HARNESSING TIDAL CURRENTS

Flood tide rushing to shore (by Jenny Lee Silver @ flickr- click on image for source)

Tidal energy has traditionally been harnessed by the installation of barrages, which resemble low hydro-electric dams. The barrage set-up involves allowing water to flow through sluice gates into an estuary which acts as a large reservoir of water during high tide. At high tide the sluice gates are closed and only opened when the tide begins to ebb away from shore (Sutherland et al 2007, p. 147). At this time, the water behind the barrage is at a height h, and is referred to as the head of water (Elliott 2004, p. 198). At this time, the water's energy is in the form of potential energy, which will be converted to kinetic energy as soon as the sluice gates are opened. As the moving water flows through the barrage it moves the blades of a turbine in the process; the blades power a generator creating mechanical energy that can then be fed into the conventional energy grid in the area (p. 203). There are barrages that can capture energy only in one direction, either on the ebb or flow alone, and then there are also barrages that are two way and can capture energy in both directions (Sutherland et al 2007, p. 147)

La Rance, France built the first tidal power plant in 1964 to harness the power of the waves from the Atlantic Ocean that wash up on its shores (Elliott 2004, p. 197). La Rance has a two way system that has the capacity to generate 240 MW of electricity, but it only produces about 100 MW on average (Sutherland et al 2007, p. 147). Britain is currently proposing to build a larger barrage across the Severn estuary, a small bay of water, to extract energy from the high amplitude waves that wash onto its shores (Elliott 2004, p.197).While the Bay of Fundy in Canada has extremely large waves, the possible environmental impacts of placing a large-scale barrage in the bay, along with high economic costs, have halted any advances in the utilization of tidal energy in that area. There is, however, a small tidal plant at Annapolis Royal in Nova Scotia that produces 50 kW of electricity for nearby homes (Charlier 2003, p. 198). The barrage system at Annapolis Royal is 225 metres long, and it also includes a fish pathway. Unfortunately this pathway has not lowered fish mortality (p. 198).

In the early 1970s, a working group was created to look into the feasibility and the environmental impacts of a potential large-scale barrage in the Bay of Fundy. The committee successfully completed Phase I and Phase II of the assessment project; however, the completion of a tidal power plant was held up in the review stage by 1975 due to inadequate funds to start the creation of the barrage (Chang 2008, p. 40). A smaller-scale tidal power plant was completed at Annapolis Royal in 1984 instead (p. 41). Some of the environmental impacts of the barrages on marine life are similar to those of the hydroelectric dams: a decrease in the tidal current speed as well as prolonged high tide inside the catch basin. The result is that water quality can be reduced significantly affecting wildlife in the area (Sutherland et al 2007, p.147).The environmental impacts of barrages are a large factor in causing most tidal power stations to be built on only a fairly small scale; economic viability also impacts creation of large tidal power plants (Chang 2008, p. 40).

Annapolis Royal: ebb tide flow (photo by cphoffman42 @flickr--click on image for source)

Currently, the idea of utilizing tidal power in the Bay of Fundy is being revisited thanks to recent improvements in tidal current technologies. These technologies claim to have fewer negative environmental impacts, but is this really the case? (Sutherland et al 2007, p. 148). The technologies to capture the power of tidal currents resemble wind mills in their design. These in-stream water turbines are easier to build because the density of water is about 800 times denser than air thereby making it easier to capture the water's energy. For this reason, the blades of the tidal turbine need to rotate fewer times to get the same wattage of power as a wind turbine (Couch & Bryden 2003, p. 2). When comparing wind and water turbines it is also important to consider that the velocity of wind is also higher, meaning that the wind flows faster than the tidal currents (p. 2). A second benefit of using tidal currents for energy production is that engineers can better anticipate the directions of the water currents more accurately than for wind currents. Wind currents can come from any direction whereas the water currents come from a predictable direction (p. 2-3).

Harnessing the power from tidal currents is said to be cheaper and more ecologically sustainable (Sutherland et al 2007, p. 147). In-stream tidal turbines do not obstruct the entire waterway in the same way that barrages do (Chang 2008, p. 52). While the environmental impact may not be as noticeable in a single water turbine, water turbine farms could change the nature of the tidal current overtime. Fish in the area, which rely on the current to orient themselves, could get disoriented (Allard 2004) and even struck by the blades of the turbine depending on the turbine design.

Researchers Couch and Bryden performed a mathematical model analysis to discover that, assuming steady current flow, the energy that can be harnessed from tidal currents is significant (Couch & Bryden 2003, p. 3). They also postulate that real-life situations are more complex and, as result, other geographic factors must be assessed along with the current flow (Couch and Bryden 2006, p. 139).

In 2002, Marine Current Turbines Ltd. installed one turbine with a generating capacity of 300 kW in Lynmouth, Devon, UK as a pilot project. This generator could only capture energy from current flowing in one direction (Sutherland et al 2007, p. 148). The company recently installed the SeaGen turbine in May 2008 in Strangford Lough. The SeaGen has twin rotors that each sweep over 200 square metres of flow. They also generate power from bi-directional flow at 45% efficiency (MCT 2010). Please visit (*http://www.marineturbines.com/21/technology/)*to see a photo and *(http://www.marineturbines.com/21/technology/32/seagen_video/)* to see an animation. Another in-stream tidal turbine development is underway in British Columbia at Race Rocks ecological reserve; the project was started in 2006. The generator is made by the company Clean Current and has a very different design than

SeaGen (CC 2009). Please see *(http://www.cleancurrent.com/technology/rrproject.htm)* to view detailed photos.

Models of kinetic power generator for tidal currents; similar to the CleanCurrent design used in BC (photo by toddraden @flickr--click on image for source)

Nova Scotia is also in the process of assessing potential environmental impacts of in-current tidal technology and is working with technology developers from around the world to pick the best devices for the region. All of this progress is initiated by FORCE (Fundy Ocean Research Centre for Energy), which is Canada's leading research centre for in-stream tidal energy, located in the Bay of Fundy, Nova Scotia (NSDE 2008). Clearly, much great work is being done in the area of tidal power generation technologies.

Bay of Fundy at low tide (photo by jeffsmallwood @flickr--click on image for source)

Source : http://www.sassweb.ca/3bb3/volume1-0/hydroelectric-and-tidal/harnessing-tidal-currents