Tidal Energy

What are good areas for exploiting tidal energy?
What is the impact on the environment?
What are anticipated costs of tidal energy?
What are some of the devices for tidal energy conversion?

What is tidal energy? Tidal energy is one of the oldest forms of energy used by humans. Indeed, tide mills, in use on the Spanish, French and British coasts, date back to 787 A.D.. Tide mills consisted of a storage pond, filled by the incoming (flood) tide through a sluice and emptied during the outgoing (ebb) tide through a water wheel. The tides turned waterwheels, producing mechanical power to mill grain. We even have one remaining in New York- which worked well into the 20th century. Tidal power is non-polluting, reliable and predictable.Tidal barrages, undersea tidal turbines - like wind turbines but driven by the sea - and a variety of machines harnessing undersea currents are under development. Unlike wind and waves, tidal currents are entirely predictable. Tidal energy can be exploited in two ways: * By building semi-permeable barrages across estuaries with a high tidal range. * By harnessing offshore tidal streams. Barrages allow tidal waters to fill an estuary via sluices and to empty through turbines. Tidal streams can be harnessed using offshore underwater devices similar to wind turbines. Most modern tidal concepts employ a dam approach with hydraulic turbines. A drawback of tidal power is its low capacity factor, and it misses peak demand times because of 12.5 hr cycle of the tides. The total world potential for ocean tidal power has been estimated at 64,000 MWe. The 25-30 ft tidal variations of Passamaquoddy Bay (Bay of Fundy) have the potential of between 800 to 14,000 MWe.

Where are good areas for exploiting tidal energy?

Tidal range may vary over a wide range (4.5-12.4 m) from site to site. A tidal range of at least 7 m is required for economical operation and for sufficient head of water for the turbines. Hammerfest Traditional tidal electricity generation involves the construction of a barrage across an estuary to block the incoming and outgoing tide. The dam includes a sluice that is opened to allow the tide to flow into the basin; the sluice is then closed, and as the sea level drops, the head of water (elevated water in the basin) using traditional hydropower technology, drives turbines to generate electricity. Barrages can be designed to generate electricity on the ebb side, or flood side, or both. Tidal range may vary over a wide range (4.5-12.4 m) from site to site. A tidal range of at least 7 m is required for economical operation and for sufficient head of water for the turbines. A 240 MWe facility has operated in France since 1966, 20 MWe in Canada since 1984, and a number of stations in China since 1977, totaling 5 mWw. Tidal energy schemes are characterised by low capacity factors, usually in the range of 20-35%. The waters off the Pacific Northwest are ideal for tapping into an ocean of power using newly developed undersea turbines. The tides along the Northwest coast fluctuate dramatically, as much as 12 feet a day. The coasts of Alaska, British Columbia and Washington, in particular, have exceptional energy-producing potential. On the Atlantic seaboard, Maine is also an excellent candidate. The undersea environment is hostile so the machinery will have to be robust.

Currently, although the technology required to harness tidal energy is well established, tidal power is expensive, and there is only one major tidal generating station in operation. This is a 240 megawatt (1 megawatt = 1 MW = 1 million watts) at the mouth of the La Rance river estuary on the northern coast of France (a large coal or nuclear power plant generates about 1,000 MW of electricity). The La Rance generating station has been in operation since 1966 and has been a very reliable source of electricity for France. La Rance was supposed to be one of many tidal power plants in France, until their nuclear program was greatly expanded in the late 1960's. Elsewhere there is a 20 MW experimental facility at Annapolis Royal in Nova Scotia, and a 0.4 MW tidal power plant near Murmansk in Russia. UK has several proposals underway. Studies have been undertaken to examine the potential of several other tidal power sites worldwide. It has been estimated that a barrage across the Severn River in western England could supply as much as 10% of the country's electricity needs (12 GW). Similarly, several sites in the Bay of Fundy, Cook Inlet in Alaska, and the White Sea in Russia have been found to have the potential to generate large amounts of electricity.

What is the impact on the environment? Tidal energy is a renewable source of electricity which does not result in the emission of gases responsible for global warming or acid rain associated with fossil fuel generated electricity. Use of tidal energy could also decrease the need for nuclear power, with its associated radiation risks. Changing tidal flows by damming a bay or estuary could, however, result in negative impacts on aquatic and shoreline ecosystems, as well as navigation and recreation. The few studies that have been undertaken to date to identify the environmental impacts of a tidal power scheme have determined that each specific site is different and the impacts depend greatly upon local geography. Local tides changed only slightly due to the La Rance barrage, and the environmental impact has been negligible, but this may not be the case for all other sites. It has been estimated that in the Bay of Fundy, tidal power plants could decrease local tides by 15 cm. This does not seem like much when one considers that natural variations such as winds can change the level of the tides by several metres.

What are the costs of tidal energy?

Tidal power is a form of low-head hydroelectricity and uses familiar low-head hydroelectric generating equipment, such as has been in use for more than 120 years. The technology required for tidal power is well developed, and the main barrier to increased use of the tides is that of construction costs. There is a high capital cost for a tidal energy project, with possibly a 10-year construction period. Therefore, the electricity cost is very sensitive to the discount rate. The major factors in determining the cost effectiveness of a tidal power site are the size (length and height) of the barrage required, and the difference in height between high and low tide. These factors can be expressed in what is called a site's "Gibrat" ratio. The Gibrat ratio is the ratio of the length of the barrage in metres to the annual energy production in kilowatt hours (1 kilowatt hour = 1 KWH = 1000 watts used for 1 hour). The smaller the Gibrat site ratio, the more desireable the site. Examples of Gibrat ratios are La Rance at 0.36, Severn at 0.87 and Passamaquoddy in the Bay of Fundy at 0.92. Offshore tidal power generators use familiar and reliable low-head hydroelectric generating equipment, conventional marine construction techniques, and standard power transmission methods. The placement of the impoundment offshore, rather than using the conventional "barrage" approach, eliminates environmental and economic problems that have prevented the deployment of commercial-scale tidal power plants.

Three projects (Swansea Bay 30 MW, Fifoots Point 30 MW, and North Wales 432 MW) are in development in Wales where tidal ranges are high, renewable source power is a strong public policy priority , and the electricity marketplace gives it a competitive edge. Q. What are some of the devices for tidal energy conversion? The technology required to convert tidal energy into electricity is very similar to the technology used in traditional hydroelectric power plants. The first requirement is a dam or "barrage" across a tidal bay or estuary. Building dams is an expensive process. Therefore, the best tidal sites are those where a bay has a narrow opening, thus reducing the length of dam which is required. At certain points along the dam, gates and turbines are installed. When there is an adequate difference in the elevation of the water on the different sides of the barrage, the gates are opened. This "hydrostatic head" that is created, causes water to flow through the turbines, turning an electric generator to produce electricity. Electricity can be generated by water flowing both into and out of a bay. As there are two high and two low tides each day, electrical generation from tidal power plants is characterized by periods of maximum generation every twelve hours, with no electricity generation at the six hour mark in between. Alternatively, the turbines can be used as pumps to pump extra water into the basin behind the barrage during periods of low electricity demand. This water can then be released when demand on the system its greatest, thus allowing the tidal plant to function with some of the characteristics of a "pumped storage" hydroelectric facility. What are some of the devices for tidal energy conversion? The technology required to convert tidal energy into electricity is very similar to the technology used in traditional hydroelectric power plants. The first requirement is a dam or "barrage" across a tidal bay or estuary. Building dams is an expensive process. Therefore, the best tidal sites are those where a bay has a narrow opening, thus reducing the length of dam which is required. At certain points along the dam, gates and turbines are installed. When there is an adequate difference in the elevation of the water on the different sides of the barrage, the gates are opened. This "hydrostatic head" that is created, causes water to flow through the turbines, turning an electric generator to produce electricity. Electricity can be generated by water flowing both into and out of a bay. As there are two high and two low tides each day, electrical generation from tidal power plants is characterized by periods of maximum generation every twelve hours, with no electricity generation at the six hour mark in between. Alternatively, the turbines can be used as pumps to pump extra water into the basin behind the barrage during periods of low electricity demand. This water can then be released when demand on the system its greatest, thus allowing the tidal plant to function with some of the characteristics of a "pumped storage" hydroelectric facility.

Why tidal energy? The demand for electricity on an electrical grid varies with the time of day. The supply of electricity from a tidal power plant will never match the demand on a system. But, due to the lunar cycle and gravity, tidal currents, although variable, are reliable and predictable and their power can make a valuable contribution to an electrical system which has a variety of sources. Tidal electricity can be used to displace electricity which would otherwise be generated by fossil fuel (coal, oil, natural gas) fired power plants, thus reducing emissions of greenhouse and acid gasses.