U.S. Tidal Power

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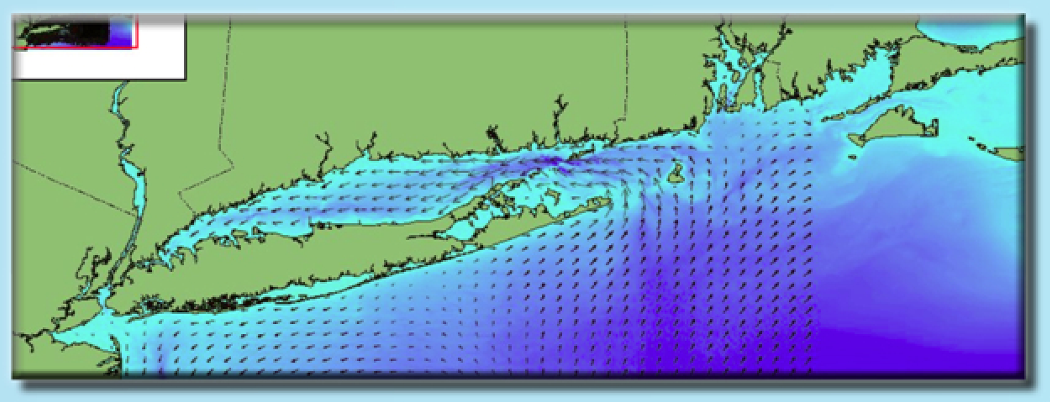
Great Problems Seminar: Power The World

Currently the United States receives less than 7% of its power from renewable hydroelectric sources. In an effort to increase this percentage, we investigate the untapped potential of ocean tidal power. Tidal power is an enormous source of renewable energy, having the capacity to serve as both an abundant and relatively inexpensive source for electricity generation that could forever alter and improve the way in which the US continues to subsist and develop. The potential energy held by tidal power has been so far ignored as a reliable energy process, and is only now in the earliest stages of being utilized. However, due to current research and development, several processes for effectively harnessing tidal power have given the process enough of a competitive edge both economically and in terms of reliability that real, fully functioning projects are now beginning. Many coastal areas would in one way or another benefit from the implementation of tidal power, as it is both a perpetual and predictable source of clean energy. If enough interest and financial backing for further tidal power research continues to remain strong, then the US may after all find a long term solution to the growing issue of sustainable development.



Barrage:

- Water builds up, due to tides, and flows through tunnels in the dam. The ebb and flow of the tides rotate turbines or generators.
- Blocks navigation of ships, poses threat to fish migration, destroys marine habitat, and changes the size and location of intertidal zones.

Horizontal Axis Turbines:

- An underwater turbine similar to those used in wind farms. These units use rotors which are usually half the size, and capable of producing equal amounts of energy as a wind turbine with a rotor four times as large.
- Must face current in order to operate, so a system that swivels or has reversing blades is required.

Helical Turbines:

- Shape eliminates vibrations and kicks the turbine into motion almost instantly when placed in any current.
- Extremely efficient, up to 35-percent efficiency.
- Rotates regardless of the direction of the current.

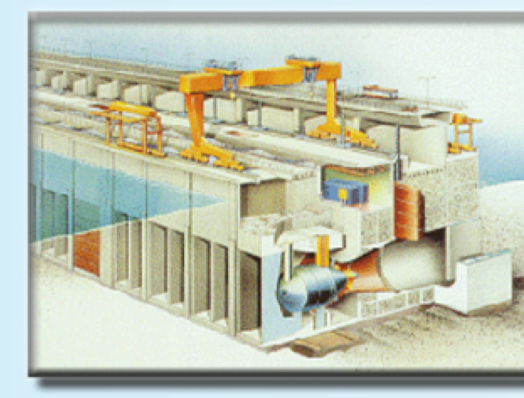
Wave Power:

- Waves move several linked segmented tubes up and down and side to side, shifting an internal fluid, which spins a turbine.
- Produces 70kW per yard on average.
- Large, 450 foot long devices which are visible on the surface of the water. Require a large area of unused open water.

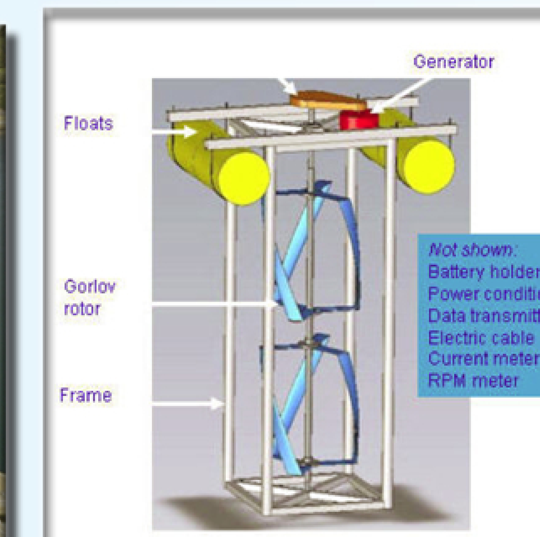
Pelamis Sea Snake

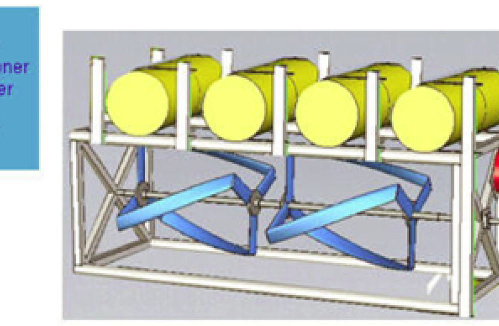
Horizontal Axis Turbines

Tidal Barrage



Helical Turbines





When considering a location for potential tidal power generation, a short list of physical factors ultimately determine whether or not the site is viable. These factors include the area of the waterway and how strong the tidal flow is. An ideal location is one with the greatest concentration of volumetric flow per area. This concept of flow density translates directly into energy density, and ultimately determines how economical it is to generate power from a given site. There are certainly many locations along the United States coast with a large volume of tidal flow. However, the low speed of these tides would require a very large area to be used in order to generate significant amounts of power. This factor ultimately results in tidal power generation being impractical and economically unviable for most coastal areas.

The number of locations in the US which meet the "energy density" criteria describe above is relatively limited. However, even among the ideal sites, there is yet another factor which again reduces there viability for power generation. This factor is location itself. Unlike traditional power plants, which can be constructed in strategic locations, usually near major population centers, tidal power must be generated at the location of the tidal flow. Since some of the best potential locations are in remote coastal areas, with no significant local population, investing in tidal power for these areas is simply not economically viable. Therefore the ideal site for tidal power generation is a water way with relatively high flow rates confined to a small area and a geographic location which is near large population centers.

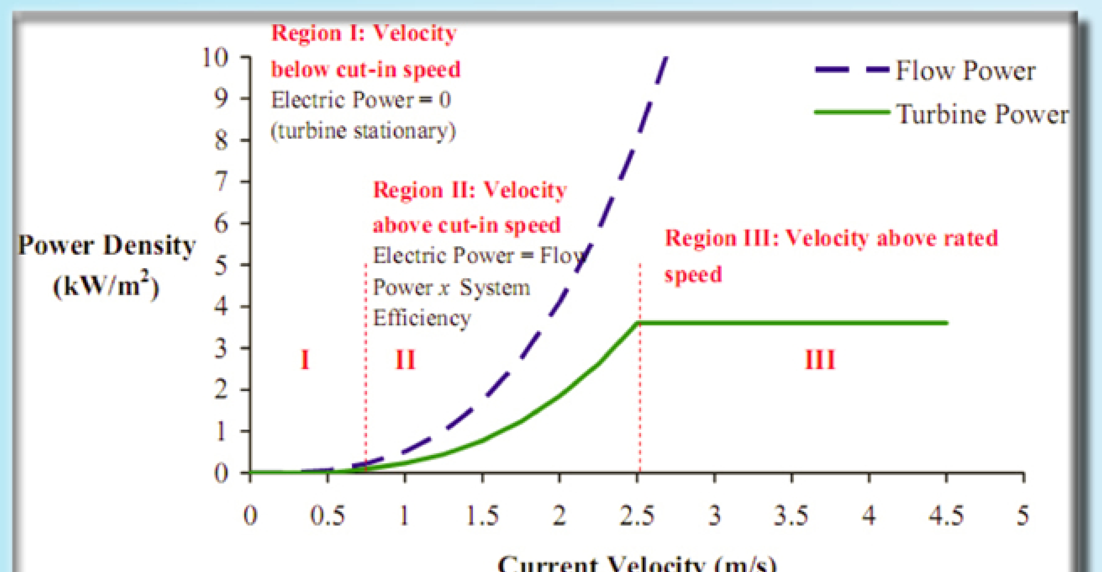
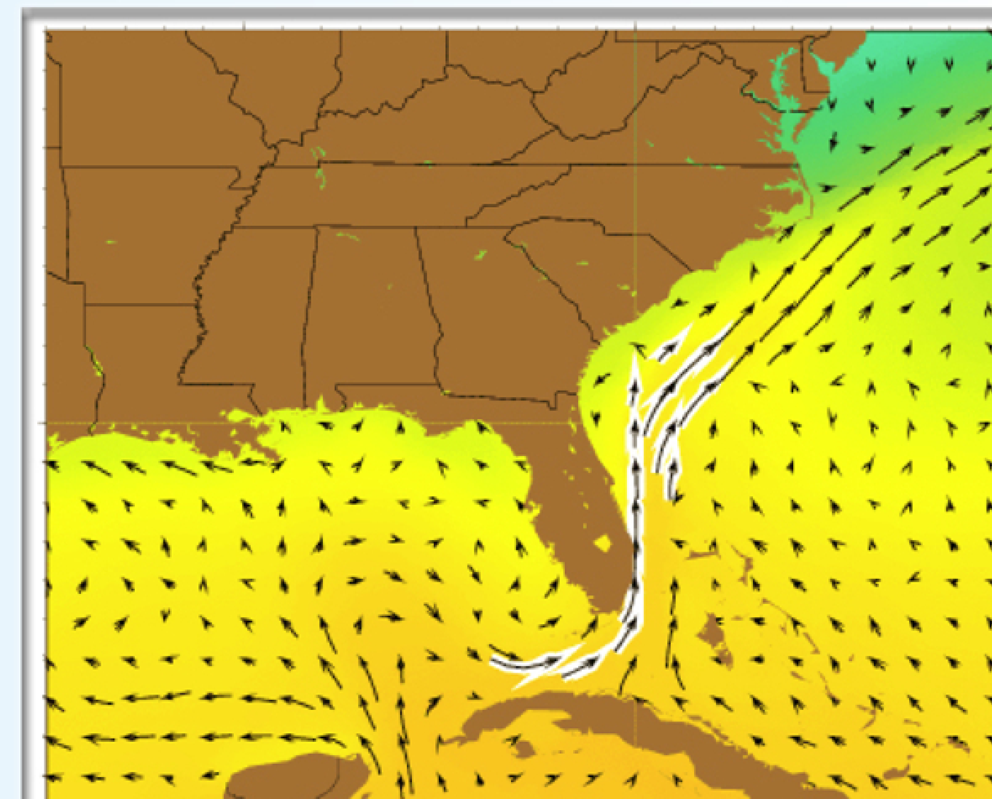


Figure 1-8: Typical Plot of Turbine Output Power versus Flow Speed

San Francisco Bay has a unique geography that makes it an ideal location for tidal power. The bay, connected to the ocean, experiences water level changes due to the tides. All the water that floods in and out of this 450 square mile bay, 400 billion gallons every day, travels through one narrow entrance and can be harnessed by tidal generators. The situation is not perfect, however, as the Golden Gate entrance is used as a major shipping lane for container ships. Even with this difficulty, smaller generators at the bottom of the entrance could produce massive amounts of power because of the fast flow rates. Horizontal axis turbines, with their circular sweep area and possibility of being shrouded, are best suited to the local conditions. Although only a fraction of the bay's tidal power could be harnessed, a project in this area is certainly viable and would contribute enormous renewable energy gains.



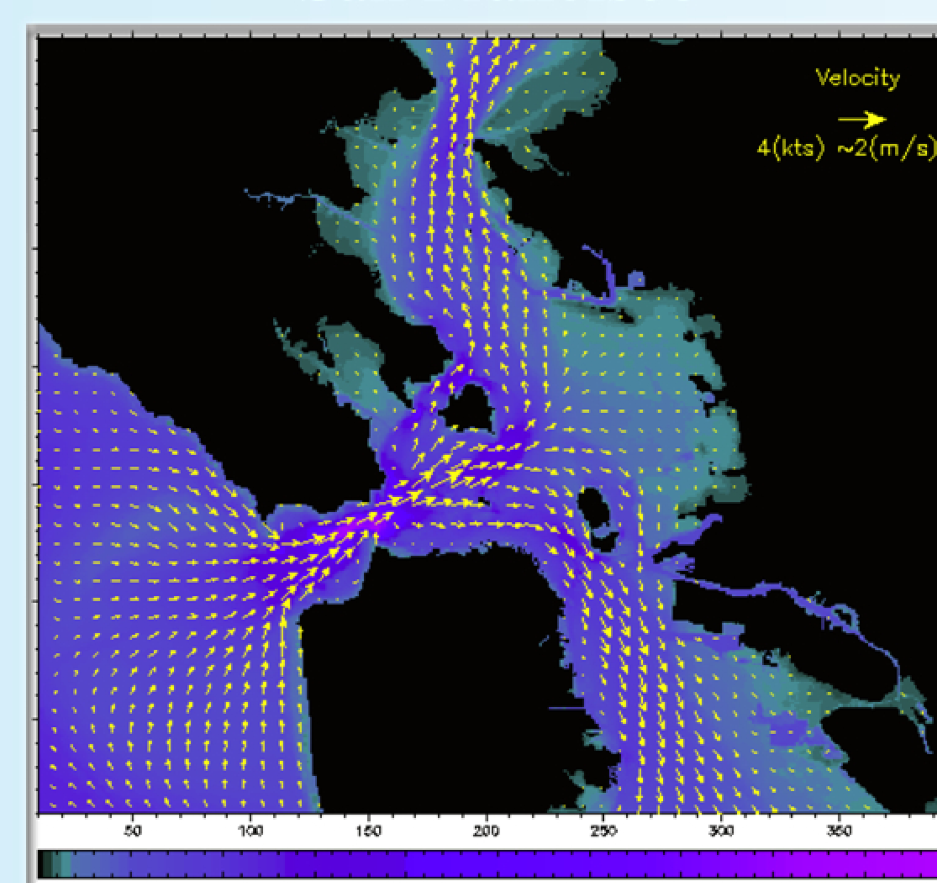
Florida Gulf Stream Current

The Florida Current is a perfect candidate for tidal power. Fast water speeds and a continuous flow make it ideal for horizontal axis turbines. The large sweep area can gather more energy than other designs. However, many problems arise when considering the Florida Current as a possible plant site. Problems include the depth of the water, boat traffic, and laws regarding the use of national and international waters. If these problems can be resolved, this project has the potential to produce a substantial amount of power for the Florida peninsula. Many small generator farms combined could easily contribute significant amounts of power to cities such as Miami. If proper research is done, generators could become more efficient and produce more power with smaller blade diameters. With the fast moving water and the amount of area in the Florida current, immense amounts of energy can be produced.

New York City

Located at the junction of the Hudson River, the East River, and the narrow western end of Long Island Sound, New York City combines both concentrated tidal flows and a very large population center. Directly along the eastern shore of Manhattan lies the East River. It serves as an important transportation and shipping route to and from the New York City area. The section best suited for tidal power use is the 10 km stretch between Wards Island and the tip of Manhattan. In this area, the river width narrows to an average of 0.5 km, while the flow rate increases to over 5 knots during peak times. Currently, the East River is the site of extensive testing for one of the nations first grid connected tidal power turbines. The Roosevelt Island Tidal Energy project, led by Virginia based Verdant Power Inc., began in 2002 with extensive environmental analysis and permitting along with prototyping and site overview. December 2006 marked a monumental step, with the installation of the first of six fully functioning turbines. These preliminary units feature an axial flow rotor with 5 meter diameter blades. So far, they have been outputting approximately 35 kW of power each.

San Francisco



RITE Turbine Design

Based on the finding in this project, it can be concluded that tidal power has the potential to be an extremely powerfull and economically feasible source of alternative energy. However, more research and test projects are needed to develop standardized methods and procedures for processes such as site selection, regulatory approval, and unit installation. A major factor which would accelerate the development of tidal power is federal funding for research projects. Additionally, changing or passing new legal procedures for the approval process would also allow tidal power projects to go from concept to completion in a much shorter time period. Since most tidal power technologies have significantly less environmental impacts compared to other hydroelectric installations, a new regulatory approval process seems appropriate.