Criteria for optimal sites selection for the installation of Ocean Thermal Energy Conversion (OTEC) plants in the Mexican Pacific (MP)

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Among the diverse Renewable Energy (RE) generation options include Ocean Thermal Energy Conversion (OTEC), which takes advantage of Temperature Differences (TD) between upper ocean layers and colder seawater, generally below 1000 m, to generate electricity. In order to ensure greater thermodynamic efficiency of the plant, it is preferable to work in areas where the TD´s of the water columns are ≥ 20 °C, with slight exceptions such as in South Korea where it works with 18 °C [1], [3-5]. Tropical regions are areas with enormous thermal potential. Mexico has seawater with optimal characteristics to develop OTEC, mainly in its tropical seas of the Mexican Pacific (MP) and Caribbean Sea (CS) supported by [5-9].

To know the reliability of any renewable plant is needed to estimate the operability, generally defined as the availability time of the system compared to the amount of time it is unavailable. By means of a comprehensive Sea Surface Temperature (SST) data, Daily Operability (DO) of OTEC plant could be estimated in the MP.

SST database used was the Satellite Oceanic Monitoring System (SATMO, from its name in Spanish) [2], which is part of the Marine Ecosystem Information and Analysis System of Mexico (SIMAR, from its name in Spanish) developed by the National Commission for the Knowledge and Use of Biodiversity (CONABIO, from its name in Spanish). The SST geoproducts have a spatial resolution of 0.01 x 0.01 grades and a daily temporal resolution of 16 years (1 Jun 2002–24 Aug 2018).

SST data results are daily averages in the time series. Where T_{sd} are SST data of every day of year, d, are days of the year and T_{Sdi} are SST data of every day of the year for every year in the time series between 2002 and 2018 (1 ≤ □ ≤ 16). Hence, T_{sd} equal to 365 for each of the points in the database. Data were grouped by season.

$$T_{s_d} = \sum_{i=1}^{16} \frac{T_{s_{di}}}{16}$$

According with data of seawater temperature to 1000 m (T-1000) from World Ocean Atlas (WOA, 2013) from 1955 to 2013, the average value T-1000 are 5 ºC with a variability of 0.2 ºC, leaving its value at 5 ºC for the entire study area.

Taking into consideration optimal TD and using de SST daily database, we estimate the DO, based on the percentage of days that exceed SST > 24 ° C in time series.

The purpose of this paper was to evaluate the time availability of the OTEC operation through DO based on SST database and to select optimal sites to OTEC deployment around MP by way of a Decision Matrix (DM) fed by different parameters, such as physical, economic, social and environmental aspects. The methodology involves a combination of Geographic Information Systems (GIS) and statistical models to identify the regions with the greatest potential for the development of OTEC.

The parameters evaluated were the following:

- Accessibility to cold and deep seawater pumping (< 10 km) [3]
- DO based on SST > 24˚C (% days) by season
- SST means by season
- Natural hazards (high, medium, low) [4]
- Distances to the connection of nodes or power plants (km) [5]
- Residential Electricity Consumption MWh (own estimate) [6]
- Homes without electricity [7]
- Peace Index (level of violence on site) [8]
- Risk of damage Protected Natural Areas (high, medium, low) [4].

Through parameters evaluated in DM, optimal OTEC deployment sites are *Puerto Ángel, Oaxaca and Cabo Corrientes, Jalisco*. However, sites selection depends on the sponsor and investor point of view.

Economics literature about OTEC [9,10,11,12,13] suggest investing in plants above 50 MW to have the lowest Levelized Cost of Energy (LCOE). OTEC plants has a high-level capacity factor, making attractive to markets that require high availability to supply base-load power; however, OTEC's LCOE is higher compared with other conventional energy technologies, including wave and current. Although these last ones, cost reduction depend on the construction of early matrices, and not on the big scale projects immediate progression. Other seawater secondary products generated by OTEC could trigger the social and economic development in the chosen areas.

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