Wave and Tidal Power Generation

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Abstract

Renewable energy is natural energy which does not have a limited supply. Renewable energy can be used again and again, and will never run out. Now- a -days, the energy which is used in the universe divided into two parts. One is the non-renewable or conventional other is renewable or non-conventional energy, classification of energy is shown below by a checker board. Tidal Power is the generation of electrical power through the harnessing of the ebb and flow of the tides or ***Tidal power****, also called* ***tidal energy****, is a form of hydropower that converts the energy of tides into electricity or other useful forms of power. Only a few such plants exist. The largest is the Range Tidal Power Station, on the Rance River, in France, which has been operating since 1966, and generates 240MW. Smaller plants include one on the Bay of Fundy, and another across a tiny inlet in Kislaya Guba, Russia).*

Keywords*: Wave Power, Tidal Power, Ocean Wave, Tidal Power Plant.*

I. Introduction

The energy available from a barrage is dependent on the volume of water. The potential energy contained in a volume of water is:

$$E = \frac{1}{2} A \rho g h^2$$

Where:
h is the vertical tidal range, *A* is the horizontal area of the barrage basin, ρ is the density of water = 1025 kg per cubic meter (seawater varies between 1021 and 1030 kg per cubic meter) and *g* is the acceleration due to the Earth's gravity = 9.81 meters per second squared [1-11].
The factor half is due to the fact, that as the basin flows empty through the turbines, the hydraulic head over the dam reduces. The maximum head is only available at the moment of low water, assuming the high water level is still present in the basin [12-19].

II. Methodology

II A. (i) Types of Tidal Power Plant

First-generation, barrage-style tidal power plants - *no longer feasible!*
Today's choice: Second-generation, tidal current power production.

(a)First-generation, barrage-style tidal power plants:

First-generation, barrage-style tidal power plants - *no longer feasible!*
The oldest technology to harness tidal power for energy generation involves building a dam or a barrage, across a bay or estuary that has large differences in elevation between high and low tides. Water retained behind a dam at high tide generates a power head sufficient to generate electricity as the tide ebbs and water released from within the dam turns conventional turbines[20-28].
Though the American and Canadian governments considered constructing ocean dams to harness the power of the Atlantic tides in the 1930s, the first commercial-scale tidal generating barrage rated at 240 MW was built in La Rance, This plant continues to operate today as does a smaller plant constructed in 1984 with the Annapolis Royal Tidal Generating Station in Nova Scotia, rated at 20 megawatts (enough power for 4,500 homes). One other tidal generating station operating today is located near Murmansk on the White Sea in Russia, rated at 0.5 megawatts. Though they have proven very durable, barrage-style power plants are very expensive to build and are fraught with environmental problems from the accumulation of silt within the dam catchment area (requiring regular, expensive dredging). Accordingly, engineers no longer consider barrage-style tidal power feasible for energy generation [29-37].

(b) *Today's choice:* Second-generation, tidal current power production:
Engineers have recently created two new kinds of devices to harness the energy of tidal currents (AKA 'tidal streams') and generate renewable, pollution-free electricity. These new devices may be distinguished as Vertical-axis and Horizontal-axis models, determined by the orientation of a subsea, rotating shaft that turns a gearbox linked to a turbine with the help of large, slow-moving rotor blades. Both models can be considered a kind of underwater windmill. While horizontal-axis turbine prototypes are now being tested in northern Europe (the UK and Norway) a vertical-axis turbine has already been successfully tested in Canada. Tidal current energy systems have been
Endorsed by leading environmental organizations, including Greenpeace, the Sierra Club of British Columbia and the David Suzuki Foundation as having "the lightest of environmental footprints," compared to other large-scale energy systems[38-46].

II B. Additional advantages of tidal current power generation:

Like the ocean dam models of France, Canada and Russia, vertical and horizontal-axis tidal current energy generators are fueled by the renewable and free forces of the tides, and produce no pollution or greenhouse gas emissions. As an improvement on ocean dam models, however, the new models offer many additional advantages:

-Because the new tidal current models do not require the construction of a dam, they are considered much less costly[47-58].

-Because the new tidal current models do not require the construction of a dam, they are considered much more environmentally-friendly.

-Because the new tidal current models do passage of water such as a fiord and offer a transportation corridor (bridge), essentially providing two infrastructure services for the price of one.

- Vertical-axis tidal generators may be joined together in series to create a 'tidal fence' capable of generating electricity on a scale comparable to the largest existing fossil fuel based, hydroelectric and nuclear energy generation facilities.

-Tidal current energy, though intermittent, is predictable with exceptional accuracy many years in advance. In other words, power suppliers will easily be able to schedule the integration of tidal energy with backup sources well in advance of requirements. Thus, among the emerging renewable energy field, tidal energy represents a much more reliable energy source than wind, solar and wave, which are not predictable[59-70].

- Present tidal current, or tidal stream technologies are capable of exploiting and generating renewable energy in many marine environments that exist worldwide. Canada and the US, by virtue of the very significant tidal current regimes on its Atlantic and Pacific coastlines – proximal to existing, significant electro-transportation infrastructure - is blessed with exceptional opportunities to generate large-scale, renewable energy for domestic use and export. not require the construction of a dam, further cost-reductions are realized from not having to dredge a catchment area[71-89].

- Tidal current generators are also considered more efficient because they can produce electricity while tides are ebbing (going out) and surging (coming in), whereas barrage style structures only generate electricity while the tide is ebbing[90-10].

- Vertical-axis tidal generators may be stacked and joined together in series to span.

Fig.1 Tidal Energy Generation

II C. Classification Tidal Turbines

1. **Vertical-axis tidal turbine**

Fig.2 Vertical-axis tidal turbine

2. Cutaway graphic of a ‘mid-range-scale’ (2 x 250 kW) vertical-axis tidal turbine.

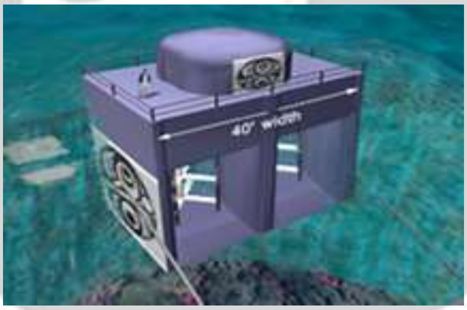


Fig.3 Cutaway graphic of a ‘mid-range-scale’ (2 x 250 kW) vertical-axis tidal turbine

3. Horizontal-axis tidal turbine

Fig.4 Horizontal-axis tidal turbine

3. **Hammerfest Strom horizontal-axis turbine being deployed in demonstration project, Northern Norway, 2003.**

Fig.5 Hammerfest Strom horizontal-axis turbine being deployed in demonstration project, Northern Norway, 2003

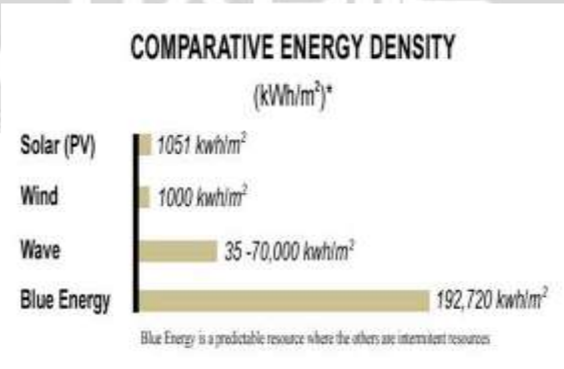
II D. Cost of the Tidal Energy

No, tidal energy power systems are expected to be very competitive with other conventional energy sources, and excellent cost advantages arise from there being no pollution or environmental expenses to remediate nor are their fuel expenses (the kinetic energy of tidal currents is free). Further, ongoing maintenance costs are expected to be modest, as they are with other large-scale marine infrastructures, e.g. bridges, ships, etc., and a non-polluting tidal energy regime will qualify for valuable carbon offset credits. A 2002 feasibility report on tidal current energy in British Columbia by Triton Consultants for BC Hydro stated, "Future energy costs are expected to reduce considerably as both existing and new technologies are developed over the next few years. Assuming that maximum currents larger than 3.5 m/s can be exploited and present design developments continue, it is estimated that future tidal current energy costs between 5¢ / kWh and 7¢ / kWh are achievable [101-105].

II E. Environmental Overview–Tidal Current Power Production:

1. Life-cycle Assessment 2. Environmental Signature 3. Main Environmental Concerns & Mitigation

II.F: Chart illustrating the comparative energy advantage of Blue Energy's vertical axis tidal current turbine system over other renewable energy options:



II.G: Life-cycle Assessment

1. Construction of components, including thin-shelled (reinforced concrete) marine caissons, durable steel turbines, electrical generation equipment, electrical transmission cables, other infrastructure)
2. Transportation, assembly and installation of energy generation system
3. Operation and maintenance of energy generation system
4. Removal, disassembly and recycling of components

II.K: Environmental Signature

- expected long-life of components (thin-shelled marine caissons, durable steel turbines, electrical generating equipment, electrical transmission cables)
- requires no fuel
- produces no emissions
- produces no waste products during operation
- little or no siltation expected during operation
- open sluice, slow-rotor design allows for easy passage of fish and marine invertebrates
- minimal noise expected during operation
- minimal EMF (electro-magnetic field) expected during operation

II.L: Main Environmental Concerns & Mitigation:

i. Impact on fish and marine mammal movement and/or migration
Mitigation: rotors stop at slack tide, protective barriers, sensory braking technology, acoustical tracking technology to guide fish and mammals[111-118]
ii. deflection of local energy regime (as energy is removed by turbines)
Response: energy displacement is NOT expected to be significant
iii. Marine fouling (encrustation) of energy system components by algae and invertebrates
Mitigation: use of non-toxic, anti-fouling materials
Iv. Noise and/or electro-magnetic fields (EMFs) in marine environment
Response: noise and/or EMF from operation expected to be minimal

II.L: From the Conclusion to 'Wave and Tidal Energy':

"As we begin to contemplate the potentially catastrophic consequences of environmental pollution and global climate change and the soaring demands for energy across the world, it is becoming increasingly clear that how we supply our energy needs will be one of the critical questions of the 21st Century. The urgent need to cut carbon emissions to counter global climate change and environmental problems now means that we must explore the potential of all significant sources of renewable energy." "We can no longer afford to neglect the potential of wave and tidal energy."

II.M Tides In Bangladesh Waters:

There are six major entrances through which tidal waves penetrate into the waterways system in Bangladesh and these are[106-110]:

1. The Pussur Entrance,
2. The Harin Chata Entrance,
3.The Tentulia Entrance,
4. The Shahbazpur Entrance,
5. The Hatiya River Entrance, and
6. The Sandwip Channel Entrance.

Originating in the Indian Ocean, tides enters the Bay of Bengal through the two submarine canyons, the 'SWATCH OF NO GROUND' and the Burma trench and thus arrives very near to the 10 fathom contour line at Hiron Point and Cox's Bazar respectively at about the same time. Of the principal constituents, most dominant are M2 and S2 whose natural periods of oscillations are 12 hours 25 minutes and 12 hours respectively. Extensive shallowness of the North-Eastern Bay gives rise to partial reflections thereby increasing the tidal range and the friction distortions concurrently. Large seasonal effects of meteorological origin coupled with the complexity of the non-linear shallow water interaction give rise to considerable number of higher harmonic representation of tide which has to be extended to accommodate all possible terms and make it as nearly representative as possible[119-120].

III. Conclusion

"Although more research needs to be carried out, the environmental impact of wave and tidal devices appears to be minimal." "Effect on marine life. Concerns have been raised about the danger to marine animals, such as seals and fish, from wave and tidal devices. We have had no evidence that this is a significant problem. Such devices may actually benefit the local fauna by creating non-fishing 'havens' and structures such as anchoring devices may create new reefs for fish colonization."

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