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Energy resources in marine environments

Alberto Nano, Samuel Volpe, and Fatemeh Ahmadi*

Department of Environment and Engineering, Science Faculty, University of Siena, Italy

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Abstract

Much attention to the risks of global climate change increases the interest in research and development of renewable energy technologies. The ocean provides a vast source of potential resources, and as renewable energy technologies develop, investment in ocean energy is growing. Research in the conversion of ocean thermal energy, wave energy, tidal energy, offshore wind energy into useful technologies and commercial expansion. The potential of these resources helps to reduce the risk of global climate change, but the ocean environment must be protected against these developed technologies. If the desired projects have proper measurement and placement and environmental guidelines are followed properly, the renewable energy resources of the ocean may be exploited without harming the marine environment. This article examines this technology and its status in the world.

Keywords: Marine environment; Energy; Renewable; Wave, Wind.

1. Introduction

The vast ocean contains a huge source of energy in the form of heat, currents, waves, and tides to more than meet the world's energy demand many times over (Takahashi and Trenka, 1996). To date, ocean energy has comprised only a small portion of the world's energy supply. Currently, widespread concerns about global climate change and other environmental impacts caused by reliance on fossil fuels have increased interest in renewable energy. In fact, increasing the research and development of ocean renewable energy for a comprehensive and complex program may be the answer to the necessary energy. While renewable ocean energy will most likely improve the environment by replacing fossil fuel power plants and reducing carbon emissions, the question that should be asked is "what after?". It must be ensured that the development of new ocean energy technologies does not

* Corresponding Author's Email: f.ahmadi12@gmail.com

harm the marine environment, which is currently subject to various threats such as overfishing, pollution, habitat loss and climate change.

This article presents and compares the main potential sources of ocean renewable energy according to the guidelines for the development of responsibility for the protection of the marine environment.

2. Development of renewable energies

The use of energy resources is one of the important and continuous issues of our time. Investments in energy efficiency and increased conservation may be the best way to tackle energy consumption. But today, more than 2 billion people worldwide do not have electricity (Flavin and O'Meara, 1997), and rapid population growth continues in developing countries, and the demand for electricity will almost certainly increase. At the same time, rising living standards and reliance on technology in developed countries may cause energy demand to grow faster than population growth, even with improvements in productivity. In the United States, for example, due to improvements in productivity, per capita energy consumption declined throughout the 1970s and early 1980s, but has since increased, and is projected for the next 20 years, as demand increases. For energy services, increase. In order to respond to the demand that is predicted despite efforts to improve productivity, and limit the production of greenhouse gases, renewable energy sources must be developed.

Renewable energy research is slow growing because for any new technology, it is difficult to compete economically with cheap fossil fuel power plants. Renewables are often of interest in the long term because the "fuel"—sunlight, wind, ocean waves, etc.—is free and unlimited. In the short term, renewable energy plants are sometimes prohibitively expensive. However, proper accounting for the external costs of energy production puts renewable energy in a more favorable position, while advances in technology and economies of scale can significantly reduce the costs of such technologies over time. time and even without calculating the costs of pollution and other side effects related to fossil fuels, it will make the costs of wind power competitive with fossil fuels (Herzog, 1999).

Renewable energy research is mainly focused on the development of solar, wind, biomass and geothermal energy sources. Considering this, it is predicted that governments, companies, engineers and scientists will increasingly pay attention to the enormous energy stored in the ocean. While the development of ocean energy necessarily presents some challenges, much of the infrastructure and know-how needed to generate energy from the ocean already existed before the offshore oil industry entered. Currently, some applications of wave, offshore wind, and possibly tidal energy may be economically feasible for limited sites, and it is likely that ocean energy costs will fall to competitive levels as research continues.

3. Renewable energy sources

3.1. Thermal Energy

This electricity is produced from the natural thermal gradient of the ocean, using the heat stored in the surface of warm water and generating steam to move the turbine, while in order to recondense the steam, cold deep waters are pumped to the surface. In a closed-cycle power plant, warm seawater heats a low-boiling fluid such as ammonia, and the ammonia vapor drives a turbine generator. Then this steam is condensed by cold water and thus the cycle system is established. In an open-cycle power plant, warm seawater flows from the surface into a vacuum chamber where it is flashed by evaporation, and the resulting steam drives a turbine. Then the cold sea water is brought to the surface and used to condense water vapor and returned to the environment. Dual fuel power plants combine the advantages of two systems, and are used for water desalination (Takahashi and Trenka, 1996). Thermal energy power plants can be built either on land or on offshore floating platforms. Floating platforms can be larger and do not need to use coastal land, but incur additional costs and affect energy transport to the coast. Energy can be transmitted through cables on the seabed, a highly developed but expensive technology that interacts with seabed organisms to affect the environment, or stored as chemical energy such as hydrogen, ammonia, and methanol. Mobile power plants used to produce hydrogen, ammonia, and methanol slowly traverse the ocean, store the energy for about a month, and then transport it to shore by tanker (Avery and Wu, 1994).

There may be other side benefits from both hot and cold water circulation through thermal energy systems. In an open cycle power plant, hot water after evaporation can be re-condensed and kept separate from cold sea water, removing salt and providing a source of fresh fresh water, sufficient for urban or agricultural use. Cold water effluent can be used for aquaculture (cultivation of marine organisms such as algae, fish and shellfish), air conditioning and other applications.

The cold, deep seawater carried by thermal energy pipes is free, parasite-free, and nutritious, and can be pumped into seaweed production ponds or other products in a controlled system. Some private companies in the world have benefited from the increase of lobsters, flounder fish, and algae with high protein in aquaculture ponds fed by cold water. In addition, this cold water can be used to grow crops such as strawberries in tropical climates. The most profitable side benefits of this type of power plant can be the air conditioning and industrial cooling system (Avery and Wu, 1994).

In the summer of 2002, the NELHA laboratory in the United States built a new closed cycle power plant, which was able to produce between 1 and 1.4 megawatts of electricity (Daniel, 2002). In addition, the US Navy established an 8-MW for thermal facility with a 2-MW turbine to replace a 15-MW gas-fired facility on the British island of Diego Garcia in the Indian Ocean. Since about 5 megawatts of the electricity produced by the gas plant is allocated for air conditioning, and can be replaced by water cooling by thermal energy tubes, lower capacities of the thermal energy plant can replace the gas plant. This facility can also help to supply the island with drinking water (Daniel, 2002). Sea Solar Power Company (SSP) has presented two conceptual models for thermal energy installations, one 10 MW, land-based model for small islands and the other 100 MW, floating platform model for use in the main area. Their model is 8 times smaller than the US government's design for a power plant with the same capacity. For this reason, significantly less water is used and at a cost of 1.4 their cost is discharged (Ramesh et al., 1997). This company was involved in a 2-year project worth 20 million dollars to test and refine each of the system's components, and then by optimizing this system, in a pilot project of 10 megawatts in Guam and a floating power plant of 100 megawatts in Tamil Nadu (Tamil Nadu) in South India began to work (Ramesh et al., 1997).

Potential

In total, it is estimated that about 10 trillion watts (TW) or 10 billion kilowatts of power, roughly equal to the current global energy demand, could be provided by thermal energy systems without affecting the thermal structure of the ocean (Daniel, 2002). However, with the current costs of generating electricity from variable thermal energy systems (Takahashi and Trenka, 1996) being significantly higher than fossil fuel costs, these sources are unlikely to be fully developed unless they are subsidized. Probably the greatest potential of thermal energy system is for use in small island developing countries, which need both electricity and local fresh water. It is likely that full utilization of the ancillary benefits (fresh water, aquaculture, ventilation, etc.) is required for economic feasibility.

Thermal energy system is the only viable system in tropical seas, in areas where the thermal gradient between the surface and a depth of 1000 meters is at least 22 C. Areas of the open ocean with this temperature difference, and suitable for thermal energy system floating power plants, are around 60 million square kilometers in total. For a coastal power plant, topography is also important, allowing access to very deep water (from 1km or deeper) directly to the sea, which is a special condition in tropical islands, atolls, and a limited number of coastal sites. (Pelc and Fujita, 2002).

Environmental effects

Although the environmental impact of thermal energy system is relatively harmless compared to traditional power plants, it has some potential environmental threats, especially if it is implemented on a large scale. These stations affect the surrounding marine environment mainly through the heating of the water, the release of toxic chemicals, the impact of organisms on the receiving plates, and the mixing of small organisms by the consumption pipes. A large amount of mixed warm and cold water is discharged near the free surface, creating a descending column of cold water. Continuous use of warm surface water and cold deep water over a long period of time may lead to some warming in the depth and cooling in the surface (Avery and Wu, 1994). Thermal effects may be significant, as local temperature variations of only 3 to 4 degrees Celsius are known to cause high mortality among corals and fish. Apart from mortality, there may be other effects such as reduction of successful egg laying and inhibition of larval growth and development, or reproduction with less success, from these thermal changes (Kennish, 1998). The increase in the amount of nutrients due to the discharge of rising water can also have a negative impact on the ecosystem, which is inherently low in nutrients and is characteristic of tropical seas.

Toxic chemicals, such as ammonia and chlorine, may enter the environment from a thermal energy power plant and kill local marine life. Ammonia in closed-cycle systems must be designed so that it does not come into contact with the environment, and open-cycle system hazards are expected to include serious damage such as collision with a ship, a hurricane, terrorism, or major human error. Avery and Wu, 1994).

Thermal energy system can significantly improve the quality of life in developing countries, and the benefits of fresh water, aquaculture and air conditioning have a major impact on this. But if this technology is shown to be safe, further research into environmental effects is necessary. Also, in tropical areas that face high electricity prices, if suitable locations can be found where environmental damage is negligible, the development of these power plants should be encouraged. Since the governments of developing countries that benefit most from thermal energy systems cannot afford high investment, the governments of developed countries should participate in research and investment efforts for thermal energy systems in developing countries. Appropriate measures should be taken to control the following environmental effects:

• Avoiding the establishment of thermal energy power plants in sensitive areas, including main fishing areas, spawning areas, and sensitive reef habitats.

• Applying discharge to achieve side benefits will cause a significant change in local water temperature.

• The accuracy of using poisons such as ammonia, chlorine, and avoiding covering the bodies of these power plants with toxic coatings that pollute water in ships and ports.

• More reliance on relatively small power plants. While the economic benefits of larger power plants may be greater, they harm a society more through discharge or mixing.

3.2. Wave energy

Wave energy has long been one of the most promising renewable technologies. Not only is energy sources widespread, wave power is available at a given location up to 90% of the time, while solar and wind energy are only available 20-30% of the time. There are more than 1,000 different patented designs for wave energy devices, and several have demonstrated the potential to produce viable commercial electricity (Falnes and Lovseth, 1991).

In 1990, a hybrid monitor system was designed by Demi-tek, which was a combination of tidal, wave and wind power. This monitor produced enough electricity to light up city sidewalks and conference halls. In addition, this monitor was deployed to help reduce the effect of waves and protect beaches from erosion. They are also anchored to the ocean floor by cables similar to those used for offshore oil drilling, and electricity is brought to shore by a submarine cable (Pelc and Fujita, 2002).

Potential

The greatest potential for wave energy exists where the strongest winds are found - in temperate latitudes between 40 and 60 degrees north and south, on the eastern borders of the oceans. One of the richest nations in terms of wave energy potential is England, and the north of Scotland also has a particularly high potential. There is considerable potential for wave energy development on the Pacific Northwest coast (Middleton, 2001) and worldwide, wave energy can potentially generate up to 2 terawatts of electricity, according to the World Energy Council (WEC, 1993), about One fifth of the current global energy demand. Although the power of wave energy is not yet economically competitive with fossil fuels, it is promising, and this situation is improving with more advanced technology. Costs have decreased rapidly in the past few years, allowing wave power plants to compete favorably with conventional power plants (Jones, 2002).

Environmental effects

Small-scale wave energy plants are likely to have little environmental impact. However, some large-scale projects that have been proposed have the potential to damage ocean ecosystems. Covering large areas of the ocean surface with wave energy devices harms marine life and can have broader effects by changing the way the ocean interacts with the atmosphere.

Wave power plants act as wave breakers and sea calmers. In fact, wave energy generation devices can be combined with wave breaking devices, and this result may slow down the mixing of the upper layers of the sea, which can have a negative impact on marine life and fisheries. Of course, demersal fish probably cannot be directly affected. However, changes in surface productivity related to reduced mixing can potentially reduce the food supply for benthic organisms. Changes in waves and currents directly affect species that spend their lives closer to the surface. Many fish species depend on currents to transport their larvae, so wave energy devices that alter currents between spawning and feeding can harm fish populations. Reducing waves may reduce shoreline erosion; Whether this effect is beneficial or detrimental depends on the particular coastline (Pelc and Fujita, 2002). While the wave reduction process may have detrimental environmental effects, more research is needed to determine the extent of this impact.

Wave energy is promising, has huge potential to reduce dependence on fossil fuels, and appears to be relatively safe for the environment at this time. More research on wave energy is recommended. For new wave power plants, especially of high capacities, the location must be carefully selected, not only for the power generation potential, but also for relying on powerful waves and the ecosystem's response to them. Also, wave power plants should be located away from places where the relaxation of waves causes significant changes in natural environmental processes.

3.3. Tidal energy

A distinct advantage of tidal energy, compared to solar, wind and wave energy, is its high predictability. The regularity of tides along with the huge energy potential increases the interest in the development of tidal energy. The first tidal barrages like dams were built across the mouth of estuaries to harness the energy of the tidal flow. Unlike a hydroelectric dam, a tidal weir must allow water to flow in both directions, although typically, it only captures the energy of estuary water flow from high to low tide. brings Tidal seal technology is well developed, and offers great potential in some areas. Tidal dams have been found to be potentially destructive to the marine environment. Most recent innovations include tidal fences and tidal turbines, which allow the use of currents synchronized with tidal currents. Tidal dams consist of turbines that are completely spread across a channel where the tidal flow is regulated by relatively fast currents.

The first and largest operational tidal dam power station in the world, built in the early 1960s, is the La Rance power station on the Brittany coast of northern France. Using the tide height of 2.4 meters at the mouth of the estuary, this power plant produces 240 megawatts of electricity. Other operational tidal power plants are in Kislaya in Russia, Jiangxia in China, and Annapolis in Canada (Hammons, 1993).

Potential

It is estimated that England can produce up to 50 terawatt hours/year of energy with tidal power plants, while Western Europe can produce about 105 million megawatt hours/year of energy. Estimates of the total production potential worldwide range from 500 to 1000 terawatt hours/year, although it is likely that only a fraction of this energy is exploited due to economic constraints (Hammons, 1993). The availability of tidal energy is highly site-specific, with tidal range affected by factors such as sea depth stratification and channeling in estuaries, reflections from large peninsulas, and resonance effects when the tidal wavelength It is determined to be about 4 times the length of the estuary, such as the average tidal range of 11 meters in the Bay of Fundy in Canada. Therefore, tidal fences and turbines can be installed wherever tidal currents and topographical constraints create currents of 2 m/s or more (Frau, 1993).

Environmental effects

Tidal power plants in the mouth of estuaries, like big dams, bring many environmental threats. By changing the flow of salt water in and out of river mouths, tidal power plants can affect the hydrology and salinity of these sensitive environments. Estuaries act as a nursery for many marine organisms as well as a unique and irreplaceable habitat for estuarine organisms, and alteration of these habitats by the construction of large tidal power plants should be avoided. . During the construction phase of the Lawrence Tidal Power Plant, the estuary was completely closed off from the ocean for 2-3 years, and it took a long time for the estuary to reach a new ecological balance. The changes caused by the dam, including the reduction of the intertidal zone, slower currents, the reduction of the salinity range and the change of deep water characteristics, led to changes in the marine community (Frau, 1993). In fact, in the future, any new tidal dams should be built with care not to close the estuary from the ocean during construction, and these power plants should not be built until a detailed environmental assessment and proof of minimal impact on marine ecosystems.

Tidal turbines can be the best option to produce environmentally friendly tidal energy. These turbines do not block the channel or mouth of the estuaries, disrupt the migration of fish or change the hydrology of the area (Osborne, 1998). Turbines and tidal barriers may provide significant generating capacity without major impact on the ocean, while tidal barrages are likely to be very destructive to the marine ecosystem. Research in tidal energy should focus on turbines, fences and similar technologies. These projects should be built and implemented in such a way that the main channels of aquatic migration are open. Turbines should work slowly enough to minimize fish mortality and to be largely unaffected by nutrient and sediment transport. Tidal barriers should be built across narrow channels, but not block an entire bay or channel (Pelc and Fujita, 2002).

3.4. offshore Wind energy

As one of the most common and promising economic technologies for producing clean electricity, wind energy has received a lot of attention. Wind energy is one of the cleanest forms of energy available, and can currently be cost-competitive with fossil fuels, depending on location. While most of the research and promotion of wind energy use has been focused on land-based sites, interest in offshore wind energy is growing. Very strong winds blow regularly over the oceans, and they have higher speeds and less rotation than the winds over land, and there is no problem accessing the wind over the ocean.

The design of offshore wind power is very similar to onshore windmills. Therefore, this technology is now well developed. Unlike onshore wind farms, offshore wind farms require high voltage cables from the windmills to the shore to transmit electricity. In addition to the transfer of energy to the coast, the main technical challenge in the development of offshore wind resources is to create sufficiently stable foundations in the harsh ocean environment and severe storms, and the economic challenge is to move these foundations and their anchors away from the coast.

The Netherlands has built two wind farms and plans to build a third park containing 100 turbines, which will generate enough electricity for 100,000 households. Sweden also has a wind park consisting of 5 x 500 KW turbines, and Swedish companies are planning to build 48 MW wind farms and possibly a 750 MW power park. Also, England plans to use the huge potential of offshore wind energy (Greenpeace, 1999).

The construction of stable foundations that can be transported to the sea or built in the sea and have the ability to face many challenges in the sea environment is one of the most difficult and expensive aspects of offshore wind energy development. The Danish Energy Agency discovered that by using steel, which is lighter and easier to transport than the currently used concrete, foundation costs can be reduced by a third. This is significantly affected by the overall costs of these turbines, because the foundation costs constitute 23 to 30% of the total costs.

Recent engineering studies show that turbines may be economically constructed in 15 meters of water, but allow the use of a wider area of the ocean (Greenpeace, 1999). In deeper waters, winds develop with greater intensity, thus allowing more power to be produced with the same power plant. Over time, with economies of scale and further optimization of offshore technology, their prices could be comparable to fossil fuel power plants.

Potential

There is relatively large potential for offshore wind at many sites. It has been estimated that wind farms around the world may have the potential to produce offshore wind power of more than one thousand terawatt hours/year, with the highest capacity at the end of the northern European coast (Gaudiosi, 1999). This technology can significantly improve the economy of power plants by reducing the costs of connecting them to the bed. Models show that combined wind and wave power plants will be more economically efficient, environmentally safer and more reliable than separate plants (Lakkoju, 1996).

It is likely that offshore wind power will increase dramatically in the next few decades. Denmark, Germany, the Netherlands, Norway, Sweden and the UK are researching larger-scale marine applications. While onshore wind power has been tested more widely and generally requires less investment, but for various reasons, offshore wind energy has received more attention. Offshore wind potential is extensive. The speed of winds on the ocean is 20% higher than the winds on land. Since the power changes with the cube of the wind speed, therefore the marine potential has a large increase of up to 70% compared to the land potential. If the wind power is not blocked by hills, tall buildings or other obstacles, it becomes more reliable. In addition, many of the Nordic countries that are investing in offshore wind farms have large populations and insufficient land suitable for wind farms (Greenpeace, 1999).

Environmental effects

Potential effects of offshore wind on the environment include its effects on fisheries, seabed organisms, and migratory birds. In addition, the vibrations caused by these windmills can disturb marine mammals. Currently, there is no evidence of harmful effects of offshore wind turbines, but few studies have been conducted on environmental effects.

For wind farms far from the coast, and in fact if the farms are not visible from the coast, the visual impact and noise pollution will be minor (DEA, 1999). While many power plants to date have been located very close to shore in shallow water, it is expected that as the economics of offshore power plants improve, future power plants will be built farther offshore and in deeper water, where visual effects and sound is greatly reduced (Gaudiosi, 1996).

Conclusion

The technologies for thermal energy, wave energy, tidal energy, and offshore wind energy are still relatively new. More research is needed on the environmental impacts as well as the economic feasibility of ocean renewable energy projects. However, research has shown that these technologies remain promising, and further research and development, by reducing dependence on fossil fuels, could solve one of the most serious environmental and social threats, and change water and May the weather help.

However, every energy technology has environmental effects. While fossil fuel power plants lead to pollution and global warming regardless of their size and location, the impacts of different renewable energy technologies are highly location and size dependent. Accurate selection of sites is very important because it can withstand environmental changes caused by power plants and develop this technology without significantly damaging the ocean. Along with any useful and new technology, it is better to continue research efforts, and cautiously with the priority of the health of the marine environment while producing clean energy.

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