DOUBLE ENERGY INPUT, A PROPOSAL FOR A NOVEL SOURCE OF ELECTRICAL ENERGY, NON-OPEN PIT MODEL.

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ABSTRACT

In order to slow down adverse global anthropogenic effects such as global climate change and the destruction of ecosystems, alternative energy sources that are clean, renewable, and efficient are needed to replace the existing energy sources.

Double Energy Input is a novel invention that gathers two renewable energy resources: hydro-electrical power and geothermal power. This invention utilises the sea as its reservoir, the dam is a wall of a big pit hole, and in the base of such pit, we will use the geothermal power for ridding off the water.

This model is designed to generate between 1,200 – 1,500 MW of power in the hydro-electrical phase and will generate about 4.86 tons of salt per second. An additional 800 MW of energy will be produced by supercharging the hot water at the bottom with heat and pressure and running a vapour power plant.

This model provides an alternative means for producing clean and renewable energy with two abundant resources, sea-water and geothermal heat.

1. NECESSITY OF SUSTAINABLE ENERGY.

1.1 Greenhouses gases effect on our planet.

According to the Joint Science Academies' statement (2005), greenhouse gases have a positive effect on life on our planet. Without them, the earth shall have temperatures 30 centigrade degrees lower than our actual temperature. But the problem is with human activities that release and concentrate a large concentration of greenhouse gases in our atmosphere, from 280 ppm in 1750 to more than 375 ppm today. Earth's temperature increased by about 0.6 centigrade degrees in the twentieth century.

The Intergovernmental Panel on Climate Change (IPCC) estimates that the global surface temperatures will be increasing in a range between 1.4 centigrade degrees and 5.8 centigrade degrees above 1990 levels by the end of this century.

Historically, the energy requirements of Humankind have increased sharply from time to time, and the rate of this growth is also growing.

Power demand tremendously increased with the advent of industrialization, and fossil fuels relatively quickly displaced traditional sources of energy.

But the increase in demand does not stop with the industrial revolution; the aerospace age requires more and more energy. The livelihood of every country is improving, and more power is needed to fulfill the requirements of the citizens of each city.

Increasing production requires new ideas to develop more renewable energy production. Solar and wind power production are trending technologies. And there is an essential growth in the development of such kinds of energies.

Renewables are taking more importance in the production of energy, and clean energy is required to fight back the problem of global warming, pollution, and the destruction of the ecosystems.

1.2 Comparison of greenhouse gas production by source.

Energy production is essential for humankind. The way of living requires a high output of energy, and the demand is increasing throughout time. With more population, it is needed more utilities, industrial production, and food. According to Vaclav (2017), by 2018 more than 80% of energy production is released by non-renewable resources.

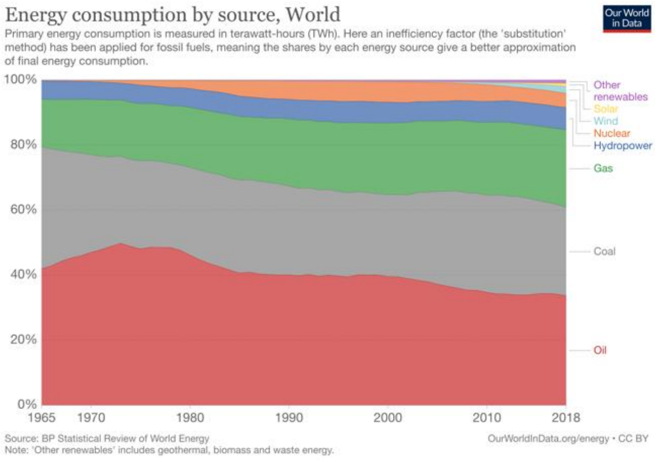

Figure 1: "Energy consumption by source, World" According to BP Statistical Revie of World Energy, this chart shows the proportion of the source of energy by production.

In figure 1, we can appreciate the gradual reduction in oil and coal use. But the rate of decline in the use of fossil fuels is slow. New sustainable sources of energy are required to compete against the infrastructure and versatility of coal and oil. Therefore, DEI is a proposal for a novel source of electrical energy.

2. DOUBLE ENERGY INPUT (DEI).

2.1 DEI Concept.

DEI is a new source of energy that combines Hydro-Electrical and Geothermal electricity production, using the sea as a reservoir and the geothermal heat located at the bottom of a vast pit as a source of thermal energy.

The difference between the level of the sea and the bottom of the pit allows this model to produce energy from the kinetic energy of the reservoir and the interaction with gravity.

2.2 Using sea-water as a source of kinetic energy.

According to the National Ocean Service (of the United States of America), sea-water is allocated at a "sea-level" and covers more than 70 percent of our planet surface, which means that there is no higher location of sea-water than the shore. The only movement of such level of water is affected by the tide effect of the interaction between the Moon, the Sun, and Earth. With their respective rotational and translational movements. Sea-water has a volume close to 1.35 billion cubic kilometres; therefore, it is a vast source of liquid with kinetic potential.

2.3 Hydro-electrical phase of DEI.

Hydro-electrical power shall be produced from the kinetic energy of the water located at a higher surface than the pit.

Sea-water and the pressure generated with the water column will move four Pelton turbines at a depth of 1,870 meters underground. Pelton turbine is the best option for DEI invention, due to the best performance in high heads and has the lesser volume of water.

As a part of this research, according to the information obtained in the The Bieudron Power plant information; Grand Dixence power plant in Bieudron uses three Pelton turbines of a capacity of 400 MW each one, producing a total of 1200 MW of energy.

The head of the water shall produce about 20 MPa of pressure over the turbines. With such pressure, the rotation of the turbines. Each turbine is designed to produce 420 MW of energy. The water will remain at the bottom of the pit once the energy has been produced.

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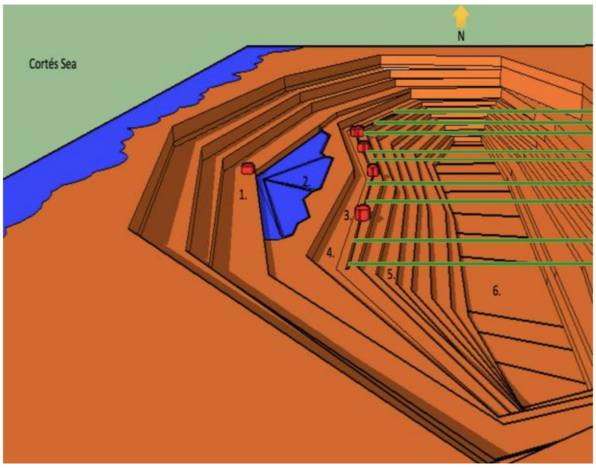

Figure 3: "DEI Conceptual model," this figure is a graphic description of the invention.

The specific steps of the hydro-electrical phase are as follows:

DEI has a filter of inverse osmosis at 900 metres below sea level (1. In figure 3); a small reservoir of fresh-water will be allocated just beside (2. In figure 3), at the same depth; Four Pelton turbines (each one will have the capacity of 423 MW) will be allocated at 1886 meters under the sea-level (3. In figure 3), and they will be feed by sea-water and fresh-water; The system will be loaded with fresh-water and sea-water.

Filtered fresh-water shall help the cleaning process of the turbines. The filter process reduces the amount of pressure in the water at about 8.2 MPa; this filter shall be allocated at a depth of 900 meters. That allows the filter functioning, using the pressure obtained by the water column of 900 meters. During the cleaning process of the turbine, the pressure of the water will decrease from 20 MPa to 11.8 MPa, producing about 60 percent of the energy generated by sea-water.

2.4 Hydro-electrical power calculations.

Calculations of the installed capacity of DEI Hydro-electrical process are as follows:

$$P = m * g * Hnet * \eta$$

Where:

P = power, measured in Watts (W).

m mass flow rate is shown in kg/s (considering that 1 litre of water equals to 1 kilogram) g is the gravitational constant, which is 9.81m/s2 H net Is the net head.

This is the gross head physically measured at the site, less any head losses. To keep things simple head losses can be assumed to be 10%, so Hnet=Hgross x 0.9 η It is the product of all of the component efficiencies, which are usually the turbine, drive system, and generator.

For a typical hydro system, the turbine efficiencies would be 85 percent, drive efficiency 95 percent and generator efficiency 93 percent, so that the overall system efficiency would be:

$$0.85 * 0.95 * 0.93 = 0.751\ i.e.\ 75.1\%$$

We shall convert the gross head into the clear net head by multiplying it by 0.9, so:

$$Hnet = Hgross * 0.9 = 1886 * 0.9 = 1697.4m$$

Then convert the flow rate in m^3 into litres/second by multiplying it by 1000, so: m^3 75 = 75,000 $litres\ per\ second$.

In this case

$$Hnet = 1886 * 0.9 = 1{,}697.4\ m$$

and the flow rate is: 75000 litres per second, hence:

$Power\ (W) = m * g * Hnet * \eta$ = 76,500 ∗ 9.81 ∗ 1697.4 ∗ 0.751 $Power\ (W)$ = 1,273.83 MW.

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Considering that 1 litre of water weighs about 1 kg, so m is the same numerically as the flow rate in litres/second, in this case, is 75,000 kg/s. But we will adjust our equation to have a better approximation with sea-water.

2.5 Water disposal.

A considerable challenge for disposing of the water underground is the flooding of our system, delivering the water underground will face the pressure and temperature of the environment (hydrostatic pressure).

One of the proposals above was using depleted coal, iron, or copper mine. But it is hard to find a place like that, and it could be hard getting a deal with the owner of the abandoned mine. As well such deep holes may fill with water from underground aquifers, for example.

Therefore, I'm proposing an Open-pit mining joint venture in a convenient place. The extraction of the mineral resources shall pay for the cost of the open pit that we need, and gives some profits to the mining company.

Once the energy is produced, a high volume of water will remain at the bottom of the pit. The flow rate of DEI invention shall be between 75 and 100 cubic metres per second. In 20 years, it will be loading to the pit, about 63 cubic kilometres of water.

Build a pit of such dimensions is not proportional to the profit of the electricity generation, therefore, returning the water to the environment shall be the next step of DEI process.

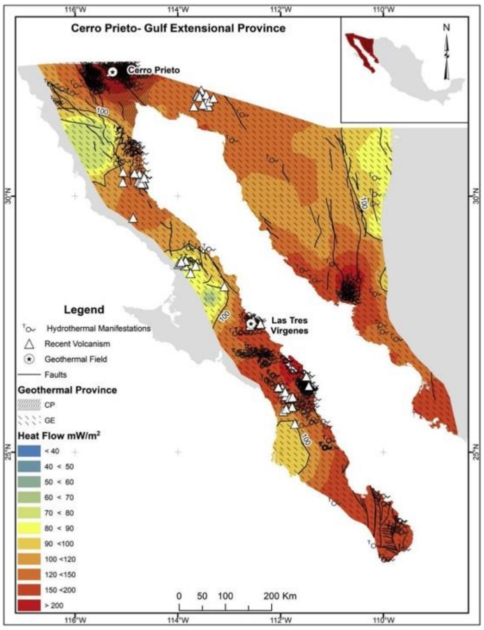

Figure 4: "Geothermal gradient in Sonora and Baja California" This map shows the regions with a high heat flow.

2.6 Geothermal phase of DEI.

The bottom of the pit shall be placed below 3,000 metres under the ground. According to Armenta (2011) the studies of the geothermal region of Sonora and Baja California, the geothermal gradient at that place shall provide a temperature between 180 up to 300 Celsius degrees. The amount of heat depends on the place that the pit shall be allocated.

The model is designed to be built at Guaymas, Sonora, México. Guaymas region is dry and hot. Close to the shore of the Gulf of California or Cortés Sea. The flow of heat is above 200 mW/m2.

Such properties are optimal for the heat exchange at the bottom of the pit. We expect a surface temperature above 150 Celsius degrees and a consistent radiation of the sun.

Fig. 18, Geothermal gradient map of Baja California Peninsula and Sonora State, the circles are in "Las tres Vírgenes area" and in "Guaymas Port in Sonora State."

Both of the places have the following properties:

They are inside an area with a very high geothermal gradient. They have minerals to gather. They are very close to the shore. The elevation of the shore is low.

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Sonora state is located in the north-west part of Mexico, along a strip that includes the great deserts of the world, it is characterized by extreme climate changes, with high temperatures and evaporation and very low rates of precipitation, runoff, and infiltration.

According to the Instituto Nacional de Estadistica Geografía e Informática "INEGI" (2020), the State of Sonora has an average annual precipitation of 336 millimetres, which is small, compared with Campeche (1,641 mm), Chiapas (2,093 mm), Tabasco (2,318 mm), and the states located in the southeast part of Mexico.

The annual evaporation in Sonora is about 2,254 mm and the runoff is practically minimal. Therefore, the majority of rivers and streams remain dry most of the year.

Based on the surface of Sonora, the precipitation volume is 64,894 millions of cubic meters, from which:

58,095 Mm3 (89.52%) evaporate; 4,444 Mm3 (6.85%) drain off ; 2,355 Mm3 (3.63%) infiltrate to recharge aquifers.

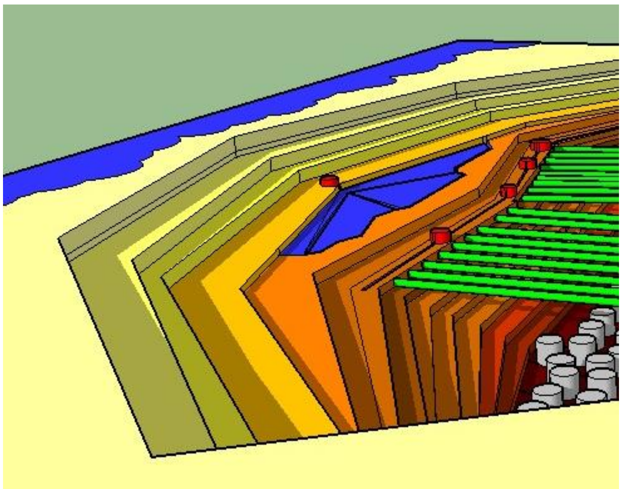

Figure 5: "Geothermal components of DEI" This figure represent the increase of the temperature of the pit, and the water superchargers.

DEI model is designed for producing Hydro-electrical energy by letting the water flood the pit and evaporate with the geothermal heat and the sun radiation. But additional energy may be producing supercharging water at the bottom of the pit. The process is as follows:

Fill a big pressured tank of water with the residual water from the turbines., add pressure from the water loading system (from 1 MPa to 32.3 MPa). Hermetically close the tank and wait until the exchange of temperature is done (we expect about 200 Cº at the bottom of the pit underground). After the exchange of temperature, we will have a pressure of 51.26 MPa; also, an internal change of 83,298 KWh, the efficiency of a steam power plant is close to 79%. Then 60 tanks of 5,000 cubic metres will be feeding our geothermal station located at the bottom of the pit, with an installed capacity of 830 MW at a rate of 270 millions of litres of water steam per hour.

2.7 Dimensions of the pit and evaporation ratio at the surface of the pit.

The pit shall be irregular or circular, but it will be required to have an area of 3.5 square kilometres at the bottom of the pit. The height of the pit shall be at least 2,200 meters. As a reference, the AngloGold Ashanti's Mponeng gold mine is the deepest mine ever made. It has a depth of 3,800 meters.

Air has limited capability to contain water, and this ratio depends on several factors such as an evaporation coefficient, speed of the air in the surface, water surface area, and the maximum humidity ratio of the air minus the current humidity of the air.

This is the formula for evaporation rate from water surface per second:

$$g\,'' = \theta\ A\ (x\,'' - x)\ /\ 3600$$

θ is the evaporation coefficient that is 25 + 19v v is the speed of the air at the surface, the mean wind speed in Guaymas, Sonora is 3.4 m/s (from 2.5 m/s to 3.95 m/s).

A is the area of the surface, that is 3,500,000 square meters.

x "is the maximum humidity ratio, it varies depending on the temperature, but for our current work, we expect temperatures from 150º to 180º Celsius degrees at the bottom of the pit, and that equals to 0.982.

x is the current humidity rate, in Guaymas the mean humidity in the humid months is 40% at 30º Celsius. That is 0.016.

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$$g_s = (25 + 19v) \ * \ A\,(x_s - x)\,/\,3600$$
$$g_s = (25 + 19 * 3.95) \ * \ 3{,}500{,}000\,m2 * (0.982_s - 0.016)\,/\,3600$$
$$g_s = (89.6) \ * \ 3{,}500{,}000\,m2 * (0.966)\,/\,3600$$
$$g_s = 84{,}149.33\,kg/s$$

That means that we can evaporate up to 84,000 kilograms of water every second.

Achieving such a rate of water evaporation per second will let us run our power plant freely. Salt recovery will be a challenge due to the extreme conditions, but it is a resource that can be sold.

2.8 Non-Open-Pit model.

Considering the costs and the complexity of the open pit model, we started a new model.

The Non-Open pit model is a variant that changes the reservoir of the open pit, to an air reservoir under the sea, at two kilometres below the sea level.

The estimated pressure of the reservoir shall be about 20 MPa; therefore, it is required to be build of reinforced cement. The dimensions of this pit shall be:

Height: 15 metres; width: 500 metres; length: 500 metres.

The estimated volume of this reservoir will be 3’750,000 cubic metres. The turbines will be allocated at the entrance of the reservoir.

The space will be distributed as follows:

2,500,000 cubic metres will be used as the undersea reservoir.

500,000 cubic metres will be used as a reservoir of a high-temperature liquid, such as oil.

750,000 cubic metres will be used for the superchargers (each one shall contain about 5,000 cubic metres.

In this model, the water will flow and move the turbines; the water will lose pressure but generate the amount of energy estimated in point 2.4.

The water shall be at 4 Celsius degrees. From the reservoir, the water will be allocated to each supercharger. The supercharger will be heated with hot liquid.

The hot liquid shall not boil at least 300º Celsius degrees. The reservoir of hot liquid will be connected with an underground web of horizontal drilling tunnels. Such underground web will be heated by the underground heat. Temperatures of 240º Celsius degrees will be expected.

Considering the volume of water, the superchargers shall heat the water in one hour to a temperature between 180 to 150º to 180º Celsius degrees and generate the estimated energy that we calculated in point 2.6.

The steams shall be captured at the surface and feed a steam power plant.

3. CONCLUSIONS

DEI is a novel proposal for energy generation. Further studies, modeling, and field investigations are required. We need to address the optimal design for the fabrication of the parts of the DEI model, in an actual location, with several studies regarding the soil and the existing infrastructure.

Opening a pit of such dimensions will be difficult, and we shall consider the complexity of digging and working on a hot surface.

Complex engineering is required to develop the non-open pit model of this novel idea, but it seems to be feasible and more economically feasible than the open-pit model.

This idea seems feasible, and it would be more profitable if we add the mineral extraction industry and salt production to the commercialisation plan.

The hydro-electrical part is the most complex because of the use of seawater and the removal of the used water.

Geothermal input will help allocate the water and the return to the environment without any kind of contamination.

Further research is required for the materials and corrosion with the sea-water. And it is required to make several test of corrosion and cleaning of the turbines and the Hydro-electrical part of DEI.

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