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Ocean Thermal Energy Conversion (OTEC) systems prospect in the Mediterranean Sea

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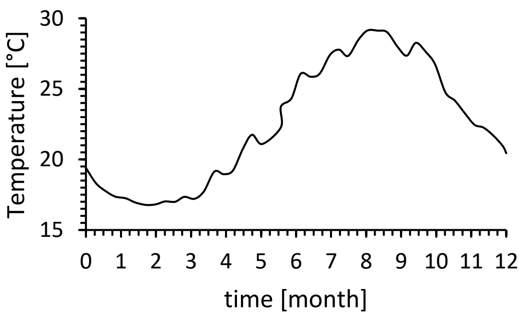
ABSTRACT

Renewable Energy systems (RES) related to the ocean and marine environment have seen a significant advancement in recent years, due to the promotion of such RES for the reduction of fossil fuels and CO2 emissions in general. Ocean Thermal Energy Conversion (OTEC) systems can be categorized as RES, as they exploit the stored solar thermal energy in the ocean surface.

The natural temperature difference ΔT between the surface of the sea and the bottom, at great depths of about 1 km, gives rise to such exploitation potential. This capability can arise either for the generation of electricity or for the delivery of a by-product. The major disadvantage of OTEC systems lies in the availability and the location (i.e., distance from the equator), as the efficiency of the OTEC system depends on ΔT. A ΔT of over 20°C is recommended to provide a Carnot efficiency of 6.7%. OTEC systems aiming at the highest available ΔT, and hence a sufficiently high system efficiency, are suggested to be ideally placed in the tropical regions (or regions with ±20° from the Equator, including the Caribbean) where high ΔTs are recorded.

The Mediterranean region (Sea), where OTEC systems could also be applied, tells another story (Soukissian et al., 2017). Compared to the Caribbean region, the sea surface temperature fluctuation is higher in the Mediterranean region (see Figure 1), with seasonal variation (i.e., winter or summer), with equally high mean values. However, the temperatures at the seabed in the Mediterranean are higher, by approximately 5°C, yielding a lower ΔT than tropical regions.

Estimation on the Mediterranean Sea temperature vertical profile in different sub-basins can be found in the literature (Carillo et al., 2012). Temperatures of 13°C at 1 km depths can be observed, with no significant changes for depths of up to 4 km, as can be seen in the sea temperature depth profile of Figure 1. The EU Copernicus Marine Environment Monitoring Service reports similar findings (through the recorded date). The rise of the sea surface temperature due to climate change, and the effect of the sources in the deep seawater, are aspects that researchers have considered and investigated (García-Monteiro et al., 2022; Sakalli, 2017).



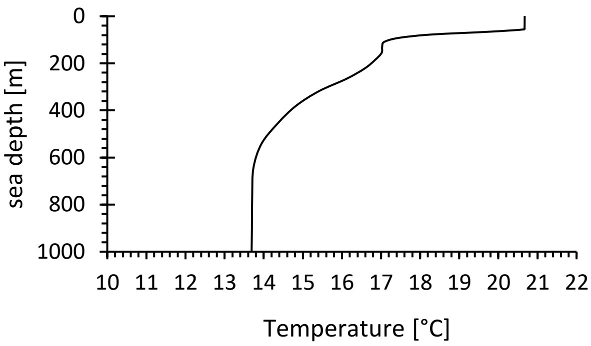


Figure 1 Surface sea temperature (top) and sea depth profile temperature (bottom) close to the Agia Napa Marina, Cyprus

It is a fact that the potential availability of the desired ΔT is evident in many locations worldwide, allowing for OTEC system installation for electricity generation. However in the case of the Mediterranean Sea, based on an initial evaluation, one would suggest that it is not sufficient. The present scientific paper aims to investigate such potentials in the Mediterranean Sea, specifically in the south-eastern Mediterranean area in the island of Cyprus, with the aim to identify how these systems, namely the OTEC systems, could be viable in order, through their possible use, to contribute towards the EU climate emissions neutrality.

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