OTEC instalation posibilities in Mexico

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ABSTRACT

This summarizes the preliminary result of the analysis of different places in the Mexican coast where OTEC or deep cold water extraction plants could be installed. The fundamental requirements for an OTEC are: water gradient temperature above 20 degrees year round; ease of close access (10km or less) to deeps (around 1000m) to gain access to the required cold water to ensure the gradient. Unfavorable conditions: probability of hurricanes in the area and restrictions on constructions in protected areas near the coasts (i.e. tourist areas).

With respect to the required gradient year round, the south Pacific coast of Mexico, the Gulf of Mexico and the Caribbean sea meet the required conditions. The access to deeps is present in the Caribbean and the Pacific coast. Restricted areas are found in the Baja California peninsula, the center of the Pacific coast and in the Caribbean. All shores are exposed to hurricanes, but with different probabilities. Even though none of the analyzed places meet all requirements, a detailed analysis of various places where OTEC or cold water extraction plants could be installed.

Keywords: OTEC, Mexico

1) INTRODUCCION

In the XXth century the main source of energy in Mexico had been hydrocarbons. However from XXIth century without a doubt this resource is limited therefore the use of alternative resources will be necessary.

Nevertheless the current technology estimates that those alternative energies will be insufficient and only a small amount of the energy requirements will be obtained so it is worth exploring.

One of the possibilities is ocean energy specifically thermal gradient. There are already small OTEC plants with room to upgrade to large scale production. This article presents an investigation to possible sites in Mexico to install this type of plants. Within OTEC plants, other application exists such as desalinization and air conditioning.

Mexico has coasts on both the Pacific and Atlantic(The caribbean and Gulf of Mexico). The aim is to study the potential sites for OTEC plants installation.

The main source of energy in 20th century Mexico was hydrocarbons. In the 21st century, however, without a doubt this resource is limited, and as a result the use of alternative resources will be necessary.

Although current technology estimates that alternative energies will be insufficient and that only a small amount of the energy requirements will be obtained, they are still worth exploring.

One option is ocean energy – specifically the thermal gradient. There are already small OTEC plants with room to upgrade to large scale production. This article presents research on possible installation sites in Mexico. OTEC plants can also be employed for applications such as desalinization or air conditioning.

Mexico has coasts on both the Pacific Ocean and the Atlantic (the Caribbean and Gulf of Mexico). The aim is to study potential sites for OTEC plant installation.

Alternative energy sources are possible. To place this into context, such sources will only be capable of supplying a small percentage of the energy required in the 21st century, but their contribution is potentially quite useful. In the case of the OTEC, it can be connected to the electricity grid or in isolated places on coasts or islands. As OTEC technology progresses, it will become more efficient; furthermore, new ideas for the utilization of the thermal energy of the sea will surely be developed.

The following requisites, vital to the installation of an OTEC plant, are analyzed in this study:

1) The existence of a thermal gradient pronounced enough with which to operate a plant. Vega [3]suggests a 20 °C minimum.
2) The distance to deep zones (access to cold water). Vega [3] suggests a distance of no more than 10 km.
3) The distance to the electrical grid and consumption centers.
4) Natural hazards.
5) Protected areas.

There are other key factors that are considered for future inclusion, such as legislation and social and environmental impact.

2. METHOD

A specific analysis was conducted for each of the factors.

2.1 Existence of a thermal gradient.

Figure 1 shows the summer thermal gradient in August 2014, and figure 2 that of the winter in January 2012. Gradients were calculated from NASA databases [1] for surface temperatures and Copernicus [2] for temperatures at 1000 m.

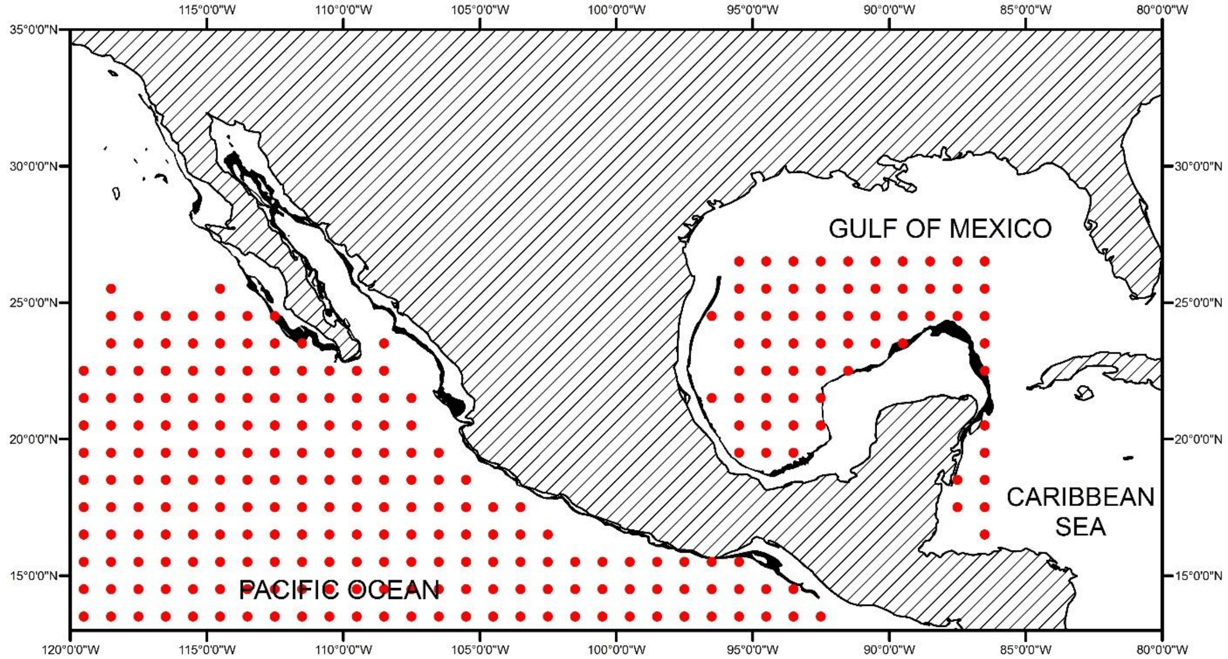

Figure 1. Temperature gradient greater than 20° along the coasts of Mexico in the summer of August 2014.

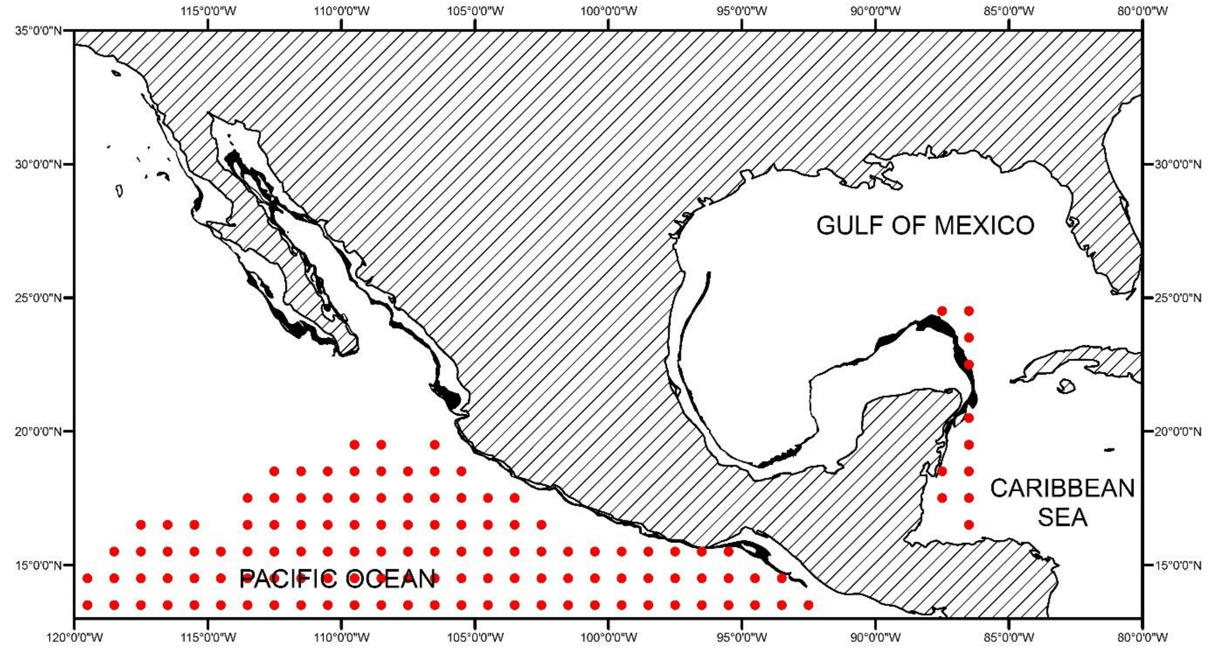

Figure 1. Temperature gradient greater than 20° along the coasts of Mexico in the winter of January2012.

2.2 Sites near the coast

Figure 3 illustrates the location of 1000 meter isobaths along the coasts of Mexico, obtained from NASA databases [2]. Current bathymetric maps are inexact. They may be used as a first approximation, but when undertaking a real project — whether it be a prototype or a large inshore or offshore OTEC plant — high resolution bathymetry is required, such as that obtained through the use of a multibeam echosounder.

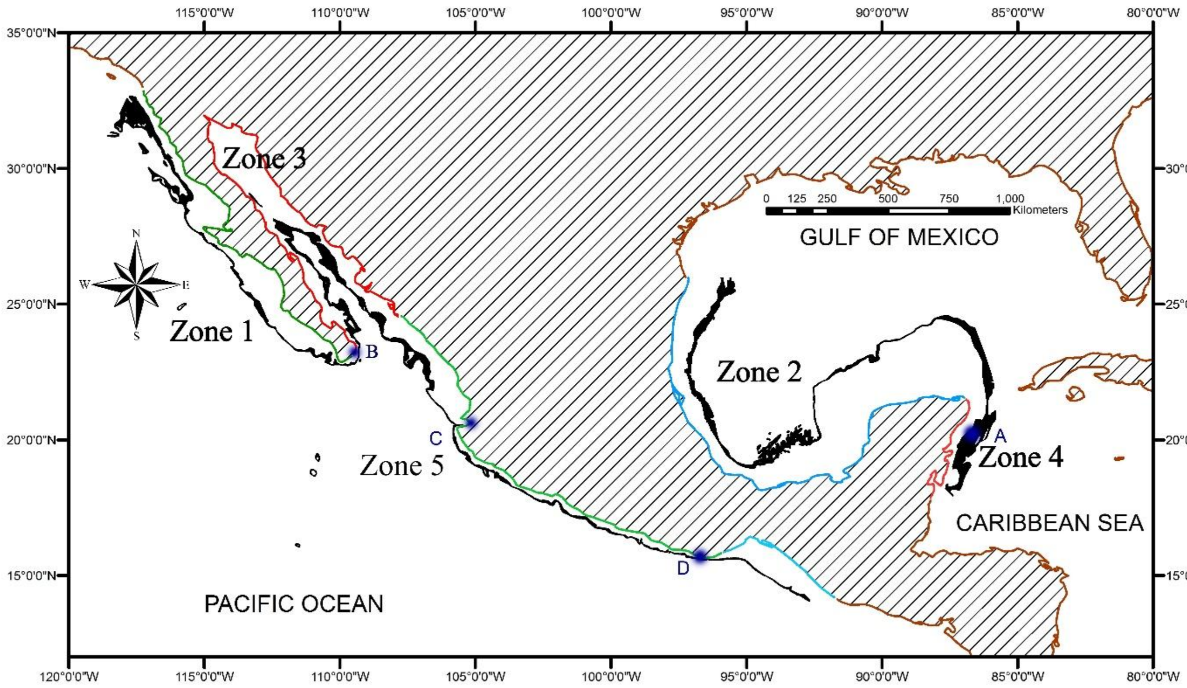

Figure 3. 1000m isobaths and selected zones and possible sites of OTEC installation.

2.3 Distance from the electrical grid and consumption centers.

Here it will initially be necessary to define how the OTEC will be applied: whether for the procurement of energy or also for the utilization of cold water, and whether it will be connected to the electrical grid (Figure 4) or if it will work independently.

Figure 4. Mexico’s electric grid [4].

2.4 Natural hazards

Hurricanes pose the main threat to OTEC plants. As hurricane trajectories are not predictable, historical data are employed to determine probabilities. Figures 5 and 6 show the category 2 and 5 hurricanes that have struck Mexico over the past 20 years, CONABIO[5].

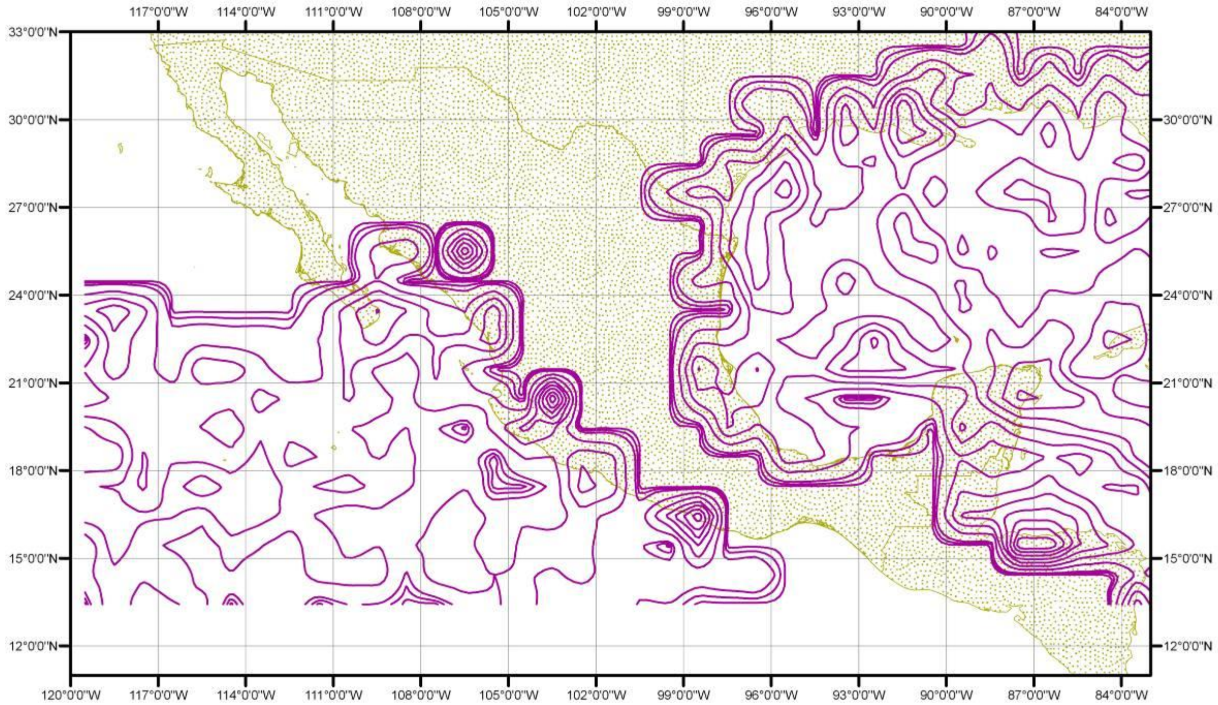

Figure 5 Probability of occurrence Category 2 hurricanes in Mexico [5].

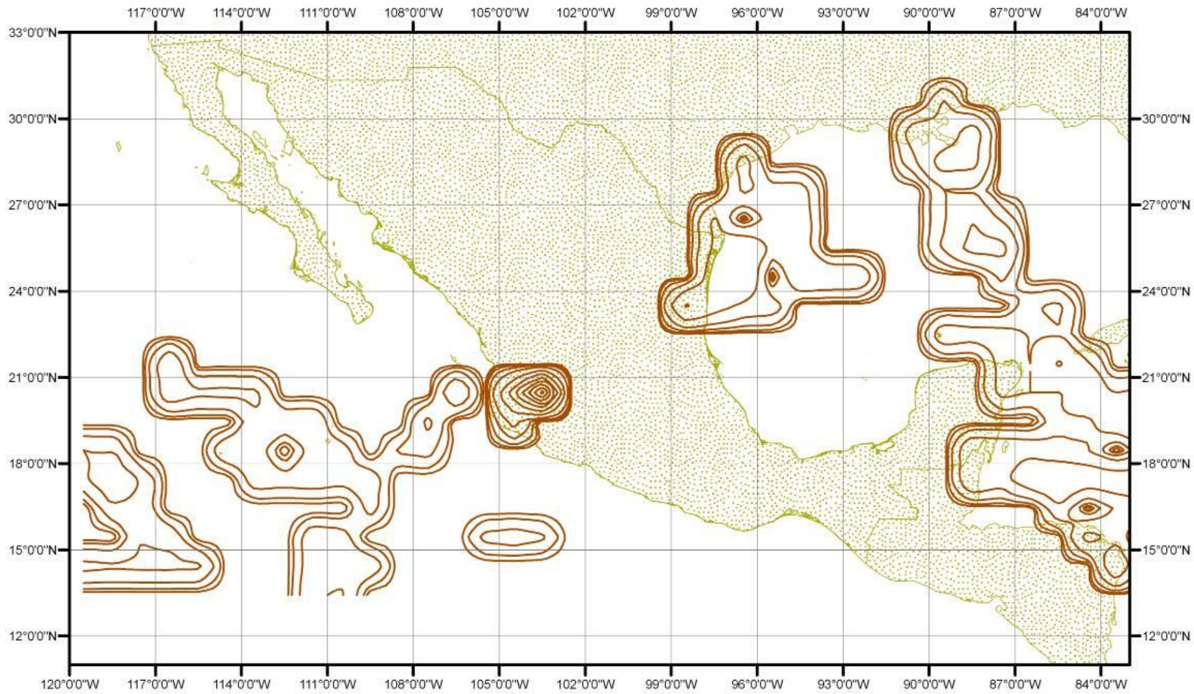

Figure 6 Probability of occurrence Category 5 hurricanes in Mexico [5].

Other hazards such as earthquakes or tsunamis have not yet been taken into account.

2.5 Protected areas

This is an important point that includes the existence of legislation covering the installation of sea energy extraction plants. In reference to Mexico, there is still no such legislation and it may be a considerably long time before it comes into existence. There are several statuses of protected areas, and Figure 7 exhibits the protected areas in Mexico that are currently under protection, such as:

- Biosphere reserves
- Sanctuaries
- Areas for the protection of natural resources
- Areas for the protection of flora and fauna
- Areas under ambiguous management

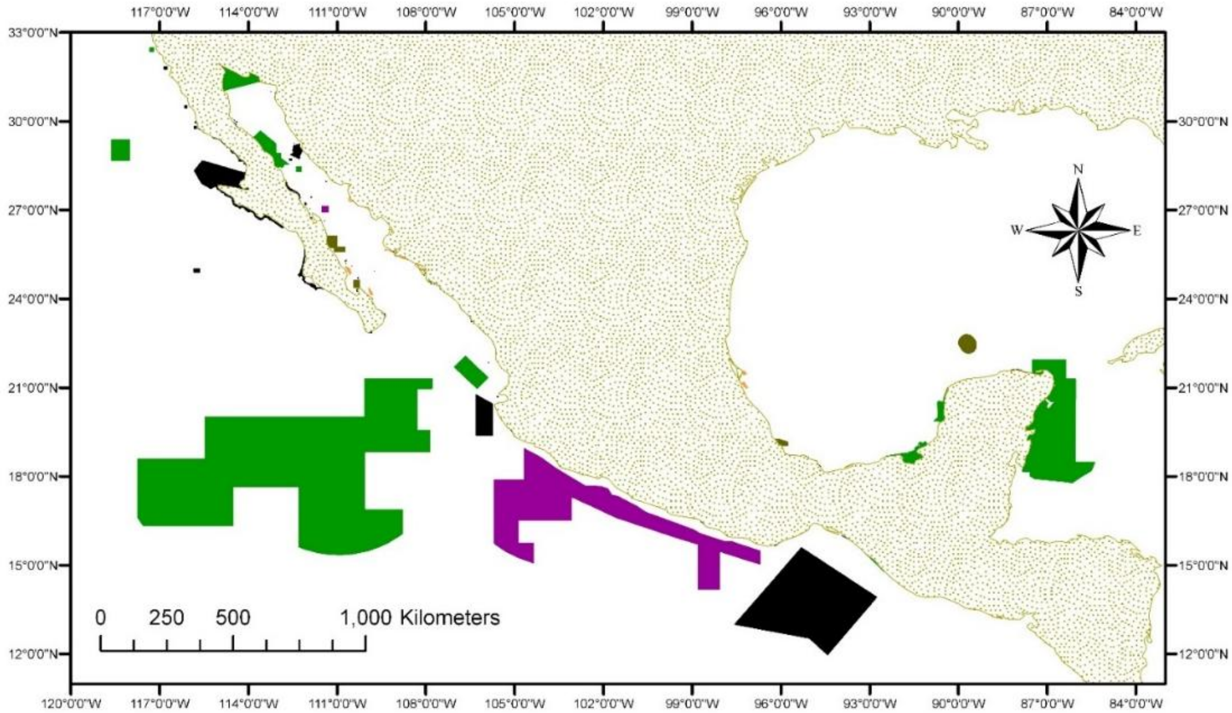

Figure 7 Protected areas in México [5].

There are different statuses for each area, and we do not necessarily consider them to exclude OTEC plant installation. For the time being, regions considered to be protected areas are presented.

3. DISCUSSION

Of all the points that have been mentioned, there is not one site that truly complies with each and every requisite. The advantages and disadvantages of each place must be analyzed. Figure 8 shows distinct zones and the conclusions to which we have come:

3.1 Exclusion

The zones that are not currently considered able to offer adequate conditions (but that may possibly be included in the future) are as follows:

Along the western coast of the Baja California peninsula (Zone 1), as surface waters are cold due to the presence of the California current, there is no adequate gradient during any season of the year.

In the Gulf of Mexico (Zone 2), the continental shelf is quite large. Despite the presence of islands, these are in shallow waters, which means that for the moment this coast has been ruled out.

In the interior of the Gulf of California (Zone 3) there are several drawbacks, such as an exceptionally wide continental shelf on the east coast, very small towns with no access to the electrical grid dotting an otherwise uninhabited west coast, waters in the northern portion of the gulf that do not reach the required depths, and a thermal gradient that is only present during the summer. Due to the above, this region has been excluded.

Although in the Southern Mexican Pacific (Zone 6) there are favorable conditions such as the gradient, a location external to any protected areas, and few hurricanes, the continental platform is extensive. Because of this zone 6 has been excluded.

3.2 Possible but tremendously difficult installation:

In the Mexican Caribbean (Zone 4), it would be quite challenging to obtain the acceptance necessary to install a plant of this kind within the touristic area known as the Mayan Riviera. Point A, east of Cozumel Island, is close to a deep site and presents the required thermal gradient year-round. Another immense inconvenience of this zone is that it lies in the path of all categories of hurricanes.

3.3 Zones that seem promising

The disadvantage of Zone 3, the southern Baja California peninsula, is that the gradient is lost during the winter. Certain noticeable advantages include the proximity of large cities with a high demand for electricity, air conditioning and desalinized water, as well as sites remarkably close to the coast that boast depths greater than 1000 meters (point B in particular, called Los Frailes).

Zone 5, the Central Mexican Pacific, is quite extensive and contains several advantageous places. The thermal gradient is favorable throughout the year, there are various sites of great depth proximal to the coast, there is access to the electrical grid, and there are important consumption centers. Among the unfavorable aspects, there is the possible presence of intense hurricanes and the fact that it contains protected areas. Concerning hurricanes on this side of the Pacific Ocean, it is important to note that they evolve from south to north in such a way that, while in the south the category is normally 1 or 2, category 5 hurricanes strike the north and even travel as far as the Baja California peninsula (Zones 2 and 3). Two sites are currently under more detailed study: point C in Bahía de Banderas, Nayarit and point D in Puerto Ángel, Oaxaca.

In relation to islands, there are several in Zone 4 (included in Figure 3). These have not been studied, but may be adequate for OTEC plant installation.

4. CONCLUSIONS

There are, in fact, several sites along the coasts of Mexico at which OTEC plants can be installed.

The most adequate points are those labeled C (Bahía de Banderas) and D (Puerto Ángel), and other such points are likely to exist within the Central Mexican Pacific zone.

Point A (Los Frailes) suffers a gradient that is absent for a portion of the year; nevertheless, other applications such as the utilization of cold water can be of great interest.

Point B (Cozumel) gives several advantages, although there are two major drawbacks: it is situated within a tourist area, and there are intense hurricanes.

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