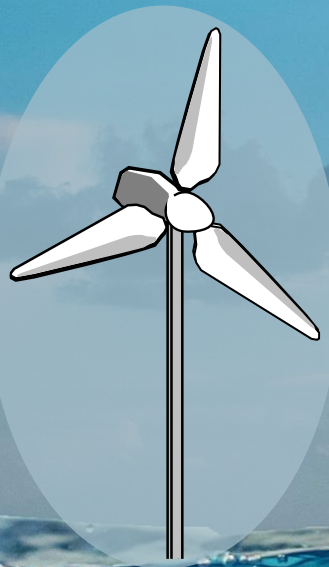
A Sea Of Opportunity

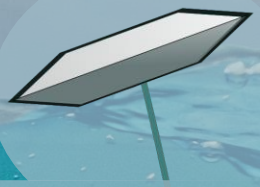
Energy from the ocean has high potential for renewable energy but it also affects marine life.

Franziska Bardel, Astrid Holtan Fredriksen, Guilherme Lemes Emrich, Jacob Samuel Moorman, Marte Rødøy Syvderud, Øystein Wallevik



Wind Power

Wind turbines can extract energy from winds.
Wind power is one of the cleanest energy types that has an economically feasible technology. [1]



Ocean Current Power

Energy from the currents made by regional differences in temperature and salinity and the Coriolis effect is harvested. [2]

Wave Power

A floater extracts energy from the vertical motion of the waves evoked by surface wind. [1]

Effects on Marine Life

collision

artificial reefs

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no-take zone

high voltage and electromagnetic field

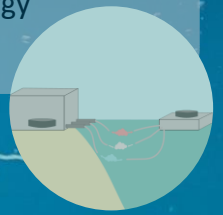
[3,4]

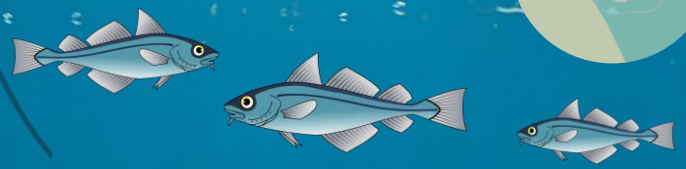
Tidal Current Power

In order to extract this energy, turbines that are located below the sea surface are used. [1]

Thermal Energy

Natural temperature differences in the ocean can be used to create energy in a process called ocean thermal energy conversion (OTEC). [1]





Ocean energy is still under development, so it may be too early to say if its effect on marine life limit the sustainability.

REFERENCES: All graphics and pictures are open source (pixabay.com) or self-made. [1] Pelc, R. and Fujita, R. M. (2002) 'Renewable energy from the ocean', Marine Policy 26(6), pp. 471–479. doi: 10.1016/S0308-597X(02)00045-3. [2] Ponta, F. L. and Jacovkis, P. M. (2008) 'Marine-current power generation by diffuser-augmented floating hydro-turbines', Renewable Energy. 33(4), pp. 665–673. doi: 10.1016/j.renene.2007.04.008. [3] Punt, M. J. et al. (2009) 'Spatial planning of offshore wind farms: A windfall to marine environmental protection?', Ecological Economics, 69(1), pp. 93–103. doi: 10.1016/j.ecolecon.2009.07.013. [4] Wilhelmsson, D., Malm, T. and Öhman, M. C. (2006) 'The influence of offshore windpower on demersal fish', ICES Journal of Marine Science 63(5), pp. 775–784. doi: 10.1016/j.icesjms.2006.02.001.

SCAN ME

A sea of opportunity

Can ocean energy hold the key to a sustainable future?

Around the world, about 840 million people are without access to electricity. Even though the global share of the population with access to clean cooking fuels and technology went from 57% in 2010 to 61% in 2017, close to 3 billion people still rely on inefficient and polluting cooking systems (UN. Secretary-General, 2019). To ensure that these people and the rest of the world will have electricity in the future has United nations (UN) agreed to have a Sustainable Development Goal (SDG) that focus on this problem. SDG 7 is made to ensure access to affordable, reliable, sustainable and modern energy for all. The aim of UN is to achieve this goal before 2030, but for this to become possible, a major change in in where we get our energy from is still needed.
Over 70% of the earth's surface are covered by ocean but by the end of 2018 did only around 1% of the global electricity come from renewable energy sources in the ocean (Roberts, 2019). For UN to reach SDG 7 should ocean energy be taken into a larger consideration. Developing technologies concerning energy sources like ocean thermal energy conversion, wave energy, tidal current power and ocean wind power can be a big step in the right direction. At the same time, an ambitious development plan for these renewable energies can help stimulate the SDG 9 (industry, innovation and infrastructure) and promote inclusive and sustainable industrialization and foster innovation. Not to mention the massive effect a complete turn-around to renewable energy would mean for the battle against climate change. Reaching the SDG 13, taking urgent action to combat climate change, could really use a hand from having the world focusing on renewable energy. But, the renewable energy share of total final energy consumption has only increased from 16.6% in 2010 to 17.6% in 2016, showing that there needs to be even more focus on integrating these alternative plans in national policies and long-term plans (UN. Secretary-General, 2019). However, there are positive signs. Since 2012 the growth of renewable energies has outpaced the growth of total energy consumption, and the money sent from developed countries to developing countries in support of clean and renewable energy has almost doubled to $18.6 billion in 2016 from $9.9 billion in 2010 (UN. Secretary-General, 2019).

The power and energy stored within the oceans could easily meet the global energy demand (Takahashi and Trenka, 1996). The difficulty lies in the extraction of such energy and converting it for human use and doing so in a sustainable fashion. The developing of ocean energy can have a negative effect on marine life. If the negative effects from ocean energy are to disadvantageous is it then worth it? Or could it be more sustainable to keep developing renewable energy on land? In this paper we aim to explore these issues. We will look at some of the different technologies and methods that have allowed humanity to harness the oceans' energy in a sustainable manner and we will consider the effects that these 'types of energy' have on the ocean, with special regard to Sustainable development goal 14 (SDG 14) 'Conserve and sustainably use the oceans, seas and marine resources for sustainable development'.

Renewable energy resources from the ocean

The natural temperature differences in the ocean can be great and are used to create energy in a process called ocean thermal energy conversion or OTEC. This technique uses a compound with a low boiling point that is heated with warm surface water and cooled with cold deep-sea water, the water gets pumped through pipelines and may be released at another depth than it was collected from. This cycle drives turbines and the compound can be reused indefinitely (*Thermal Gradient (OTEC)*, n.d.; Pelc and Fujita, 2002). This technique works best in equatorial waters where the ocean temperature is stable all year round. (*Thermal Gradient (OTEC)*, n.d.; Pelc and Fujita, 2002)

Wave power has great potential for producing big amounts of energy, because waves are produced by surface wind which is very consistent, especially close to the poles. One of the ways to harvest this energy uses a device called a floater, this extracts energy from the vertical motion of waves (*Wave Energy*, n.d.; Pelc and Fujita, 2002).

Tidal current power is the energy harvested from the change in tides. In order to extract this energy, turbines that are located below the sea surface are used. Tidal energy is a very reliable energy source since there are always two low tides and high tides in a day. Since the turbine is dependent on tidal changes, the turbines have to be placed along the coasts (*Tidal/Current Energy*, n.d.; Pelc and Fujita, 2002). There are however other currents in the ocean than tidal current. It is, for instance, also possible to harvest energy from the currents made by regional differences in temperature and salinity and the Coriolis effect (Ponta and Jacovkis, 2008).

In much the same way that a current turbine extracts energy from the currents in the ocean, wind turbines can extract energy from the winds. Since the oceans usually have strong winds which are less turbulent than the winds over land, offshore wind power has received more attention with the years. Wind power is one of the cleanest energy types that has an economically feasible technology. (Pelc and Fujita, 2002). Today, most wind turbines are fixed to the seabed in waters less than 60 meters deep, but there is also development of floating wind turbines that can be placed further out to sea (Floating offshore wind - Equinor , no date).

Environmental effects on marine life

Even though these energy sources are renewable and inexhaustible they may not be as sustainable as we think, all changes humans make in nature have effects, both positive and negative. Energy converters at offshore locations need power cables connected to land to transfer energy. Such cables are often high voltage and create an electromagnetic field that can interfere with organisms that are electro- or magneto-sensitive (Punt *et al.*, 2009; Hammar *et al.*, 2017). OTEC has more than one negative effect on the environment, the exchange of water can cause relocation of nutrients and toxic metal as well as small organisms like plankton, eggs and larva (Pelc and Fujita, 2002; Hammar *et al.*, 2017). Change of temperature is also one of the effects and can lead to death for some species of fish and corals (Pelc and Fujita, 2002; Hammar *et al.*, 2017). Devices for converting wave, wind, tidal and ocean current power can cause collisions with flying and diving seabirds, fish and mammals, due to the speed of the moving parts that makes them hard to avoid (Punt *et al.*, 2009; Hammar *et al.*, 2017).

However, submerged constructions can also act as artificial reefs and may influence pelagic and larger demersal fish species several hundred meters from the construction (Wilhelmsson, Malm and Öhman, 2006). With no-take zone or limiting fishing effort around wind farms and other energy construction these areas can also act as marine protected areas (MPAs) which can have a positive effect on the marine life (Punt et al., 2009; Hammar et al., 2017; Wilhelmsson, Malm and Öhman, 2006).

Is energy from the ocean more sustainable than energy from land?

To answer the question if energy from the ocean is more sustainable than energy from land we must remember what characterizes the development of such sustainability. According to the UN, when still chaired by the Norwegian Prime Minister Gro Harlem Brundtland in 1987, the sustainable development "meets the needs of the present without compromising the ability of future generations to meet their needs"(WCED,1987).

And what are those needs? the Brundtland report states that they are "employment, food, energy, housing, water supply, sanitation and health care" (WCED,1987). Knowing that sustainable development is directly related to human needs, we can make two parameters: First, in which kind of energy the basic human needs are better met? And second, in which of these two areas are these needs most at risk (through environmental impacts, poor income distribution, less employees or waste production)?

The question on whether energy produced on land is more sustainable than energy produced in oceans will always depend on human activity, on the geographical factor, as well as on the local economy to be answered. In cases of places where there is no feasibility to implement a clean model of energy with low level of emissions, the environment keeps suffering devastation by the enormous number of range of pollutants, hazards which degrades the ecosystem over wider areas. (Dincer, 1999)

With regard to environmental impacts, for example, energy collected from the ocean can be immensely sustainable. Therefore, the investment in technologies that increase the efficiency of

clean energy devices, such as the so-called horizontal-axis turbines are very Important. These turbines are responsible to absorb and also reduce the life-cycle environmental impacts for all categories by “76% and 56%, respectively” (Weber and Nevala, 2006). Simultaneously, on land, the resources from which solar energy is produced are the energy inherent in sunlight as well as the direct and indirect impacts of this light on the earth. (Dincer, 1999)

Conclusion

The oceans certainly have the potential to be the key holders to providing sustainable and renewable energy for the growing global population. The effects of utilising the oceans energy are varied, with both positive and negative impacts on the ocean habitat. It could be argued that some of the effects of these energy systems are counterproductive to achieving specific goals and targets in the UN Sustainable Development Agenda and therefore their sustainability is limited. On the other hand, it may still be too early to know all the effects since ocean energy is still under development. There are however now no large reasons to believe that energy from the ocean is less sustainable than energy from land or that the negative effects on marine life are to harmful. In order to achieve all the SDGs that have been discussed here, further research into the technologies and methods currently used to extract ‘sustainable’ energy from the ocean must be revised. For instant is it possible to extract energy from the open ocean where there is usually a lower density of marine life? Finding a way for ocean energy to reach its full potential without harming the environmental could be a key factor to achieve a sustainable future.

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