Presentation given at the Marine Katoomba meeting

Katoomba XVI:
Building a Blueprint to Harness New Investment for the Protection of Marine and Coastal Ecosystem Services

February 9-10, 2010
Moore Foundation, Palo Alto, CA

Hosted by the Katoomba Group

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An Overview of Ocean Renewable Energy Technologies; Converting the Resource into Electricity

Katoomba XVI

February 9, 2010

Palo Alto, CA

Michael Miller, Director, Environment

Tina Taylor, Roger Bedard and Paul Jacobson

Types of Marine or Ocean Renewable Energy

"Marine or Ocean Renewable Energy" is a term used to describe all forms of renewable energy derived from the sea including:

- Wave
- Tidal In-Stream or Current
- River In-Stream or Current
- Ocean Current

3 Variants of Current Energy

Basically the same type of energy conversion machine

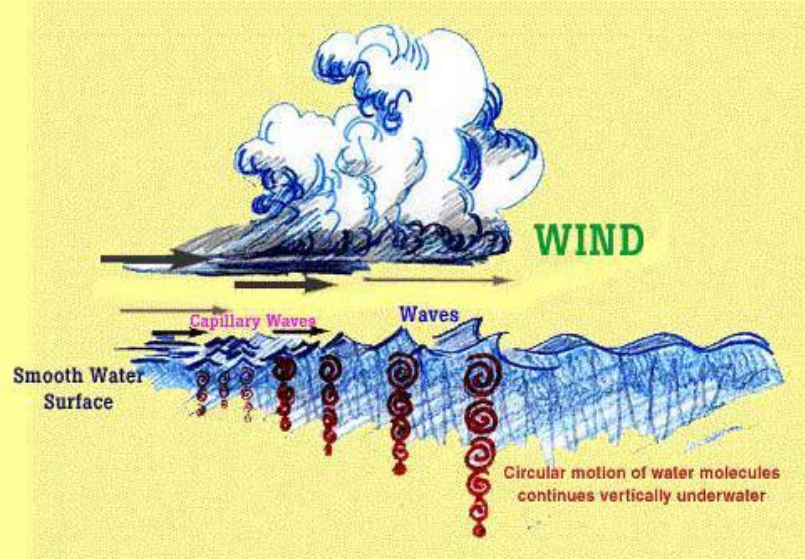
sometimes called marine hydrokinetics

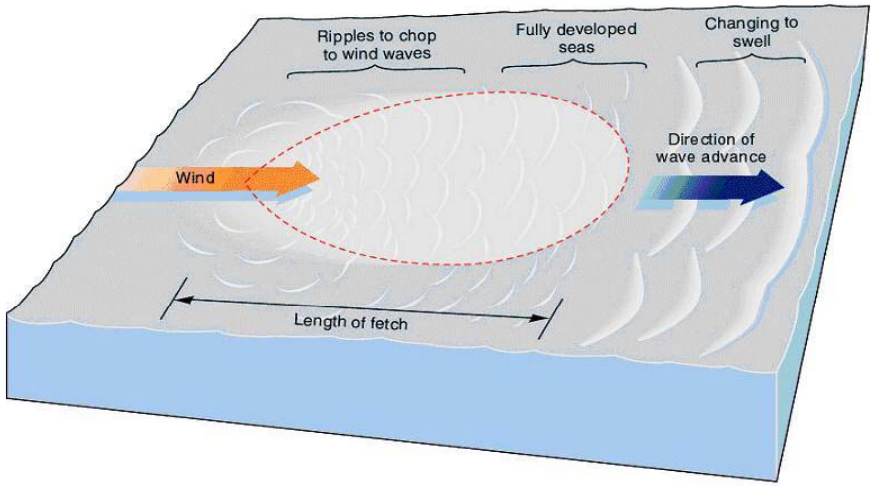
- Offshore Wind
- Ocean Thermal
- Ocean Salinity Differences

How is wave energy formed?

Uneven global heating of the Earth by the sun generates winds

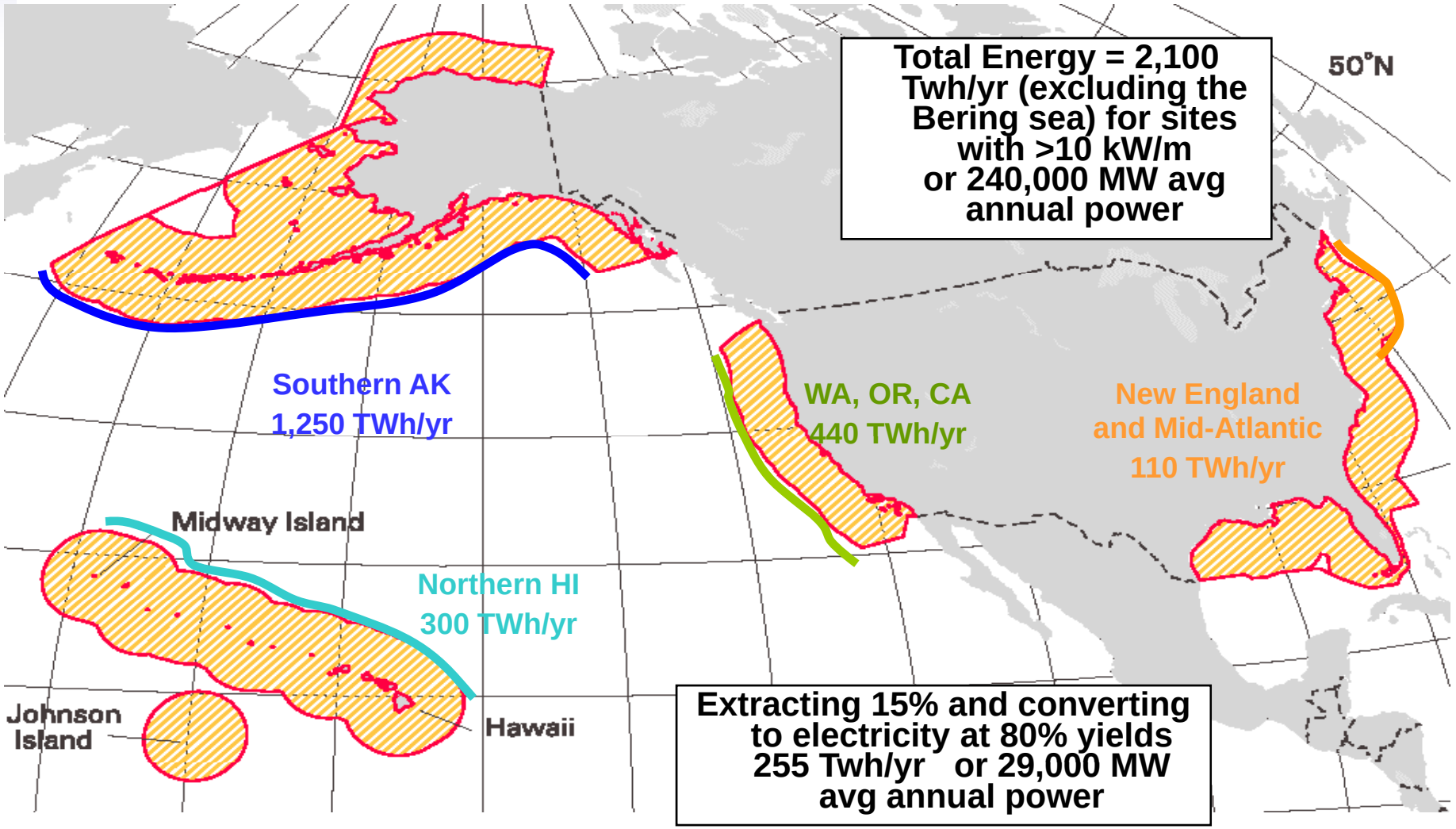
Sustained wind blowing over a sufficient fetch of water generates waves





Waves are a derived and concentrated form of solar energy and wave power per unit wave crest length

U.S. Offshore Wave Energy Resources



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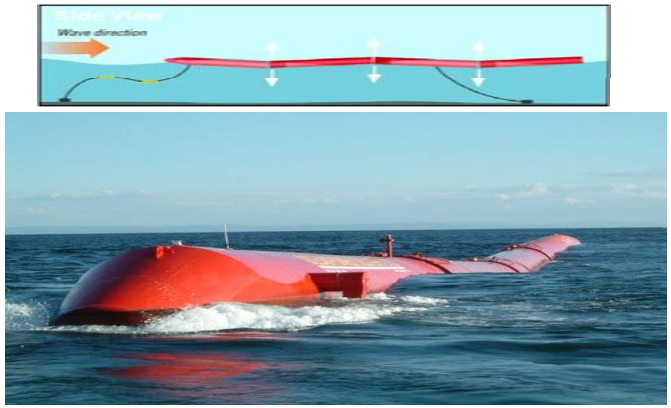
Wave Energy Conversion Technology; 4 Types

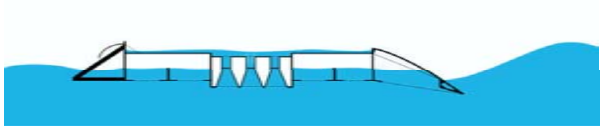
Ocean Power Technologies
Point Absorber

OceanLinx
Oscillating Water Column

Pelamis Linear Attenuator



Wave Dragon Overtopping



Waves overtopping the ramp

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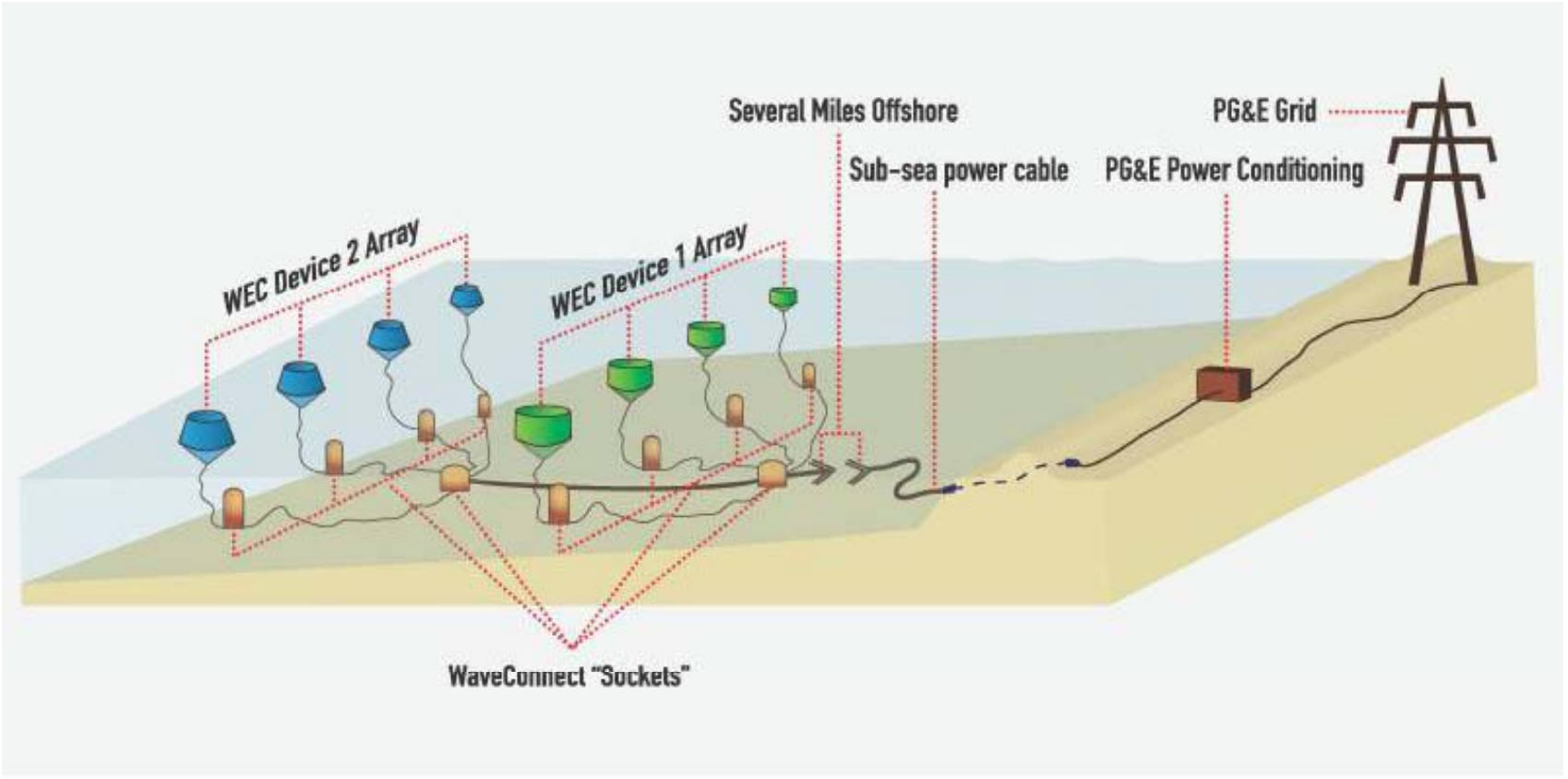
WaveConnectTM



Wave energy conversion (WEC) devices capture the ocean's energy. The energy is transmitted through an undersea cable to land, where the energy is conditioned and fed to the electric grid.

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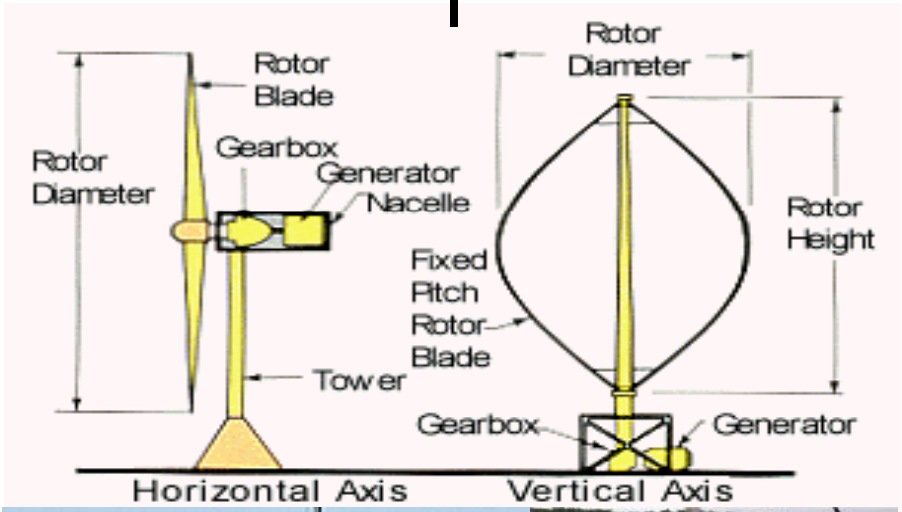
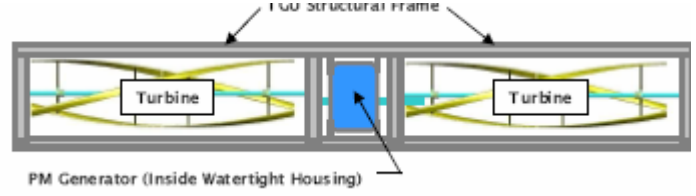
Two Types of Tidal/River Water Turbines

- Axial Horizontal Axis

Cross Flow Vertical Axis and Horizontal Axis

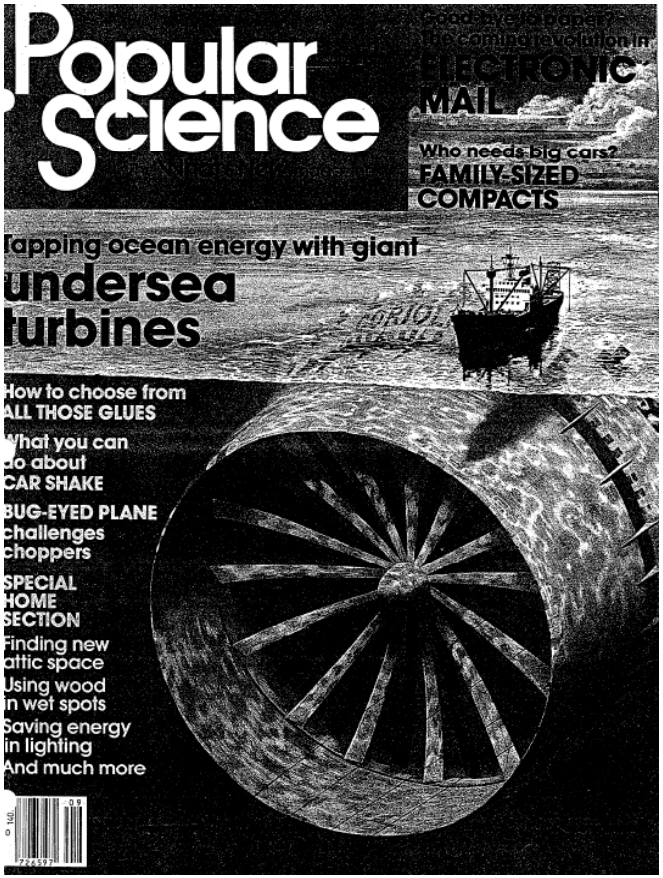




Courtesy: Marine Current Turbines, Lucid Energy and Ocean Renewable Power Corporation

Open-Ocean Current Turbine Technology

A Bit of History – the 1970s Coriolos Project Popular Science, Sep 1980



Today's Technology

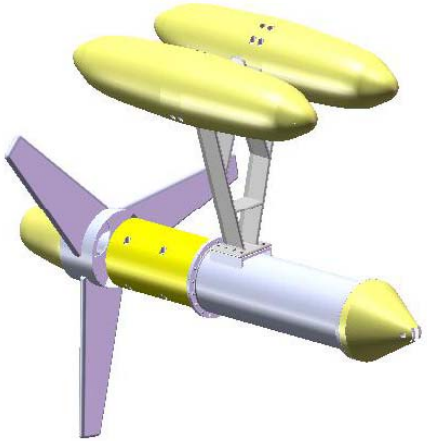
Courtesy: Florida Atlantic University

Demonstrate feasibility of extracting ocean current energy

Investigate technology gaps and hurdles

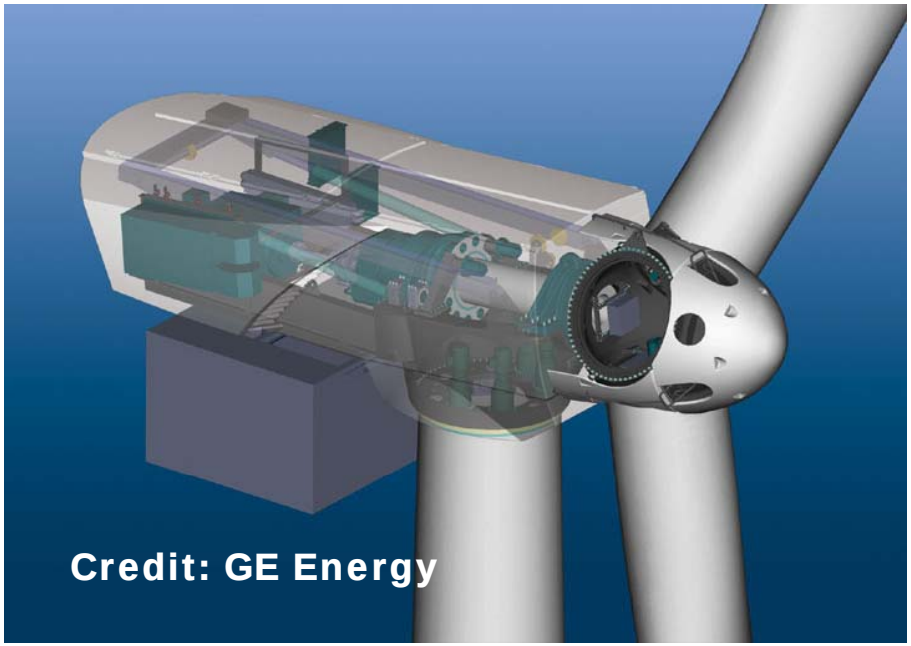
Study environmental and ecological interactions

Develop a 20 kW platform to support ocean energy technology development



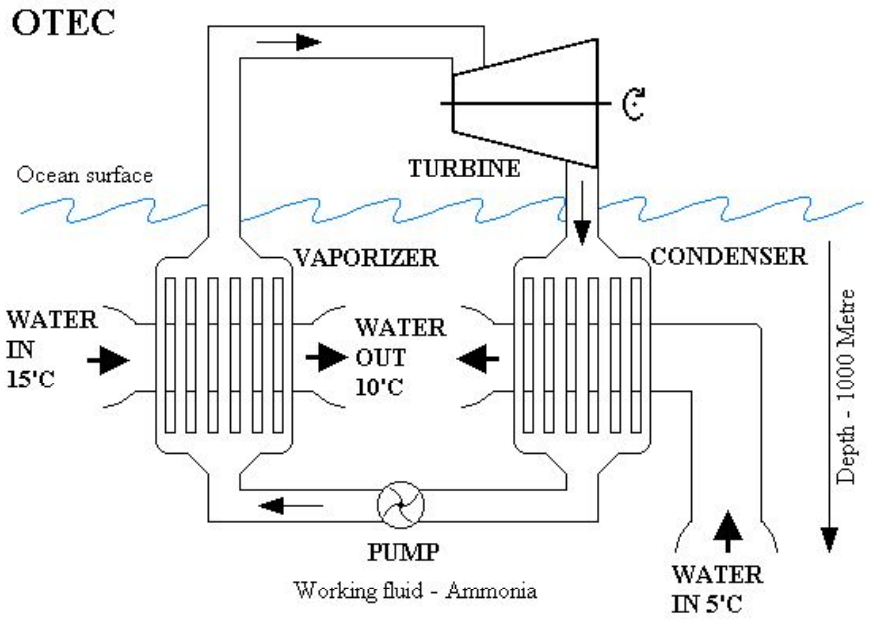
Offshore Wind Turbine Technology

Typical Offshore Wind Turbine



Typical Offshore Wind Farm

Ocean Thermal Energy Conversion



Salinity Gradients

Two practical methods for this are Reverse Electro Dialysis (RED), and Pressure Retarded Osmosis (PRO). Both processes rely on osmosiswith ion specific membranes

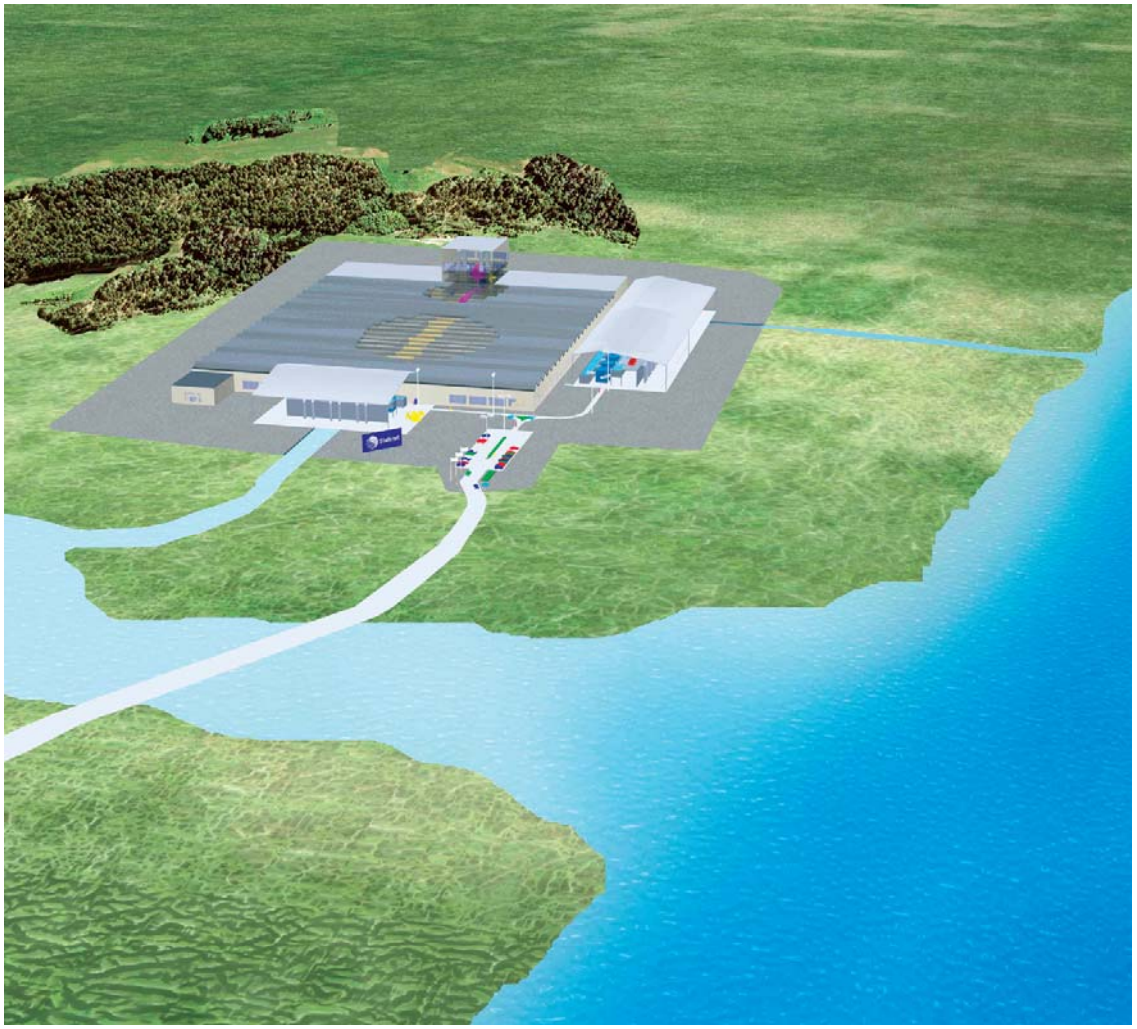


Illustration of a PRO plant placed at sea level (Courtesy of Statkraft, Norway)

Sustainability Considerations

What are the sources of concern?

- Energy absorbed by devices is not available to perform other work in the environment
  - Water circulation patterns
  - Wave action on shorelines
- Adverse effects of equipment and operations
  - Alteration of the physical and chemical environment
  - Collision between biota and equipment
  - Altered behavior of biota

Sustainability Considerations

Are effects benign? It depends on:

- System
- Siting
- Scale

What's Needed?

- Identification and evaluation of impacts
- Computer modeling and lab studies
- Field studies
- Monitoring

Summary

- Many forms of ocean energy
- Variety of conversion technologies for each form
- Active area of R&D
- Except for shallow water offshore wind, ocean energy technologies are still in an emerging stage of technology
- Too early to know which technologies will be the most cost-effective, reliable, and environmentally sound.
- We have an opportunity to learn and address issues now.

Stay Tuned!