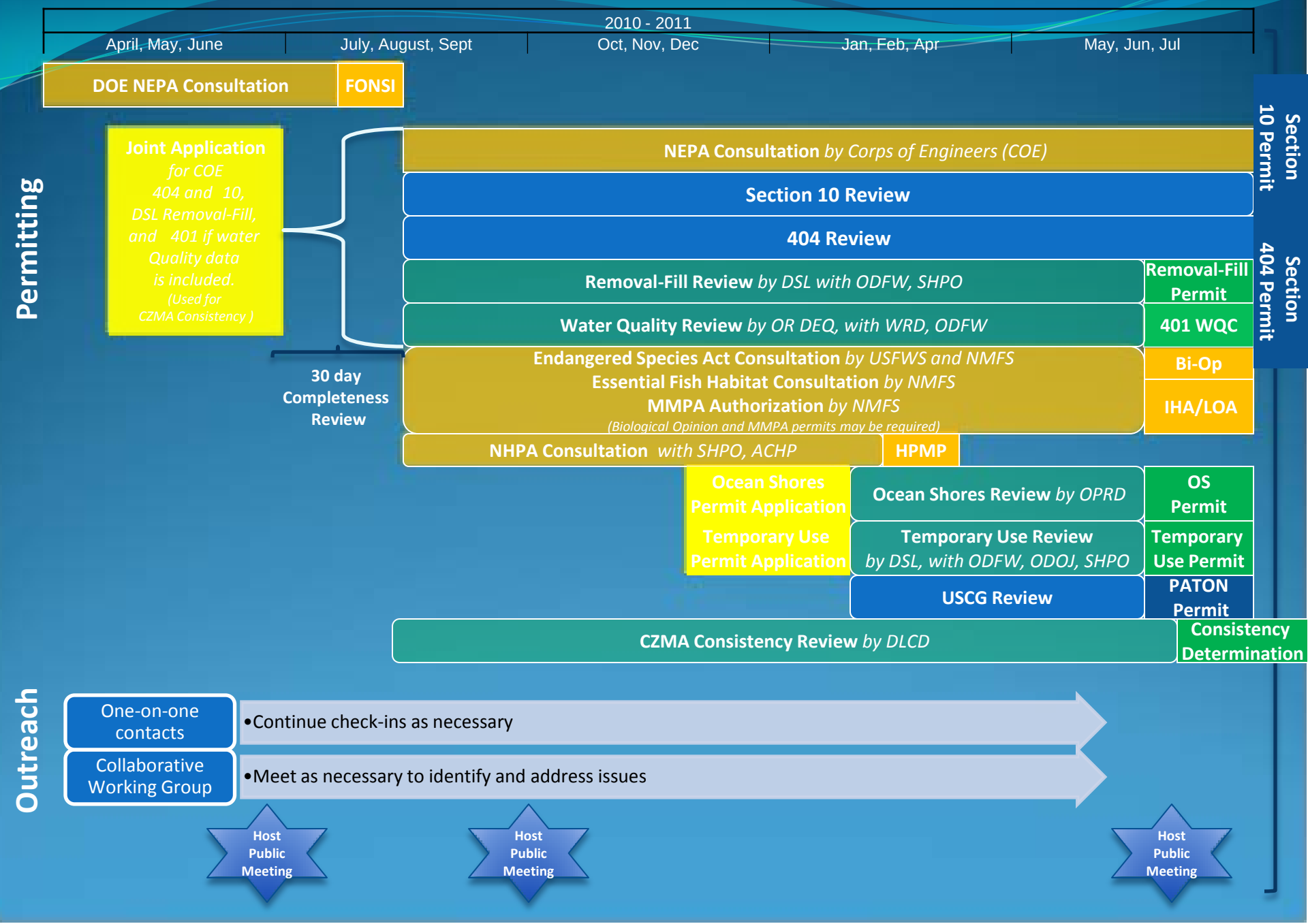
Collaboration

- NNMREC collaborates with the National Renewable Energy Laboratory (NREL) on design, testing requirements and protocols
  - Wave energy to adopt wind energy lessons learned
- NNMREC practices “The Oregon Way”
  - Incorporate stakeholder concerns
  - Fishermen Involved in Natural Energy (FINE)
    - Active member reviewing MOTB design
- NNMREC leverages the scientific talent and technical facilities at Oregon State University and the University of Washington for device developers
  - Oregon State University (OSU) Hatfield Marine Science Center, Newport, Ore.
  - OSU O.H. Hinsdale Wave Research Laboratory, Corvallis, Ore.
  - OSU Wallace Energy Systems & Renewables Facility (WESRF), Corvallis, Ore.
  - University of Washington Applied Physics Laboratory, Seattle, Wash.

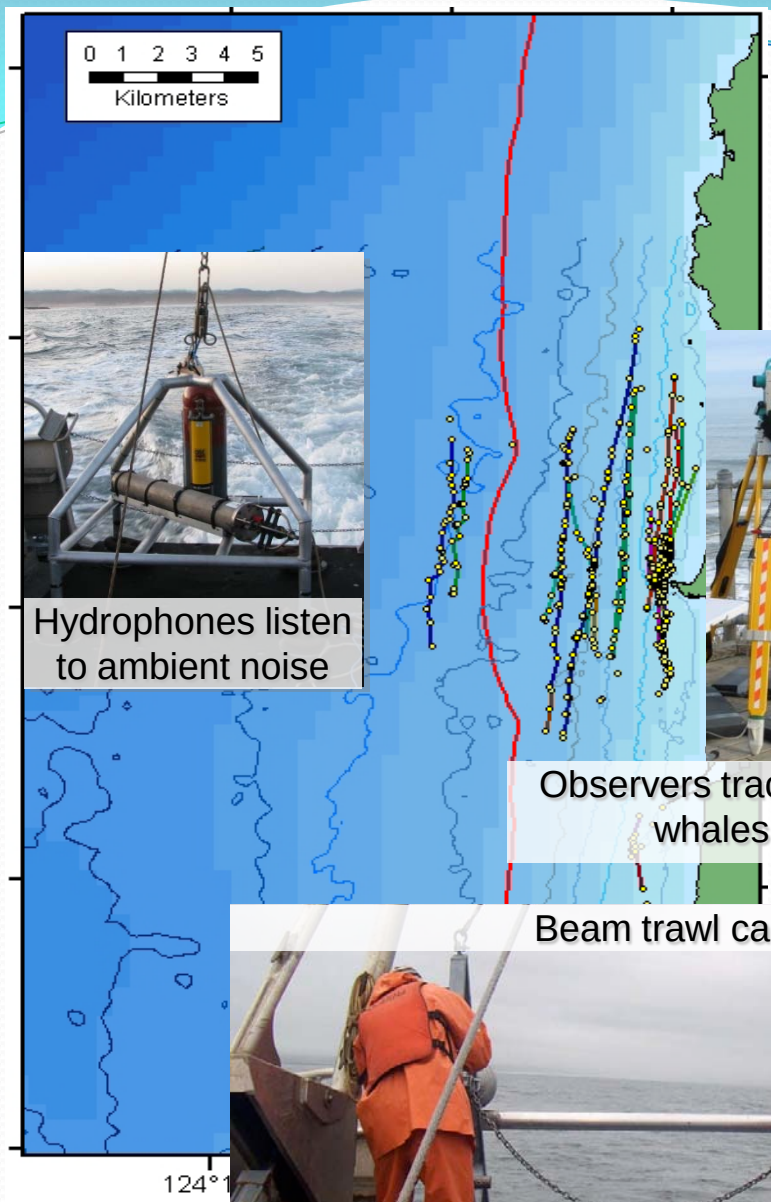
Community Effects & Public Engagement is Important

- Wave energy development will have an impact on local communities
  - Some negative – ocean space use, fishing restriction, etc.
  - Some positive – new economic stimulus around manufacturing buoys, maintenance and operation
- NNMREC researches these effects with Oregon Sea Grant
- NNMREC engages the community
  - FINE
  - Public Meetings
  - Test Berth Committee

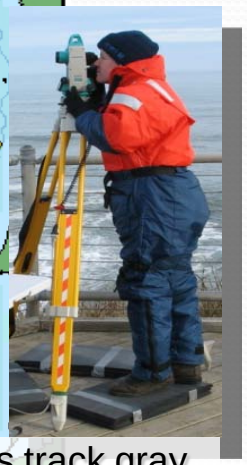
NNMREC MOTB PERMITTING and OUTREACH ROADMAP



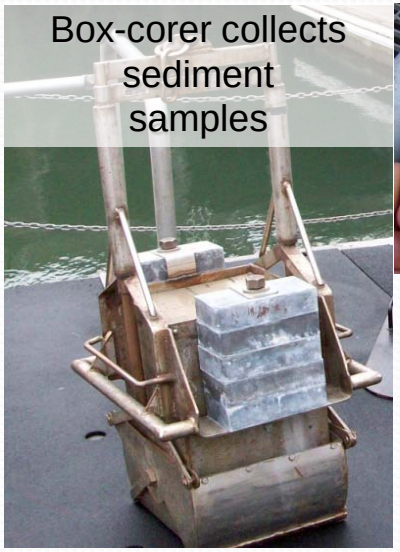
NNMREC Environmental Investigations



Hydrophones listen to ambient noise



Observers track gray whales



Box-corer collects sediment samples

Sieve

Identify infauna

Beam trawl captures bottom fish and mobile invertebrates

MOTB Schedule

- Pre-design is complete with the exception of two challenging items:
  - Grid mimic/emulation
  - Cable design
- Design to be complete in early/mid 2011
- Build & commission early 2012
- First WEC test spring 2012