Tidal Power

Turning the Tides on Energy

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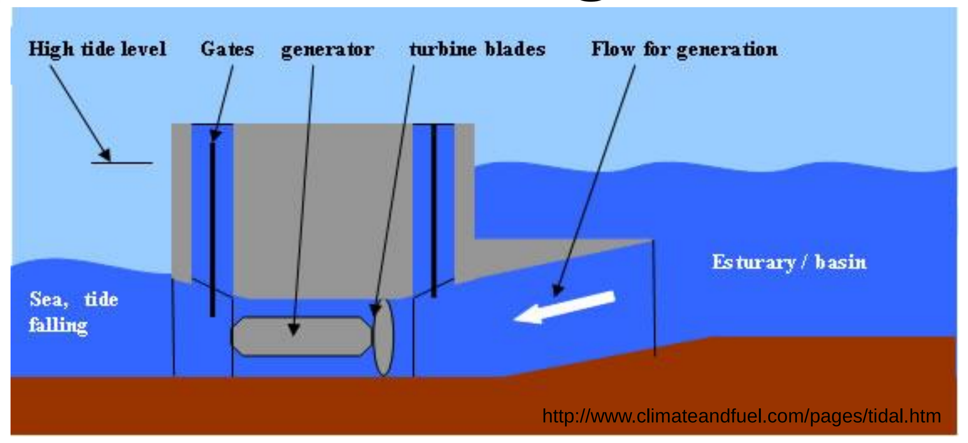
Abstract

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.

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

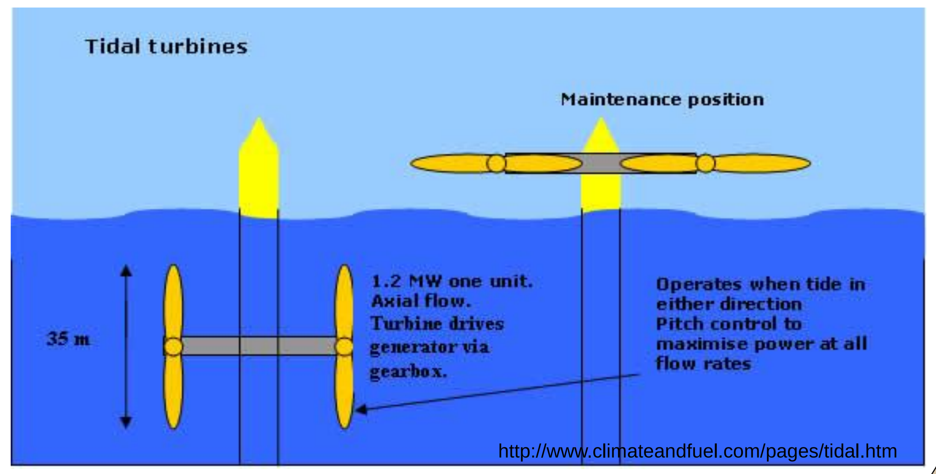
Turbines

Captures the Kinetic Energy of moving tides

Uses "farms" of turbines installed off shore

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

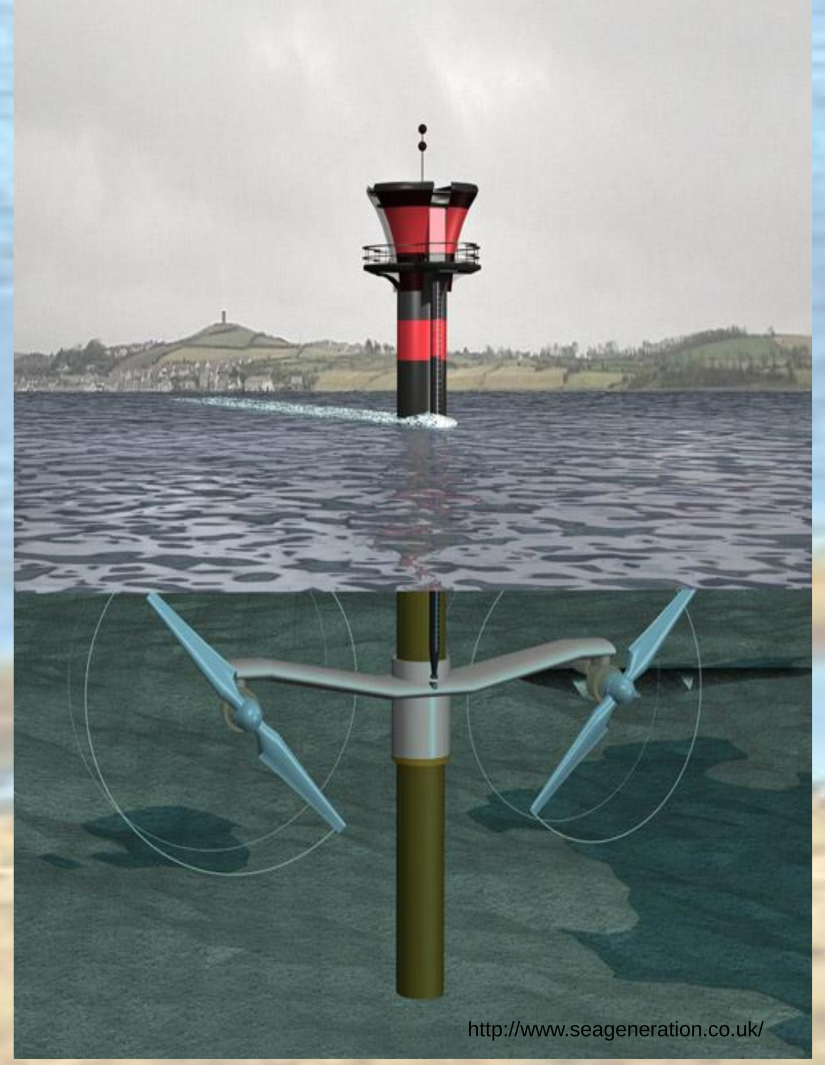
-drilling may cause destruction of habitat and marine benthos (small /localized)

-installation of cables may also cause sediment displacement

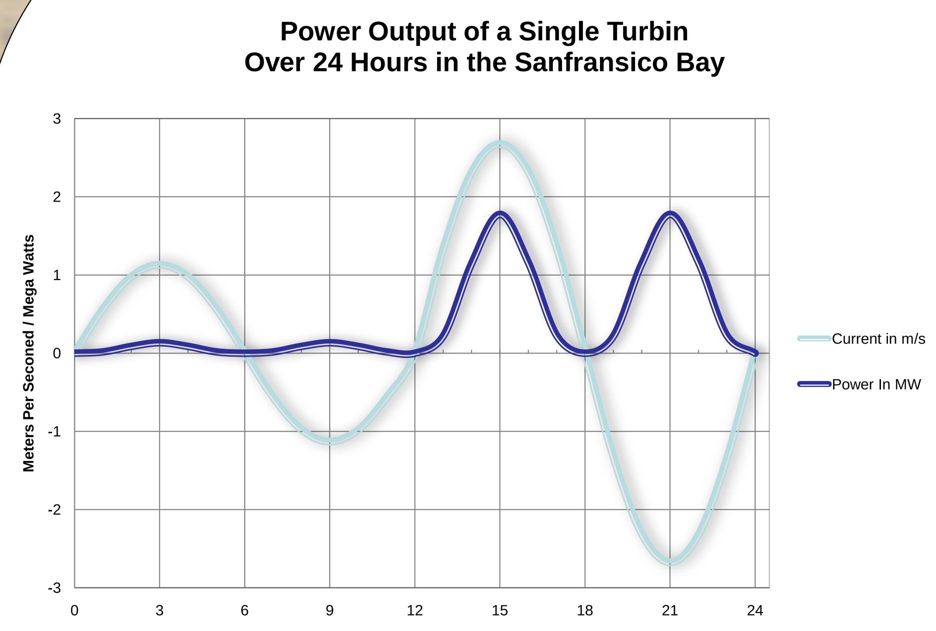
-potential pollution from leaking

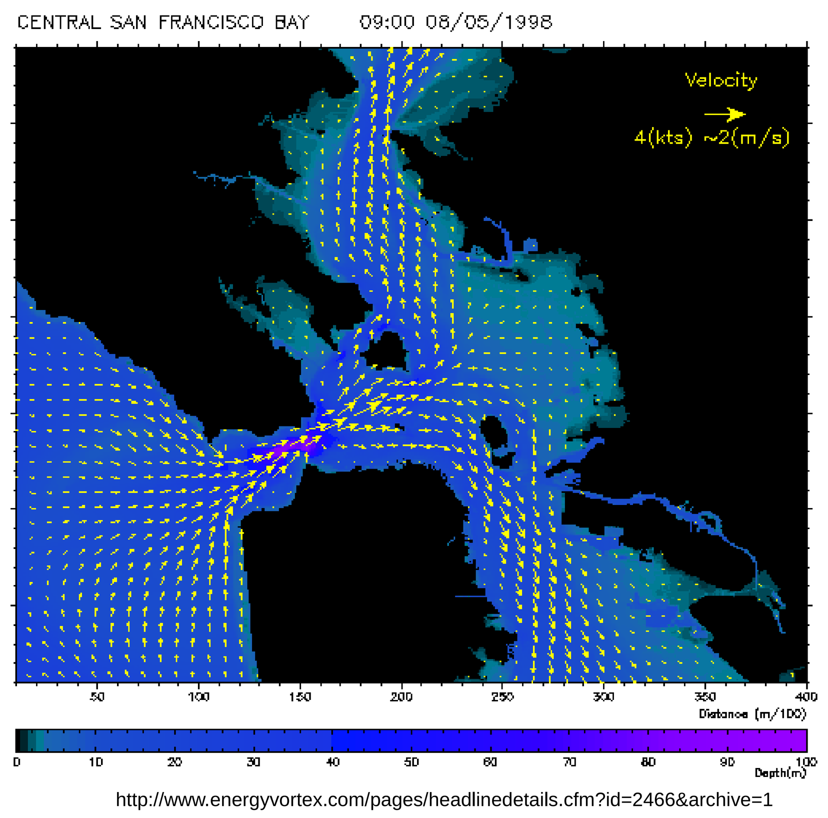
Methodology

- 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



Case Study: San Francisco





$$\$46,800,000 = \frac{\$0.1536 - \$0.0297}{kWh} \times \frac{40,000,000\ kWh}{year} \times (x\ \#\ of\ years)$$

$$\$46,800,000 = \frac{\$0.1239}{kWh} \times \frac{40,000,000\ kWh}{year} \times (x\ \#\ of\ years)$$

$$\$46,800,000 = \$4,956,000\ x$$

$$x = 9.4\ years$$

	Single Turbine	12 Turbine Farm
Yearly Energy Output	3400 MWh	40 GWh
Equivalent houses	1,021	12,294
Equivalent Carbon	1516 Tonnes C02/Year	18286 Tonnes C02/Year
Approximate Cost	5 Million Dollars	46.8 Million Dollars
Payback Period	10.7 years	9.4 years

Cost Comparison

Barrage Power Plants

$$\$900,276,913.13 = \frac{\$0.1536 - \$0.030}{kWh} \times \frac{600,000,000\ kWh}{year} \times (x\ \#\ of\ years)$$

$$\$900,276,913.13 = \frac{\$0.1236}{kWh} \times \frac{600,000,000\ kWh}{year} \times (x\ \#\ of\ years)$$

$$\$900,276,913.13 = \frac{\$74,160,000}{years}\ x$$

$$x = 12.2\ years$$

Turbine Power Plants

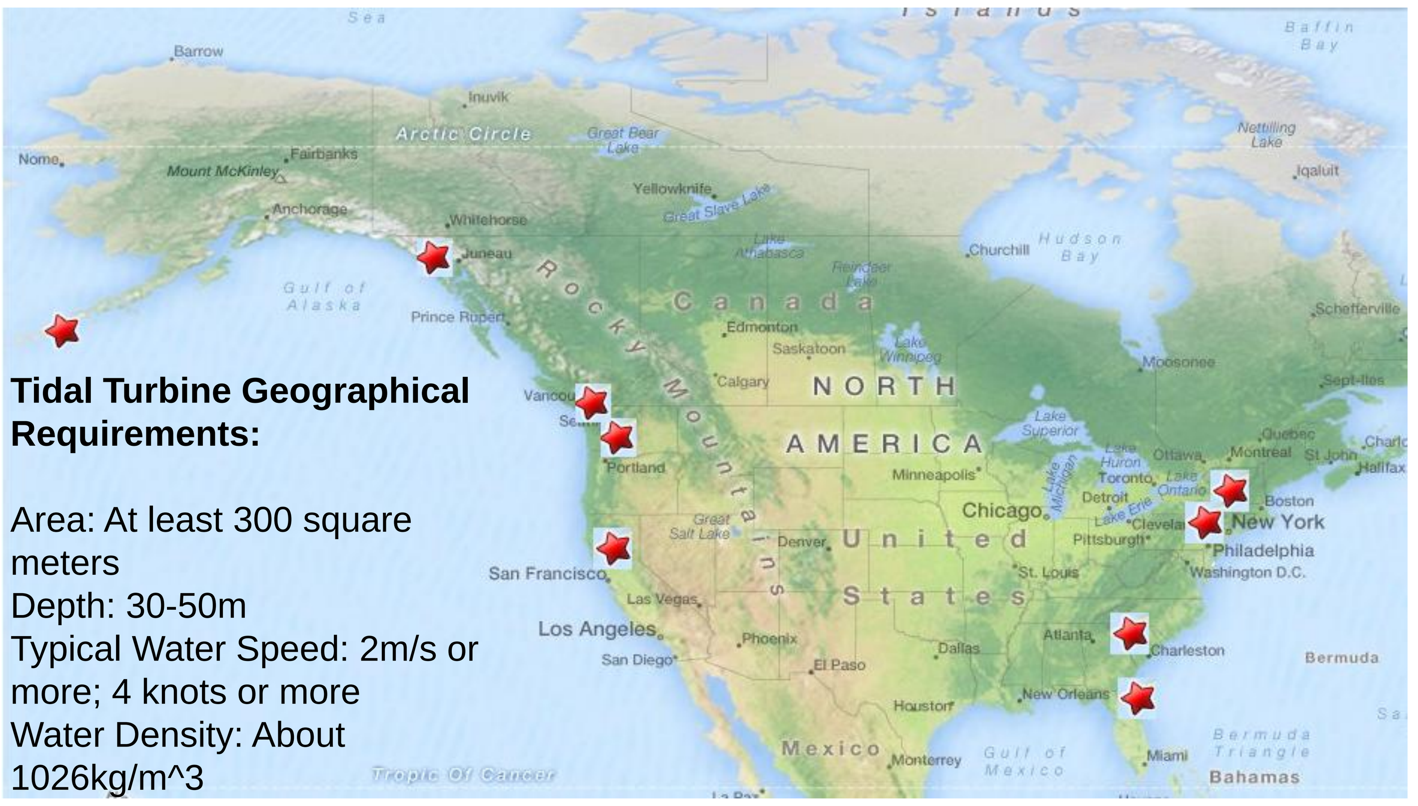
$$\$5,000,000 = \frac{\$0.1536 - \$0.0297}{kWh} \times \frac{3,800,000\ kWh}{year} \times (x\ \#\ of\ years)$$

$$\$5,000,000 = \frac{\$0.1239}{kWh} \times \frac{3,800,000kWh}{year} \times (x\ \#\ of\ years)$$

$$\$5,000,000 = \frac{\$470,820}{year}\ x$$

$$x = 10.7\ years$$

Potential Geographical Locations



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

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