Report to Congress on the Potential Environmental Impacts of Marine and Hydrokinetic Renewable Energy Technologies



Environmental Effects of Marine & Hydrokinetic Energy Projects A Report to Congress Under EISA Section 633



Managed by UT-Battelle for the U.S. Department of Energy

#### Glenn Cada Oak Ridge National Laboratory

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# **Energy Independence and Security Act of 2007 (EISA)**



Sec 633 (b). The Secretary of Energy, in conjunction with the Secretary of Commerce... and the Secretary of the Interior... shall provide to the Congress a report that addresses—

(1) the potential environmental impacts, including impacts to fisheries and marine resources, of marine and hydrokinetic renewable energy technologies...

`marine and hydrokinetic renewable energy' defined as following:

(1) waves, tides, and currents in oceans, estuaries, and tidal areas;

(2) free flowing water in rivers, lakes, and streams;

(3) free flowing water in man-made channels; and

(4) differentials in ocean temperature (ocean thermal energy conversion).

Explicitly excludes "energy from any source that uses a dam, diversionary structure, or impoundment for electric power purposes."





### **Outline of the EISA Environmental Report**

- Introduction
- Description of the technologies

Wave energy

**Current energy** 

**Ocean thermal energy conversion** 

- Potential environmental impacts, minimization, and mitigation measures
- Monitoring and adaptive management



#### **Current and Wave Energy Technologies**

Energy Efficiency & Renewable Energy





Oscillating Hydrofoil (Stingray) Source: The Engineering Business



Horizontal Axis Turbine (DEEP-Gen) Source: Tidal Generation



Vertical Axis Turbine (Blue Energy Ocean Turbine) Source: Blue Energy





Ducted Horizontal Axis Turbine (Open-Centre Turbine) Source: OpenHydro





Submerged Pressure Differential (Archimedes Wave Swing) Source: AWS Ocean Energy



Overtopping (Wave Dragon) Source: Wave Dragon, Ltd.



Attenuator (Pelamis) Source: Pelamis Wave Power



Oscillating Water Column (OEBuoy) Source: Ocean Energy



Oscillating Wave Surge Converter (Wave Roller) Source: AW Energy



Point Absorber (AquaBuOY) Source: Finavera



### **Ocean Thermal Energy Conversion (OTEC)**

How ocean power operates Electricity created Warm seawater 2 Saltless water vapour turns is converted into water turbine creating vapor by solar electricity 40°E 80°E 120°E 160°E 160°W 120°W 80°W 40°W 0°W energy 40°N Solar Turbine Evacuated energy evaporation 20°N chamber Equator Warm seawater 20°S 3 Water vapour 40°S condensed in chamber Temperature difference between surface and depth of 1000 m creating pure water Less than 18°C 22° to 24°C Cold seawater Condensing 18° to 20°C More than 24°C chamber 20° to 22°C Depth less than 1000 m • • • Waste Desalinated 5°C salt water water



**Energy Efficiency &** 

**Renewable Energy** 

## **Environmental Issues**

- Alteration of currents and waves
- Alteration of substrates and sediment transport and deposition
- Effects of habitat alteration on benthic organisms
- Noise
- **Electromagnetic fields**

- Toxic chemicals
- Interference with animal movements or migrations
- Strike
- Impingement
- Effects of single units vs. cumulative effects of multiple units
- **Unique effects of OTEC**





**Environmental Assessment, Monitoring, and Adaptive Management** 

> Assess problem Design Adjust Implement Complexity of the second s

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# **EISA Report Approach and Schedule**



- Literature Review
- Contacts with technology developers, regulatory agencies, resource agencies, academia, and non-governmental organizations
- Major input from NOAA and Department of Interior
- Draft reports for public and agency review, webinar
- EISA Report Due to Congress in June 2009
- Will be posted to www1.eere.energy.gov/windandhydro/



Energy Efficiency & Renewable Energy

### **Questions and Comments?**

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