Tidal Power: Turning the Tides on Energy

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Abstract
The concept of using the energy within tidal currents is examined thoroughly by looking at the costs and benefits of tidal barrages and tidal turbines. Tidal power is a renewable form of energy that is predictable, does not release greenhouse gasses, has costs similar to wind power, and can be paid back within its lifespan. Tidal energy needs to be constructed in certain areas with enough of a tidal range, depth, and tidal velocity to support a profitable amount of energy and a minimal effect on the environment. This project determines the benefits of tidal power first hand by using a small scale model of a tidal turbine to generate energy.

Methodology
- Cost/Benefits
  - Calculate cost per kWh for turbines
  - Calculate payback period
- Requirements for Tidal Power
- Environmental effects
  - Calculable?
  - Depend upon location
- Turbine specifications
  - Shape of propeller
  - Create geographical map
- Depths and velocity
- Building/Testing Model

Barrage vs. Turbines
- Barrages
  - Captures the change in Potential Energy due to the rise of sea level
  - Entails building a barrage across an entire inlet
  - Captures High Tides and then runs water through turbines like a dam
- Turbines
  - Captures the Kinetic Energy of moving tides
  - Uses "farms" of turbines installed offshore
  - Fences used to direct water flow
  - Comparable to wind farms only under the ocean

Environmental Effects
- Barrage:
  - change the salinity by altering the flow of water into and out of estuaries
  - destroy the marine life
  - a reduction in intertidal area
  - slower current
  - change seafloor characteristics
- Turbines:
  - chance to hit fish is pretty minimal
  - potential reduction in tidal reach
  - will not block tidal flow
  - drilling may cause destruction of habitat and marine benthos (small/localized)
  - installation of cables may also cause sediment displacement
  - potential pollution from leaking

Case Study: San Francisco
- Power Output of a Single Turbine
  - Over 24 Hours in the SanFrancisco Bay

Tidal Turbine Geographical Requirements:
- Area: At least 300 square meters
- Depth: 30-50m
- Typical Water Speed: 2m/s or more; 4 knots or more
- Water Density: About 1026kg/m^3

Cost Comparison

<table>
<thead>
<tr>
<th>Barrage Power Plants</th>
<th>5990,276,913.13 + 59,900,000,000 kWh</th>
<th>460,000,000 kWh</th>
<th>(x of years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine Power Plants</td>
<td>5990,276,913.13 + 60,000,000 kWh</td>
<td>460,000,000 kWh</td>
<td>x = 12.2 years</td>
</tr>
<tr>
<td>x = 12.2 years</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Barrage | 460,000,000 kWh | 460,000,000 kWh | x = 16.7 years |

<table>
<thead>
<tr>
<th>Single Turbine</th>
<th>3400 MWh</th>
<th>40 GWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equivalent houses</td>
<td>1,021</td>
<td>12,294</td>
</tr>
<tr>
<td>Equivalent Carbon</td>
<td>1516 Tonnes C02/Year</td>
<td>18286 Tonnes C02/Year</td>
</tr>
<tr>
<td>Approximate Cost</td>
<td>5 Million Dollars</td>
<td>46.8 Million Dollars</td>
</tr>
<tr>
<td>Payback Period</td>
<td>10.7 years</td>
<td>9.4 years</td>
</tr>
</tbody>
</table>

Conclusion
- Must have currents of two meters per second and depths of thirty meters for turbines to function and a tidal range of five meters for barrages to work
- Searching through tidal charts, several possible sites exist in the United States such as San Francisco Bay, East River in New York, and several sites in Alaska
- Payback period for tidal turbines is approximately ten years
- Similar to wind powered turbines both in cost and energy generation
- Tidal energy is renewable and has zero emissions
- Could replace a large coal plant