TIDAL HYDRAULIC TURBINES LTD

This project is supported by Pembrokeshire Coast National Park through the Environmental Development Fund

TIDAL HYDRAULIC GENERATORS LTD

A BRIEF SUMMARY OF THE PEMBROKESHIRE TIDAL ENERGY PROJECT

The project commenced in 1997, following work with the Pembrokeshire Coast Marine Nature Reserve.

A wave monitoring buoy was established in St Brides Bay about 2 miles off the Pembrokeshire Coast.

It was apparent from the difficulty in mooring the buoy that a considerable current was present in this area . This was later estimated to be up to 3.5 knots, with very little turbulence visible on the surface.

The Marine Reserve have concerns over stray fishing trawlers creating havoc with rare coral etc in the reserve, and were investigating ways these areas could be protected.

One way that was discussed, was to establish a water turbine farm, similar to a wind farm, and create a no fishing area, where fish stocks and sea flora could develop.

The problem with conventional technology was that it would create a great deal of disturbance fixing the structures to the sea bed.

From information gained from the buoy the maximum wave height measured in that area was slightly under 40 feet from peak to trough.

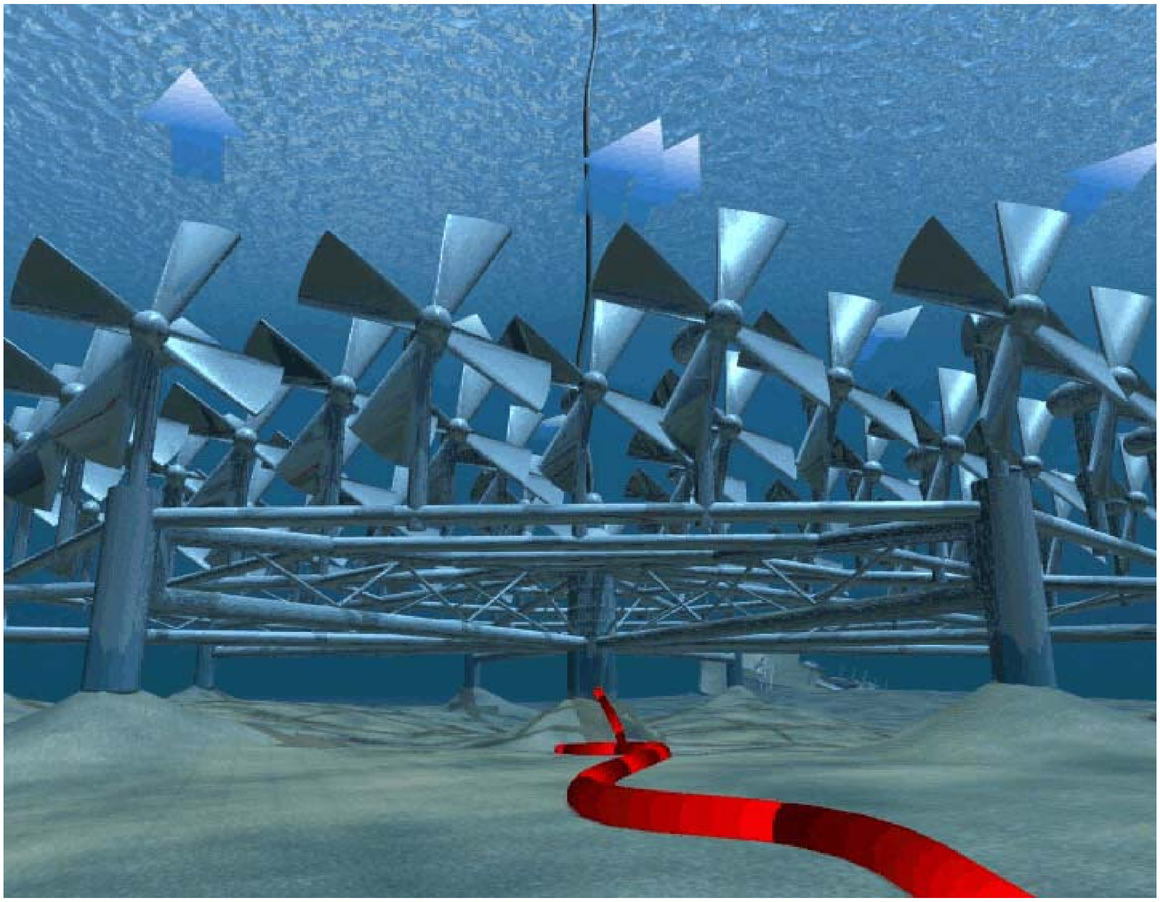
Wave damage could therefore be expected down to a depth of about 150 ft, as a rule of thumb.

The sea depth is about 200 ft.

Any energy capturing device would need therefore to work in the area between 150 ft and 200 ft.   Energy density in kinetic water movement is comparable to wind energy, but more difficult to transmit. As the blade size was going to be limited by height the only way that a cost effective system could be developed was to expand sideways.

As the proposed system was to be used in a National Park environmental consideration were paramount.
Many systems were considered. The favourite for some time was a series of vertical mounted rotors similar in operation to an anemometer.

Animation still of the rig as viewed from the seabed



TYPICAL SEABED INSTALLATION. THE UNIT IS BALLASTED TO HOLD IN PLACE. THE TURBINE HEADS CAN TURN THROUGH 360 DEGREES TO SEEK THE TIDAL DIRECTION. THE ABOVE IS SCHEMATIC ONLY, AND DOES NOT SHOW THE ACTUAL BLADE SHAPE , CLEANING SYSTEM, BEARING SYSTEM ETC.

AT THE CURRENT REQUIRED FOR COST EFFECTIVE USE IT IS LIKELY THAT THE SEABED WILL BE ROCK ,OR SCOURED DOWN TO HEAVY AGGREGATES, RATHER THAN LIGHT SAND AS REPRESENTED HERE

These were fixed to a series of water pumps. The rotors gathered energy from a large area of water moving at 3 to 4 kt and transformed in into a smaller quantity of water travelling at high pressure in a pipe system similar to a conventional hydroelectric scheme.

Problems came from the complexity of the design, and fouling of moving parts.

A much simpler design is the current schematic of a lattice structure, with multiple independent free flow turbines. High torque low revving hydraulic pumps are very efficient. All the energy gathered is to be collected at one central point were a high torque motor would drive a generator.

The advantages of this system were many fold.

Because the sea bed currents are a known rate the maximum loading can be calculated with out regard to storm loadings as in wind turbines.

The lattice can be held in place by self weight to avoid seabed damage.

Many existing systems can be used to position and recover such a structure.

The stress in the structure is in direct relation to the water speed and can simply be designed in mild steel using impressed current as an anti corrosion system.

Vegetable oil can act as an environmentally friendly lubricant.

Ships propeller shaft technology can provide well proven seals with a life of over 25 years.

A pressure compensating system will ensure that even at 200 ft down the pressure inside the seals is the same as outside.

The power transmission systems are used in many already existing fields. Submersible pump technology is well established, a submersible generator could not pose many technical problems.

It was therefore theoretically possible to construct a generator from existing technology apart from one critical area.

There was a lack of knowledge generally, regarding power transmission from water to free running turbine blades at low speed, especially after prolonged exposure to fouling.

Computer modelling gave very interesting results, tending to be confirmed by the trials carried out by John Swanson in the Northern Territories of Australia, during our development programme.

It was also apparent that if an inexpensive and reliable system could be developed there were many hundreds of suitable sites even around Britain.
Tip speed, shaft speed, torque, drag and cyclic fouling, and surface coverings, could only be ascertained by actual field trials, using almost full scale turbine blades.

Although naturally antifouling materials could be used, even a film of marine growth would hugely affect drag.

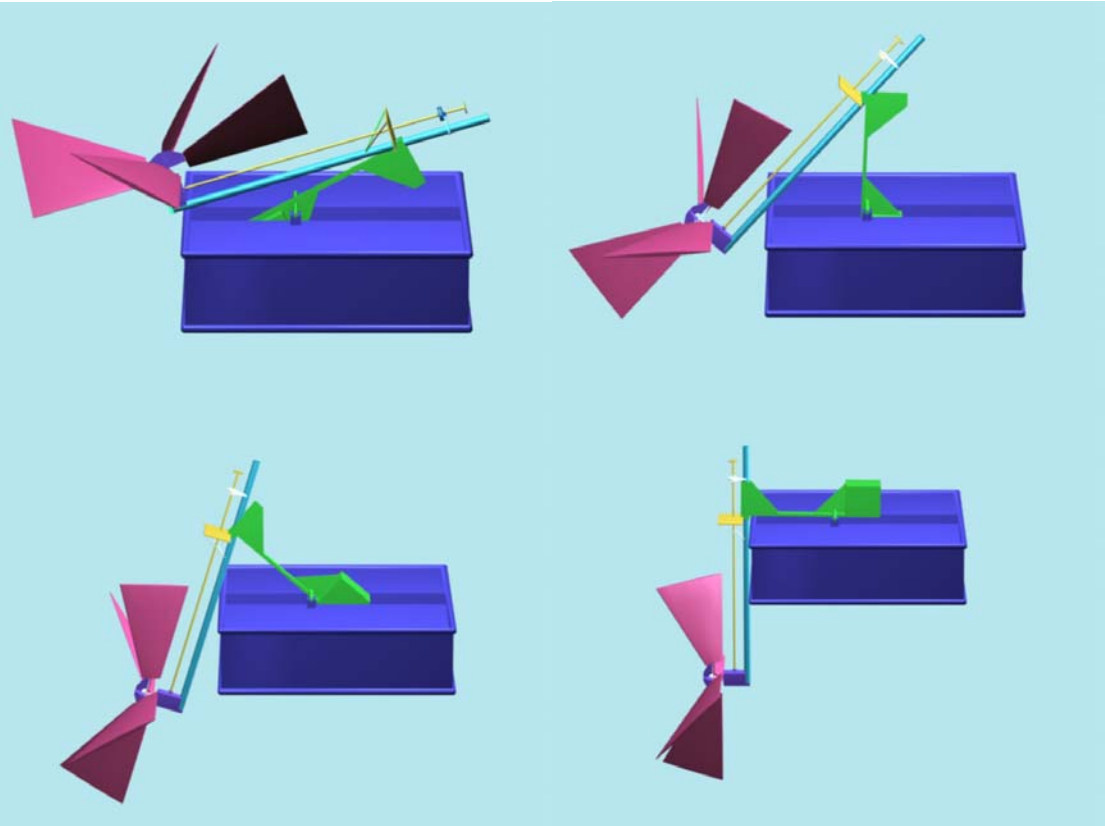
It was imperative that a cleaning/ polishing system along with net rope and debris cutters be incorporated in the design otherwise major service will be required several times per year.

Our feeling is that the existing technologies in this field will exceed a 10 year service interval

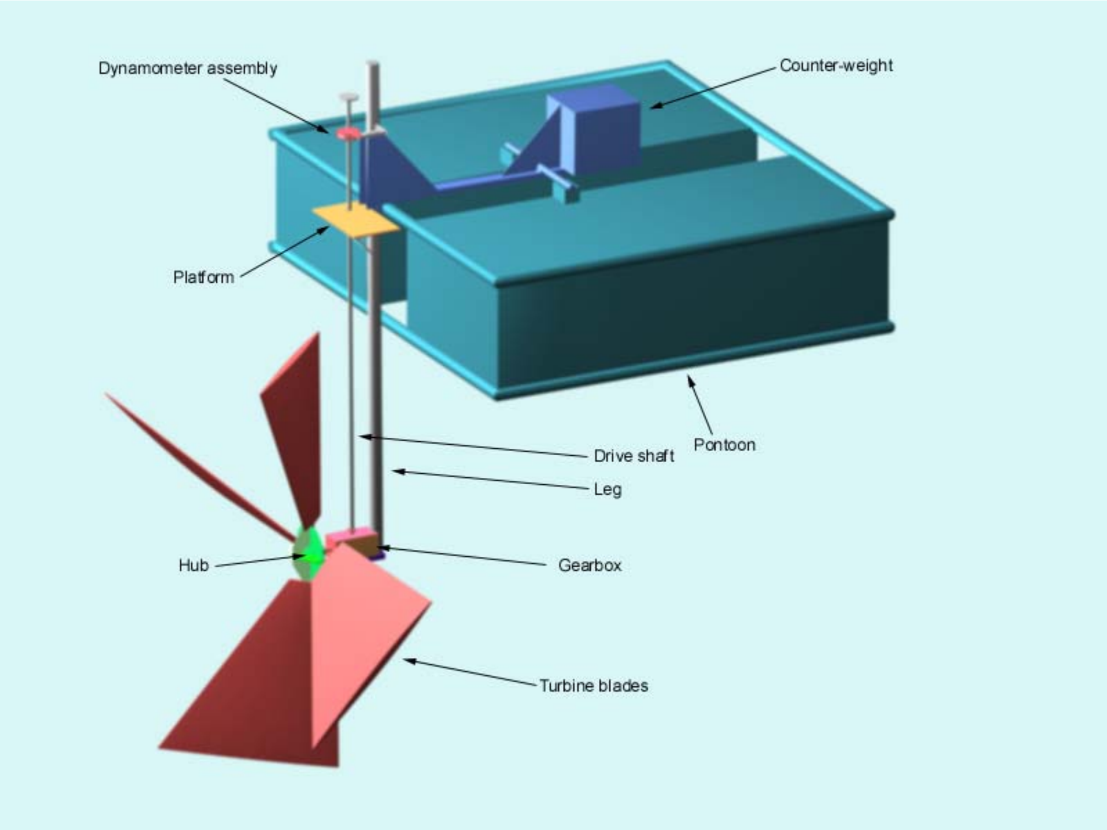
The sea areas are so extreme that in-situ service is not an option. The unit must be able to be removed simply for service.

To answer the question raised by the blade design a test rig using 6m dia blades was fabricated and installed in 3.5 kt of sheltered tidal water in Milford Haven Waterway.

Simple paddle blades were attached to try to develop a reliable power measurement system. The torque proved difficult to measure accurately at 2 to 3 rpm, and fairly major changes have had to be made to give higher gearing to enable a smooth operation for the sensitive stress measuring equipment. This has now been achieved and the rig now awaits the first set of computer designed blades to be fitted. These are currently under manufacture and will be fitted by February 2002.



Deployment of turbine hub-leg assembly



General arrangement of pontoon, leg and turbine on test rig

Power output from the paddle blades was on the computer predicted power output.

Following the next set of dynamometer readings, it is currently proposed to simulate long term wear by generating electricity from the test rig. Fouling can be monitored, and further readings taken to show any drop in performance. Mechanical anti fouling equipment can be tested.

In parallel with this it is proposed to attempt to set up phase two with the help of a strengthened team, and an ETSU grant. Phase three of the project will install a 1MW average (5MW peak) in a seabed location.

Commercial generation could commence from the completion of phase 2 but is fully planned for phase three.