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UNDERWATER WINDMILLS

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ABSTRACT

We have already seen extracting power from wind energy. But just think what, if we put turbines underwater to extract useful power from downhill water flow. It was first introduce by the British consultants that power can be generated by using pump without fuel and causing pollution. British engineering in briston channel have taken the windmill by turning it on its on side and sink it in ocean.

Underwater windmills are driven by the kinetic energy of moving water, just in the similar Way that of windmills use moving air. UK government have said that this generator can produce up to 10% of UK energy needs.

The gravitational of moon produces a swift tide current there that caused through the channel of about 8 ft per second and spin 33ft long blades of turbine, the blade automatically turns and rotate of a pace of seven revolution per min. Which is sufficient to produce 70 lakh kilowatt hours of non polluting energy per year.

***Keywords: turbines, windmills, swift tide, energy*.**

I. INTRODUCTION

I just did a Search here for "underwater" and "windmill" and it came up blank, so if this idea really has been posted here using some other verbiage,

Anyway, this Idea should be somewhat obvious in hindsight. We build ordinary windmills to extract useful power from wind energy. We put turbines(usually in dams) to extract useful power from downhill water flow. The second is more "energy intensive" than the first, which is why we all know that dams are great sources of electrical power. Do note that the ocean has different currents at different depths. I once read somewhere that near the seafloor underneath the Gulf Stream is another current going the opposite direction. If true, then we can build towers on the seafloor, just like ordinary windmills, to extract power. Being so deep will protect them from ships, and most sea life is found at other depths, so they won't be bothered. Also, another thing that protects sea life is the fact that underwater windmills will have a SLOW rotation rate, due to that same greater density of water over air. This means we can also put windmills in the rich-life upper ocean currents; animals will have time to dodge the blades. Consider buoyant windmill modules can be anchored by cables to the bottom. They float up to perhaps fifty meters beneath the surface, in the midst of the ocean current. There they stay and generate power.The global strive to combat global warming will necessitate more reliance on clean energy production. This is particularly important for electricity generation which is currently heavily reliant on the use of fossil fuel. To overcome from such problems, large scale increase in electricity generation from renewable resources will be required. Marine currents have the potential to supply a significant fraction of future

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electricity needs. A study of 106 possible locations in the EU for tidal turbines showed that these sites could generate power in the order of 50 TWh/year. If this resource is to be successfully utilized, the technology required could form the basis of a major new industry to produce clean power for the 21st century.

II. HISTORY

Two British consultants have developed an underwater pump that can irrigate riverside fields without using fuel or causing pollution. The prize-winning turbine is easy to construct and can work continuously. Originally designed to harness the energy of the Nile to irrigate the desert areas of Sudan, the pump has a three-blade rotor that utilizes the energy of moving water, just as a windmill uses wind. The underwater pump can be operated by a single person with little training Imagine taking a windmill, turning it on its side and sinking it in the ocean. That, in effect, is what engineers have done in the Bristol Channel in England. The aim is to harness the energy the tide produces day in, day out. the world's first prototype tidal energy turbine was launched. The "Sea flow" installation was built into the seabed about one and a half kilometers (one mile) off the Devon coast. Above the surface, only a white and red-striped tower is visible. Beneath, 20 meters down, the single 11-meter long rotor turns up to 17 and a half times a minute at a maximum speed of 12 meters per second, drawing energy from the water's current.The €6 million ($7 million) project's supporters -- which include the British and German governments and the European Union -- hope that tidal turbines may one day be a further source of energy. Unlike sun and wind energy, tidal energy is reliable, since it's not affected by the weather.

"As long as the earth turns and the moon circles it, this energy is a sure thing," Jochen Bard from ISET, a German solar energy institute involved in the project, told the dpa news agency.The red dots show locations where tidal energy turbines could be employed in Britain and northern France. Sea flow can generate around 300 kilowatts, while rotors developed in the future should be able to produce a megawatt. The new facility is pegged to be linked to Britain's national grid in August, and a second rotor is to be added by the end of 2004. Marine Current Turbines (MCT), which operates Seaflow, estimates that 20 to 30 percent of British electricity needs could be provided by the new technology.

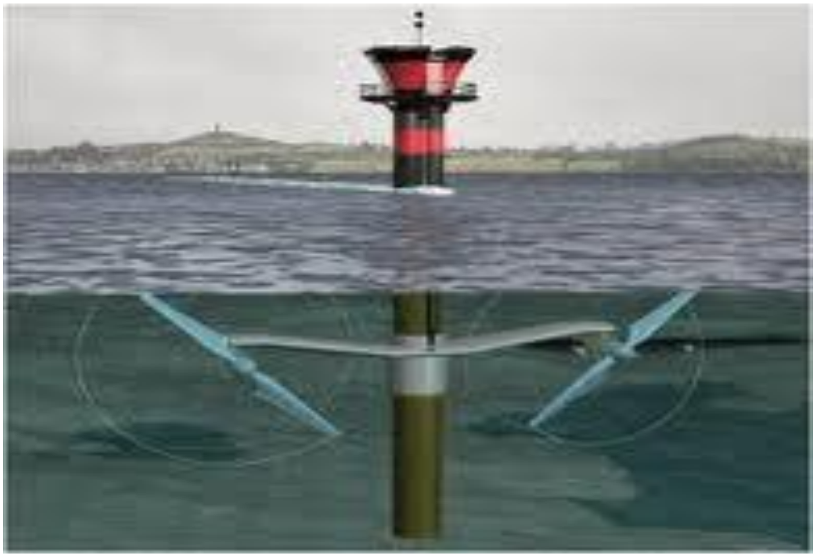

Fig. 4 Turbines running under water without harming the water animals.

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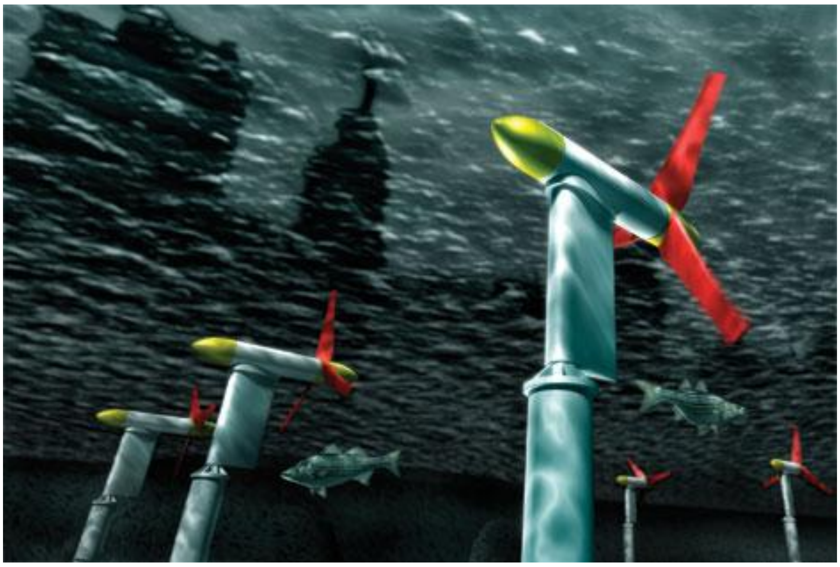

Fig.5 huge turbine placed under the sea and rotating in the direction of flow.

UNDERWATER WINDMILL

DEFINITION

Tidal stream turbines are often described as underwater windmills. They are driven by the kinetic energy of moving water in a similar way that wind turbines use moving air. The generator is placed into a marine current that typically results when water being moved by tidal forces comes up against, or moves around, an obstacle or through a constriction such as a passage between two masses of land. There are sufficient numbers of such fast-flowing underwater currents around the world to make this form of marine renewable energy worth pursuing. This is the first time in the world that electricity directly from a tidal current has been feed into a power grid. The gravitational tug of the moon produces a swift tidal current there that cause though the channel at about 8 feet (2.5 meters) per second and spins the 33-foot (10 meters) long blades of the turbine. The blades automatically turn and rotate at a pace of seven revolutions per minute, which is sufficient to produce 700,000 kilowatt hours of non-polluting energy per year- enough to power about 35 Norwegian homes (70 U.S homes).

It can also be defined as, Energy derived from the moon that now helps to power a small arctic village. An Underwater windmill-like device gets power from the tides. The gravitational pull of the moon produces a swift tidal current, which courses through the channel and spins the long blades of the turbine.

III. WORKING

Underwater turbines rely on tides to push water against angled blades, causing them to spin. These turbines can be placed in natural bodies of water, such as harbors and lagoons that naturally feature fast-moving flows of water. These turbines must be able to swivel 180 degrees to accommodate the ebb and flow of tides, as demonstrated by the SeaGen prototype turbine in Ireland. As the blades spin, a gearbox turns an induction generator, which produces an electric current. Other devices can be tethered and attached to a float, such as the Evopod in England. This design allows the face of the turbine to always face the direction of the current, much like a moored boat does.

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Many wave power machines are designed to capture the energy of the wave's motions through a bobbing buoy-like device. Another approach is a Pelamis wave generator, now being tested in Scotland and in Portugal, which transfers the motion of surface waves to a hydraulic pump connected to a generator.Tidal power typically uses underwater spinning blades to turn a generator, similar to how a wind turbine works. Because water is far more dense than air, spinning blades can potentially be more productive than off-shore wind turbines for the same amount of space. In addition to being renewable, another key advantage of ocean power is that it's reliable and predictable, said Daniel Englander, an analyst at Greentech Media.Although they can't generate power on-demand like a coal-fired plant, the tides and wave movements are well understood, giving planners a good idea of energy production over the course of year.

There are only a few underwater turbines in operation today and they all operate like underwater windmills, with their blades turning at right angles to the flow of the water. In contrast, the Oxford team's device is built around a cylindrical rotor, which rolls around its long axis as the tide ebbs and flows. As a result, it can use more of the incoming water than a standard underwater windmill

IV. DESIGN AND CHALLENGES

There are three factors that govern the energy capture by any water current kinetic energy converter: the swept area of the rotor(s); the speed of the flow (kinetic energy is proportional to the velocity cubed) and the overall efficiency of the system. There have been many challenges to make tidal turbines commercially viable, among these has been the need to place the systems in the right locations where the water depth, current flow patterns and distance to the grid make a project economically viable, and to make units efficient and easy to maintain.

Perhaps the greatest challenge relates to creating an underwater structure with foundations capable of withstanding extremely hostile conditions. The drag from a 4.5 m/s current such as MCT's SeaGen experiences at the peak of a spring tide at Strangford is equivalent to designing a wind turbine to survive wind speeds of 400 km/h (250 mph).

MCT's most recent turbine installation is located in Strangford Narrows, Northern Ireland. Known as 'SeaGen', it became operational in 2008 using twin 16 m diameter rotors each sweeping over 200 m2 of flow that develop a rated power of 1.2 MW at a current velocity of 2.4 m/s. It is accredited by Ofgem as a UK power station and is the largest and most powerful water current turbine in the world, by a significant margin, with the capacity to deliver about 10 MWh per tide, adding up to 6,000 MWh a year. Its distinctive shape and functions have been developed by years of trials of locating and operating underwater systems

An in-stream tidal turbine, also called a tidal current turbine, works a lot like an underwater windmill. In-stream technology is designed to use the flow of the tides to turn an impellor, just like a windmill uses the flow of air to turn its blades. Each turbine technology deals with this challenge differently, but each uses the rotation of a turbine to turn an electrical generator.

Open Hydro and ALSTOM/Clean Current both house their impellors in a shroud or duct, to accelerate the flow of water over the blades, and improve the efficiency of the units. Marine Current Turbines uses two reversing pitch propellers, just like a conventional wind turbine, and uses the design of their blades to maximize efficiency.

V. OPERATION

must operate in a range of speeds from zero to 8 knots, depending on where they are sited and how deep they are positioned. Water speed is fastest at the surface and slowest near the sea floor. Tidal power output is very sensitive to water speed, just as windmills are to wind speed. For example, if the water speed doubles, the turbine will produce eight times more power. The potential of electric power generation from marine tidal currents is enormous. Tidal currents are being recognised as a resource to be exploited for the sustainable generation of electrical power. The high load factors resulting from the fluid properties and the predictable resource characteristics make marine currents particularly attractive for power generation and advantageous when compared to other renewables.

There is a paucity of information regarding various key aspects of system design encountered in this new area of research. Virtually no work has been done to determine the characteristics of turbines running in water for kinetic energy conversion even though relevant work has been carried out on ship's propellers, wind turbines and on hydro turbines. None of these three well established areas of technology completely overlap with this new field so that gaps remain in the state of knowledge. This paper reviews the fundamental issues that are likely to play a major role in implementation of MCT systems. It also highlights research areas to be encountered in this new area. The paper reports issues such as the harsh marine environment, the phenomenon of cavitation, and the high stresses encountered by such structures are likely to play a major role on the work currently being undertaken in this field.

Power Generation by Underwater Windmill And Cost

Energy derived from the moon now trickles into an Artic tip of Norway via a novel underwater windmill like device powered by the rhythmic slosh of the tides. The tidal turbine is bolted to the floor of the Kvalsund channel and is connected to the nearby town of Hammerfest's power grid on September 20th. This is the first time in the world that electricity directly from a tidal current has been feed into a power grid. The gravitational tug of the moon produces a swift tidal current there that cause though the channel at about 8 feet (2.5 meters) per second and spins the 33-foot (10 meters) long blades of the turbine. The blades automatically turn and rotate at a pace of seven revolutions per minute, which is sufficient to produce 700,000 kilowatt hours of non-polluting energy per year- enough to power about 35 Norwegian homes.

70 U.S homes An underwater turbine that generates electricity from tidal streams was plugged into the UK's national grid today. It marks the first time a commercial-scale underwater turbine has fed power into the network and the start of a new source of renewable energy for the UK Tidal streams are seen by many as a

plentiful and predictable supply of clean energy. The most conservative estimates suggest there is at least five gigawatts of power in tidal flows around the country, but there could be as much as 15GW.

The trial at Strangford Lough, in Northern Ireland, uses a device called SeaGen and generates power at 150kW. However, engineers have plans to increase power to 300kW by the end of the summer. When it is eventually running at full power SeaGen will have an output of 1,200 kW, enough for about 1,000 homes.

SeaGen was designed and built by the Bristol-based tidal energy company Marine Current Turbines (MCT), which also installed the test device at Strangford in May.

VI. FUTURE DEVELOPMENT

MCT is now concerned not only with ensuring that its SeaGen type device is installed in other locations, but also with the conception of new forms of this technology that are both more powerful (to gain further economies of scale) and viable in shallower and in deeper water than the 20 m to 40 m range that suits the current design. In shallower water the existing twin rotor system would provide too small a swept rotor area to be cost-effective, while deeper water brings concers about taller tower structure cost and strength. A potential solution under consideration and already patented is a buoyant support tethered to the seabed by rigid but hinged struts. This system, which is based on the same rotors, control systems and power-trains as the existing SeaGen, has been labeled SeaGen "U" and is already under development. A 2 MW at 2.4 m/s version with three rotors is planned for installation in the Minas Straits of the Bay of Fundy in Nova Scotia, Canada by 2012-3. Systems rated at over 5 MW with up to six rotors are expected to follow. The wind industry has improved the cost-effectiveness and efficiency of windturbines by gradually enlarging them – a few years ago 1 MW was the norm but today up to 5 MW systems are preferred. There is a similar pressure to develop larger in order to improve their cost-effectiveness and generate electricity more cheaply.

Peter Fraenkel thinks that as with all new technologies, tidal turbines will be initially too expensive to be immediately competitive. They will need to benefit from economies of scale and learning curve effects to get their costs down. As a result he believes this new renewable energy technology market needs government subsidies such as ROCs (Renewable Obligation Certificates) to help finance early stage small projects, and to see the technology through the stage between R&D and full commercial competitiveness. Fraenkel is confident that tidal turbine technology will become competitive reasonably quickly but the first projects will need support to leverage the necessary inves In the face of Global Warming and Peak Oil, there is an urgent need to prove and bring on stream new clean energy technologies such as tidal turbines. The technology under development by Marine Current Turbines Ltd has the potential to be commercially viable well within the next 5 years and it is hoped that it will be effectively demonstrated through the Seagen project in less than a year from now. The key to arriving at this result is to gain the operational experience to develop the reliability of the systems, to value eng ineer them in order to get costs down and to ensure they can reliably deliver electricity from the seas with minimal environmental impact.

VII. EFFECT ON ENVIRONMENT

"I think we have invented one of the least offensive energy methods," MCT technical director Peter Fraenkel told Deutsche Welle. He explained that the effect on marine life would be minimal. "Any kind of higher marine

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mammals is as likely to run into it as a human begin is to walk into a brick wall." Not only do marine creatures mainly move faster than the rotor, water spirals through it in such a way that even jellyfish would be likely to go right through without being harmed. Greenpeace climate and energy campaigner Robin Oakley told Deutsche Welle he didn't expect negative impacts from Seaflow either. When it comes to environmental impact, "there's a very big positive that has to be taken into account," Oakley said. "You have to weigh the effects carefully, he said. "That can't be allowed to slow down the development of green energy."

It is the first of a kind SeaGen serves as a testbed for tidal power generation. To date, it has not yet had a full year of operation unconstrained by other research considerations. From installation until November 2009 the system could only be operated when two marine mammal observers were on board, and able to look out for seals that might be in danger from the rotors (which rotate at about 14 rpm). Further seal monitoring restraints continued to reduce operation to daylight hours until March 2010, so energy yield was significantly reduced. There is great concern to avoid sanctioning anything that could cause negative environmental impact at the Strangford site. After two years of independent environmental monitoring no sign of a detrimental effect has so far been detected. At the time of writing, seal movements near the turbine still have to be monitored in real time using sonar by an operator onshore who can shut the turbines down within five seconds if they feel a seal might be in danger. It is expected that this requirement may soon also be relaxed as there are no signs yet of seals having so far been harmed. The environmental monitoring programme which will run for five years in total will cost some £2 million by the time it concludes. It has been very useful in terms of environmental data acquisition and giving new insights on the behaviour of seals and other marine wild-life endemic to this environmentally significant location.

VIII. GLOBAL RESOURCES

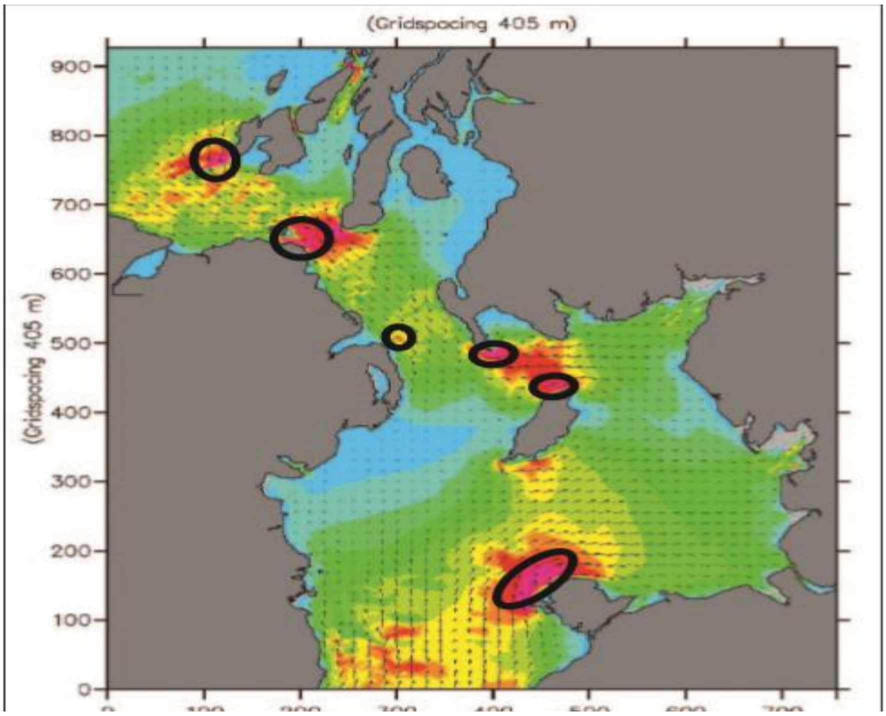

Fig. map showing the pinch points where strong tidal currents are to be found.

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In this case it is a model of the Irish Sea contoured for velocity at a particular mome in the tidal cycle. The areas marked in magenta are the only ones with strong enough currents for cost-effective energy capture.The magenta colour represents speeds above 1m/s, while the darkest blue represents 0m/s

IX. ADVANTAGES AND DISADVANTAGES OF UNDERWATER WINDMILL

ADVANTAGES

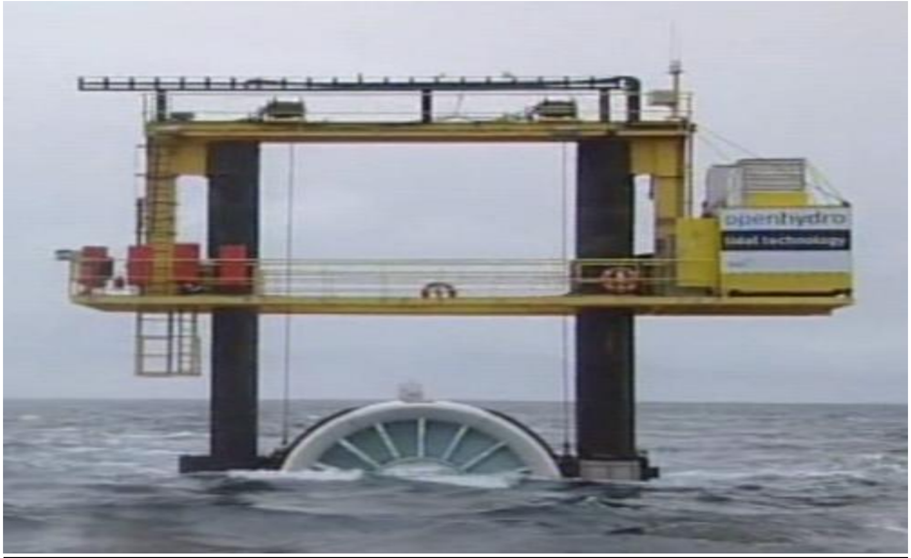
- One of the most important and highly significant benefits of using the power of the tides is that there are no fuel costs. The energy is fueled by the reliable and sustainable force of the ocean. Although initial construction costs are high, the overall maintenance of the equipment and the return of power in the form of electricity can help offset this expense.
- And, unlike renewable resources such as wind power, the ebb and flow of the ocean tides are entirely predictable and consistent and aren't affected by outside forces such as the weather.
- Tides are predictable and go in and out twice a day, making it easy to manage positive spikes.
- Its predictability makes it easy to integrate into existing power grids.
- Tidal energy is completely renewable.
- Tidal energy produces no emissions.
- Energy output is a 100 % reliable , as tides are as sure as the moon.
- Hidden beneath the water.
- When the tides go out gravity sucks the water through the turbines to generate electricity
- Tidal energy reduces dependency on oil reserves from other countries.

DISADVANTAGE

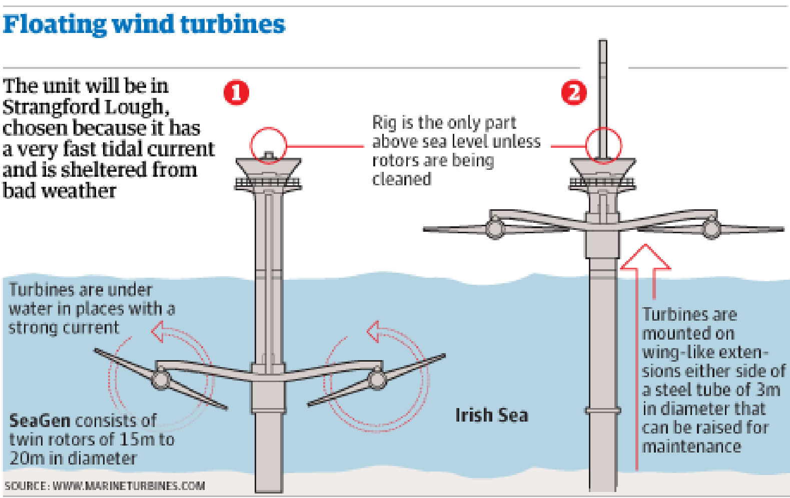
- The major difficulties with this type of system is that the off shore turbines cost more money than land / wind based turbines.
- They are also more expensive to maintain as they function under water. Furthermore, sea water is corrosive to steel and other metals because of the salt content.
- Fishing has to be restricted in the areas of the power plant.
- Damages habitat up to 500km away

X. MAINTENANCE OF UNDERWATER WINDMILL

Maintenance of the device while it is submerged in fast currents would be exceptionally challenging and expensive, so a key patented feature of the technology is that the rotor and drive train (i.e. gearbox and generator) can be raised completely above the surface. Once raised, any maintenance or repairs can readily be carried out from the structure attended by a surface vessel.



Underwater windmill under maintenance process.



XI. CONCLUSION

Ocean energy can play a significant role in our nation's renewable energy portfolio. With the right support, the ocean energy industry can be competitive internationally. With the right encouragement, ocean renewable energy technologies can help us reduce our reliance on foreign oil – fossil fuels, in general – and provide clean energy alternatives to conventional power generating systems. And with the right public awareness, our coastline communities can use ocean renewables as a springboard for coastal planning that reflects the principles of marine biodiversity.

In conclusion, we believe that the intense and predictable marine current resource offers the possibility of clean energy at a cost that will ultimately be competitive not only with the other renewables, but in the long run we believe we can compete head on with most forms of fossil fuelled power generation at present-day costs. We think that, given appropriate government support to help the technology through its early and immature stages, it can play a significant role in producing clean energy.

Tidal energy has potential to become a viable option for large scale, base load generation in Scotland. Tidal Streams are the most attractive method, having reduced environmental and ecological impacts and being cheaper and quicker installed.

Development of a robust offshore renewables industry can:

- Reduce reliance on foreign oil.
- Rely upon ocean terrain for power generation as opposed to onshore land resources.
- Revitalize shipyards, coastal industrial parks and shuttered naval bases.
- Create jobs in coastal communities.
- Allow the US to transfer technology to other countries, just as a country like Scotland is exporting its marine renewables.
- Provide low cost power for niche or distributed uses like desalination plants, aquaculture, naval and military bases, powering stations for hybrid vehicles and for offshore oil and gas platforms.
- Provide use for decommissioned oil platforms through "rigs to reefs program".
- Promote coastal planning that reflects the goals of bio-diversity, that maximize best comprehensive use of resources and capitalizes on synergies between offshore industries.

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