Ocean Energy

Haley, Shane, Alston
What is Ocean Energy?

- The world’s oceans cover nearly 70% of the world's surface
- The oceans are the world's largest collector of the sun’s energy that is continually renewed at all times
- The ocean is an amazing resources that could be utilized but many challenges stand in the way
- The various forms of ocean energy generation in use and researched into today are: OCEAN CURRENTS, OFFSHORE WIND, OCEAN THERMAL / OTEC, WAVE ENERGY, and TIDAL ENERGY.
Overview

Anybody who has sailed, anybody who has been on a fishing boat.
History
Tidal Energy

How Does It Work?

The movement of water by tides pushes or pulls a turbine to generate electricity

Barrages

Lagoons

Undersea/ Offshore
Tidal Barrages

Dam like structure that captures tidal energy entering or exiting an area

Gates control water movement

Used to spin a turbine

Bay, River, Estuary
Tidal Barrages- Example

Rance Tidal Power Station
Tidal Lagoons

Built structure that contains turbines

Closes off a tidal area similar to a harbour

Tides can flow through turbines four times a day at high tide and low tide
Tidal Lagoon- Example

Tidal Lagoon Swansea Bay
Undersea/ Offshore Tidal Turbines

Newest form of tidal energy

Estimated a 100 ft turbine could produce 13.5 MW or enough for roughly 13,000 high use American homes

Underwater “Wind Farms”

Only small scale creations at this point
Tidal Energy Availability

Tides are entirely predictable and constant

Requires tidal range of at least 7 m

Largest Tide is at the Bay of Fundy and is calculated to produce 14,000 MW

Ocean capacity of Tidal Energy is estimated to be 64,000 MW

Prevalent in coastal areas
# Tidal Energy Efficiency and Costs

<table>
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<tr>
<th>Efficiency</th>
<th>Costs</th>
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<tr>
<td>Low Capacity Factor 20-35%</td>
<td>Technology is well established but still very expensive</td>
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<td>Misses Peak Demand</td>
<td>High costs of 3 - 15 million based on scale</td>
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<td>Rivers can typically produce 300 MW compared to a nuclear plant with 1000 MW</td>
<td>Construction periods of 3 - 10 years</td>
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<td>Geographically limited</td>
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Tidal Energy Impacts

Environmental

0 gas emissions during operation
Implementation damages bays and estuaries
Damage to aquatic and shoreline ecosystems
Damage varies by site

Social

Effects on local industry
Power transition period
Stability
Wave Energy

The energy in waves comes from the movement of the ocean and the changing heights and speed of the swells.

Kinetic energy, the energy of motion, in waves is tremendous. An average 4-foot, 10-second wave striking a coast puts out more than 35,000 horsepower per mile of coast.
Wave energy

As long as the sun shines, wave energy will never be depleted. It varies in intensity, but it is available twenty-four hours a day, 365 days a year.
Wave power is renewable, green, pollution-free, and environmentally invisible, especially if placed offshore.

The best wave generator technology being used in the United Kingdom is producing energy at an average cost of 7.5 cents per/kWh.
What can harness Wave Energy?

There are three basic methods for converting wave energy to electricity

1. Float or buoy systems
2. Oscillating water column devices
3. “Tapered channel” or “tapchan” systems
Float or Buoy Systems

These use the rise and fall of ocean swells to drive hydraulic pumps.

The object can be mounted to a floating raft or to a device fixed on the ocean floor.

A series of anchored buoys rise and fall with the wave. The movement allows an electrical generator to make electricity that is then shipped ashore.
Float or Buoy Systems

Surface float

Pneumatic "spring"

Generator

Hydraulic piston

Cable guide

Cable

Metal plate

8 meters (26 feet)

30 meters (100 feet)
Oscillating Water Column Device

These devices use the in-and-out motion of waves at the shore that enters a column and forces air to turn a turbine.

The column fills with water as the wave rises and empties as it descends. In the process, air inside the column is compressed and heats up, creating energy the way a piston does.
Oscillating Water Column Device
“Tapered channel” or “tapchan” systems

These rely on a shore-mounted structure to channel and concentrate the waves, driving them into an elevated reservoir.

The water flows out of this reservoir and is used to generate electricity, using standard hydropower technologies.
“Tapered channel” or “tapchan” systems
Wave Power

Unlike wind and solar power, power from ocean waves continues to be produced around the clock.

while the industry has made halting progress, experts agree that it remains decades behind other forms of renewables, with large amounts of money and research required for it to make progress

The Ocean provides a huge issue from a technical point of view and is far more difficult than on land. Saltwater is a hostile environment for devices, and the waves themselves offer a challenge for energy harvesting as they not only roll past a device but also bob up and down or converge from all sides that creates a complicated factor to adjust for.

Wave energy shows huge potential for energy capture, but an optimum design is far from being agreed on.

Lack of large company investment could aid progress but it is not economically smart decision.

the United Kingdom — Scotland in particular — is focusing heavily on wave energy development and could help the technology along.
Ocean Thermal Energy Conversion (OTEC)
# OTEC Benefits & Drawbacks

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<tr>
<th>Environmental</th>
<th>Social</th>
<th>Monetary</th>
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<tbody>
<tr>
<td>1. Immense Resources (+)</td>
<td>1. Offshore (+)</td>
<td>1. LARGE Up-front Investment (-)</td>
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<tr>
<td>2. Baseload Power (+)</td>
<td>2. Aquaculture Farms (+)</td>
<td>2. Location (-)</td>
</tr>
<tr>
<td>3. Dispatchable Power (+)</td>
<td>3. Chilled Agriculture (+)</td>
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“Various renown parties estimate the amount of energy that can be practically harvested to be in the order of 3 to 5 terawatts of baseload power generation, without affecting the temperature of the ocean or the world’s environment. That’s about twice the global electricity demand.”

- OTEC News
Reality of OTEC

Availability

Available, but not PRACTICAL

Efficiency

Determined by temperature difference

- Larger change \( \Rightarrow \) efficiency

Sustainability

Yes, not on a large scale
Conclusions

Massive amounts of clean energy is available that could make a huge impact on the world’s energy consumption.

Huge technological issues are holding advancements back and lack of widespread investment holds real progress.

Ocean energy is still in its early stages but if advancements are made the positive impact could be huge.


