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Assessment of OTEC Potentiality in the Niger Delta and Lagos State Coastal Regions of Nigeria

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ABSTRACT: The gap arises as a result of the high usage together with the electricity generation, which has caused everyday epileptic power supply and dependence of stand-in electric generators that restrict productivity. Energy assurance concerns loom in the future as a result of the decrease in the production of domestic oil. Therefore, pursuing renewable source of energy like OTEC, which deals with ocean thermal gradients, can give reliable, clean energy to ameliorate the power generation. Precisely, in order to bring investment of OTEC in the Niger Delta and Lagos State coastal regions, the assessment of OTEC potentiality in these regions has been conducted. Accordingly, the work looked at the OTEC potentiality along the Niger Delta and Lagos State Coastal cities like Brass, Bonny, Burutu, Calabar, Ebute-Ikorodu, Esuk-Oron, Lagos, Okirika, and Port Harcourt respectively. The results show that the minimum average approximate monthly hot seawater temperatures of these areas considered are between 25^0C and 27^0C and a cold seawater depth of around 800m to 1000m, which translates to an approximate average cold seawater temperatures of between 5^0C and 6^0C representing 20^0C differential temperature thereby displaying OTEC potentiality in these regions. That means the investment of OTEC is possible.

KEYWORDS: Assessment, OTEC, Potentiality, Niger Delta, Lagos State, Coastal Regions, Nigeria.

I. INTRODUCTION

Nigeria's economy, as regarded as the biggest economy on the African continent, is expressing a fast increase in the consumption of energy. Comparably, each power utilization in Nigeria is low when it is being compared to other emerging African countries. Also, the need for energy has really increased from 6% to 7% yearly as a result of high hope in the economy after the recession. The fossil fuels have been the major source of electricity, and the national electricity consumption as of 2018 has surpassed 22 TWh (Igomaet al., 2024). Precisely, Nigeria has plenty of renewable energy resources and energy that is not renewable energy resources, but the provision of electricity to its citizens has failed. It entails about two hundred trillion cubic feet of available natural gas together with nine billion barrels of crude oil reserves, but the country is suffering from epileptic power supply capacity of four thousand megawatts (4,000 MW), comparable to an expected needs of more than twenty times that, and the present general grid generates less than forty percent of the need, making hospitals, businesses, and homes depend on electric generators at great expenses. Also, the subsisting energy supply infrastructural framework relies basically on natural gas (Bimbolaet al., 2016; John et al., 2018).

The ocean thermal energy conversion is a renewable energy source that works based on seawater temperature variation regarding the depth of the ocean, and the temperature difference can be utilized to run the thermal machine that produces the needed work, which is converted to electrical energy (Jiaet al., 2018). The ocean captured the heat produced via solar radiation, and it covers over seventy percent of the earth's surface, thereby enabling the ocean thermal energy conversion plants to be relatively the most illimitable source of energy. This effectively makes them the most efficient energy depository plants globally because they depend only on sunlight and the currents of the ocean, and it has been valued that the energy gotten from the ocean has no harmful effect on the environment and is about three trillion watts to five trillion watts of power (Zhao et al., 2013; Nihous,

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2018). Also, the ocean thermal energy conversion operates on a smaller temperature difference than the traditional thermal engines. Precisely, the real efficiency of a heat engine compelled through a regular temperature gradient of 20 °C is lower than the hypothetical maximum as a result of the heat together with the frictional loss in the ocean thermal energy conversion plant, and this makes it show as a more doable energy source only if a better improvement of the thermal efficiency is done to avert the low energy conversion efficiency (Amyraet al., 2015). Naturally, the upper surface seawater is utilized as the heat source and is indispensably accessible in very considerate quantities as an optional energy source, and very many appraisers reckoned on ocean thermal energy conversion as probably the renewable energy source, hopefully for considerable large scales of energy production, particularly in the coastal part of Nigeria (Leeet al., 2005).

The gap arises as a result of the high usage together with the electricity generation, which has caused everyday epileptic power supply and dependence of stand-in electric generators that restrict productivity (Ibitoye&Adenikinji, 2007). Energy assurance concerns loom in the future as a result of a decrease in the production of domestic oil. Therefore, pursuing renewable source of energy like OTEC, which deals with ocean thermal gradients, can give reliable, clean energy to ameliorate the power generation of some part of Nigeria like the Niger Delta and the Lagos State Coastal cities (Khalid et al., 2017).

The ocean thermal energy conversion is a renewable energy source that works based on seawater temperature variation regarding the depth of the ocean, and the temperature difference can be utilized to run the thermal machine that produces the needed work, which is converted to electrical energy (Jiaet al., 2018). The ocean captured the heat produced via solar radiation, and it covers over seventy percent of the earth's surface, thereby enabling the ocean thermal energy conversion plants to be relatively the most illimitable source of energy. This effectively makes them the most efficient energy depository plants globally because they depend only on sunlight and the currents of the ocean, and it has been valued that the energy gotten from the ocean has no harmful effect on the environment and is about three trillion watts to five trillion watts of power (Zhao et al., 2013; Nihous, 2018). Also, the ocean thermal energy conversion operates on a smaller temperature difference than the traditional thermal engines. Precisely, the real efficiency of a heat engine compelled through a regular temperature gradient of 20 °C is lower than the hypothetical maximum as a result of the heat together with the frictional loss in the ocean thermal energy conversion plant, and this makes it show as a more doable energy source only if a better improvement of the thermal efficiency is done to avert the low energy conversion efficiency (Amyraet al., 2015). Naturally, the upper surface seawater is utilized as the heat source and is indispensably accessible in very considerate quantities as an optional energy source, and very many appraisers reckoned on ocean thermal energy conversion as probably the renewable energy source, hopefully for considerable large scales of energy production, particularly in the coastal part of Nigeria (Leeet al., 2005).

Precisely, the surface seawater temperatures differs from 25^{0}C to 30^{0}C pending on the period, and the deep seawater temperatures hangs around moderately constant at 4^{0}C to 10^{0}C, as shown in the worldwide ocean surface temperatures of **Figure 1** and **Figure 2**, respectively (Bruce, 2008; Yusuf & Lydia, 2000). The Ocean is the world's biggest solar receiver and storage system, and in a day, sixty million kilometers per square (60 MKm2) of equatorial seas absorbed the total ratio of solar radiation that is equitable to the heat proportion of approximately two hundred and fifty billion barrels of oil (Walter &Farshid, 2014; Alkhalidiet al., 2014).

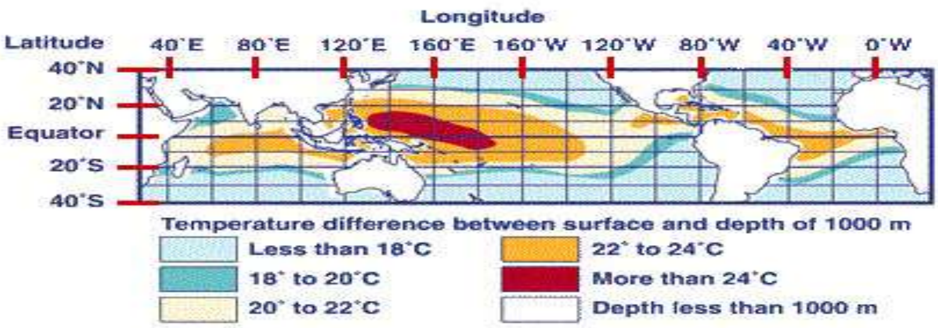

Figure 1: Worldwide Ocean Surface Temperatures (Yusuf & Lydia, 2000; Walter &Farshid, 2014)

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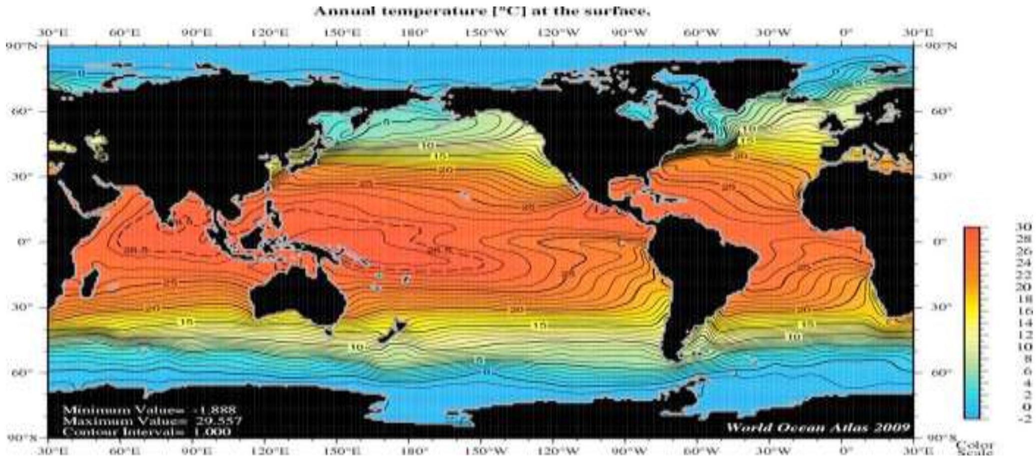

Figure 2: Worldwide Water Surface Temperatures (Yusuf & Lydia, 2000; Walter &Farshid, 2014

Also, ocean thermal energy conversion is a technique that engages innate occurrence of the variation in temperatures, and the seawater utilized is affluence in nutritious components that can also be utilized to cultivate marine organisms together with plant life. And its potentiality can also be used as a source of nearly weariless renewable energy, which can generate billions of watts of electric power (Alkhalidiet al., 2014). Notwithstanding, the ocean thermal energy conversion is solar energy likened to renewable energy due to the conspicuous fact that the ocean absorbs the sunlight daily, and this is equitable to different thousand times the elementary energy needs of the earth planet we are living on (Avery and Wu, 1994). Precisely, this energy is reserved as heat in the surface (upper) part of the oceans, and the equatorial coastal part of the surface of the earth has a mean temperature of between 27^0C and 29^0C, and the deep temperature decreases from 4^0C to 5^0C as the depth rises to 1000m and above the depth of 1000m; the temperature decreases to another degree even at a mean ocean depth of 3650m as depicted in **Figures 3** and **4**, respectively (Othmer&Roels, 1973).

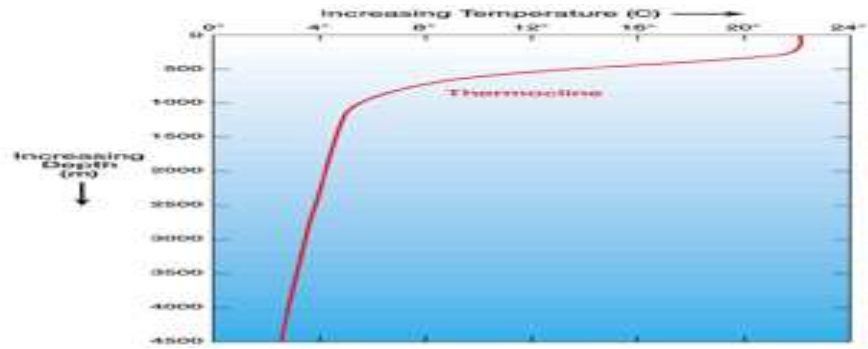

Figure 3: The Temperature Profile of Ocean Water (Walter and Farshid, 2014)

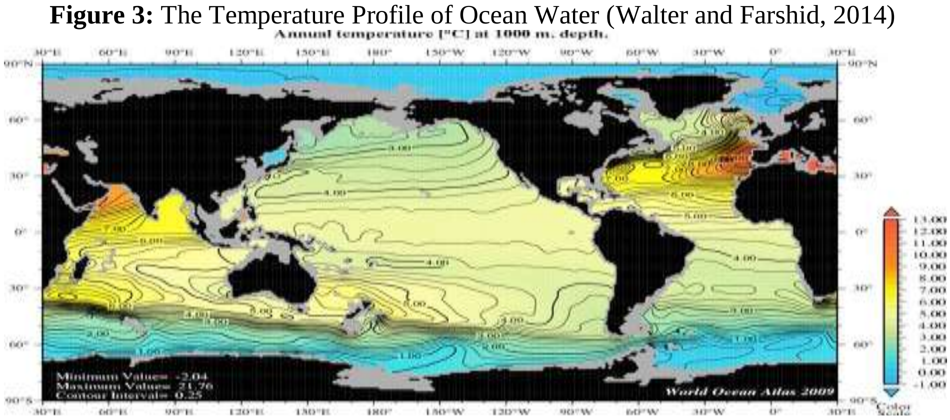

Figure 4: Worldwide Temperature of the Ocean of One Thousand Depth (Walter andFarshid, 2014)

Ocean Thermal Energy Conversion Systems

Ocean Thermal Energy Conversion (OTEC) is a promising renewable energy technology that generates electricity by exploiting the natural temperature difference between warm surface seawater and cold deep ocean water. Precisely, the warm surface seawater heated by the sun, acts as a heat source, while the cooler seawater from the ocean depths serves as a cooling agent, helping to drive power generation using heat engines (Nihous, 2018; Igomaet al., 2024). Research suggests that OTEC could provide an estimated 80,000 to 140,000 TWh of energy annually, with the most favorable conditions found in tropical regions (Kempener& Neumann, 2014). This technology relies on a temperature difference of 20–25 °C, typically observed in tropical oceans where surface water reaches 25–30 °C, while water from depths exceeding 1,000 meters remains around 4-5 °C (vega, 2010). By using this thermal gradient, OTEC systems power a Rankine cycle to produce electricity, similar to conventional steam turbines but operating at lower temperatures. There are three main types of OTEC systems, each with its own unique operational method.

Closed Cycle OTEC System

The initial idea instituted by D'Arsonval is to engage unmixed working fluid that will evaporate at the hot seawater temperature. The vapor will expand together with doing work before condensation through the cold seawater. Precisely, this procedural process measures will be frequently uninterrupted with indistinguishable working fluid and the flow path together with the process of thermodynamic depiction, which comprises of closed loops, therefore the emanation of the nomenclature. A closed cycle whose peculiar process is embraced is the Rankine-vapor power cycle (Masutani& Takahashi, 2001). The closed cycle comprises a working fluid sustained in a closed circuit that sequentially evaporates together with condensation. It utilizes a working fluid like ammonia because of its low boiling temperature, as displayed in **Figure 5.** The ammonia, which is the working fluid, boils after being heated from warm seawater that is being pumped from the surface of the ocean to the heat exchanger. The vaporized working fluid goes amid a turbine fixed to a generator, and it condenses through the ocean's cold seawater to finish the process (Etemadiet al., 2011; Faizal and Ahmed, 2013; Walter andFarshid, 2014; Aydinet al., 2014; Aldale, 2017; Adesanyaet al., 2020). Also, in the closed-cycle OTEC system, the heat transmitted from the warm seawater surface that happened in the evaporator generates vapor that is saturated from the ammonia, and electrical energy is produced when there is an expansion of the gas to decrease the pressure via the turbine. The working fluids that this system utilizes most are ammonia together with different types of fluorocarbon refrigerants (Masutani and Takahashi, 2001; Lise, 2021).

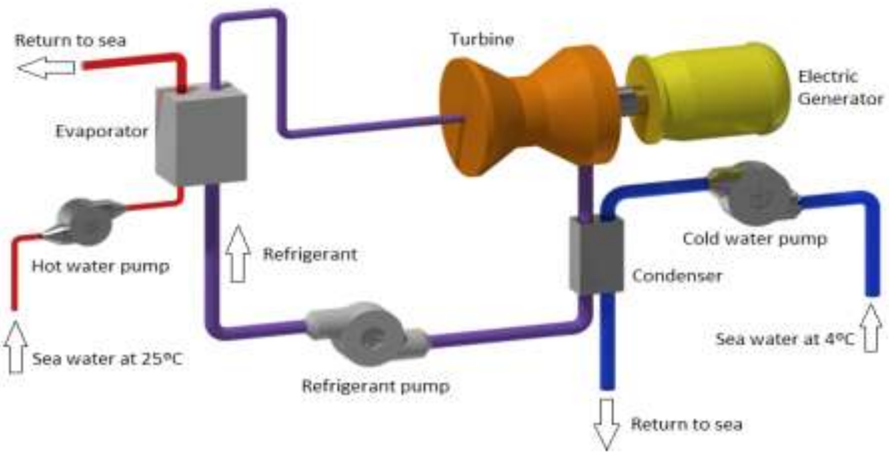

Figure 5:OTEC utilizing the Fundamental Rankine Cycle (Finney, 2008; Vegas &Michaelis, 2010; Jorgeet al., 2021)

Open Cycle OTEC System

The concern Claude had about the cost, together with possible biofouling of the heat exchangers of a closed cycle, made him propound utilizing steam produced straightway from the hot seawater as the ocean energy conversion working fluid. The thermodynamic processes of the open cycle are flash evaporation of warm seawater in a

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partial vacuum; steam expands via a turbine to produce energy; the vapour condenses through an unhindered channel of heat transmission to the seawater that is cold coupled with the compressing and discharging of the condensable product together with any residues of gases that do not condense. Also, the nomenclature open cycle originated from the factual reality that the working fluid which is steam is emitted following an individual pass doubled with dissimilar initial and final thermodynamics stages therefore, the flow path and the process is open (Masutani and Takahashi, 2001).

However, in designing the open cycle OTEC, a generator is propelled through steam and warm seawater is a makeover to steam utilized to drive the generator. The water via desalination is attained when the cold seawater chills the steam. Also, the liquid is releasable into the sea. Furthermore, the open cycle uses hot surface seawater that is being heated by sunlight to produce electrical energy expressly and the methodical diagrammatic open-cycle ocean thermal energy conversion system is depicted in **Figure 6** (Nihousand Syed, 1997; Adesanyaet al., 2020; Lise, 2021).

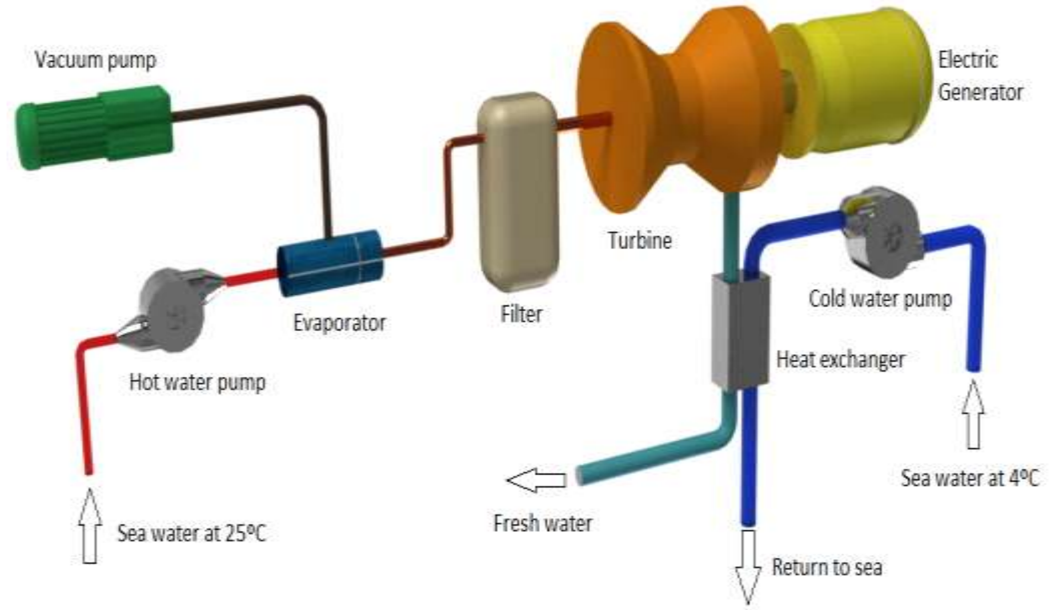

Figure 6: Depiction of Open-Cycle OTEC System (Masutani and Takahashi, 2001; Jorgeet al., 2021)

Hybrid Cycle OTEC System

The conception of the hybrid OTEC system emanated after a series of investigations hinted that this OTEC system could give electrical energy together with water thereby accessing the marketplace more preferably than OTEC systems devoted exclusively to the production of electrical energy. The hybrid cycles produce portable water which is possible with the open cycle together with the potential for enormous electric energy production proffered through the closed cycle OTEC (Adesanyaet al., 2020; Lise, 2021). A different hybrid cycle has been propounded like the Claude Cycle: hot seawater at the surface in a flash evaporator in a partial vacuum. The low-pressure steam flows into a heat exchanger where the steam is engaged with a vaporisation pressure of a low boiling point fluid like ammonia (Igoma, 2024). Precisely, amid this operational process, condensation occurs to very much of the steam thereby producing desalination potable water. Also, the ammonia vapour moves via a single closed cycle energy loop and cold seawater are used to condense it. The steam that is not condensed together with other gases going out of the ammonia evaporator, additional cooling may be applied via the heat transfer to the liquid ammonia flowing out of the ammonia condenser or cooled seawater.

Procedurally, the process continues, and water and electrical energy production could be regulated in independent form so that it can be in operation should a subsystem breakdown or service requirement. The hybrid OTEC cycle in a nutshell is the combination of the open and closed OTEC systems which also improves the efficiency of the ocean thermal energy conversion system as shown

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in **Figure 7**(Claude, 1930; Nihous and Vega, 1991; Syed et al., 1991; Soto andVergara, 2014).

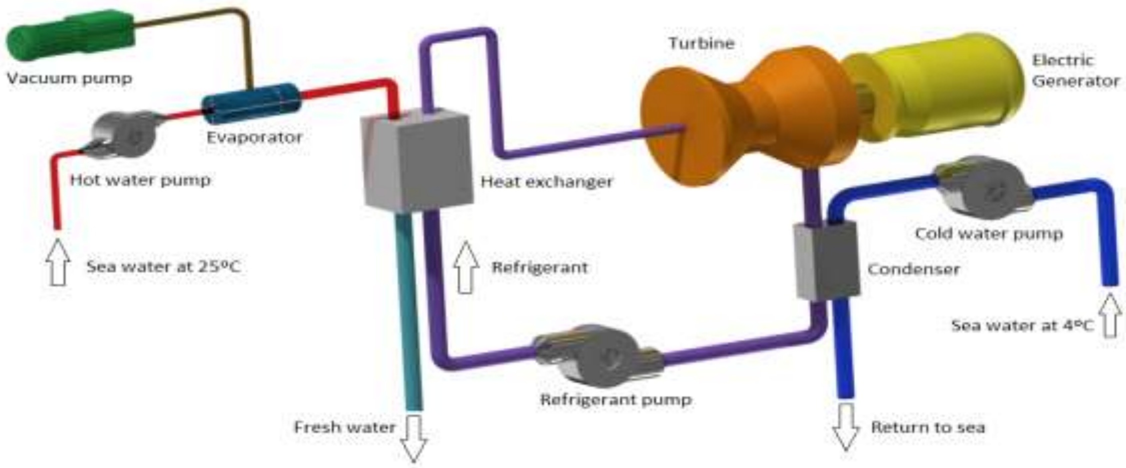

Figure 7: Systematic Diagram of Hybrid OTEC Cycle(Takahashi &Trenka, 1996; Jorge et al., 2021)

Ocean Thermal Energy Conversion Systems and the Environment

The ocean thermal energy conversion systems are not harmful to the environment compared to other energy systems that use fossil fuels which deplete the ozone layer. Notwithstanding, incidental leaking like in closed cycle OTEC working fluids: ammonia pose danger on normal operational conditions, but the fluids are seawater discharges that are mixed coupled with the gases that are dissolved fallout of the mixed solution when the seawater pressure is released (Carlson et al., 2014; Del Rio and Mir-Artigues , 2014). However, the handful of all kinds of release gases maybe meaningful for bigger ocean thermal energy conversion systems but these release gases are not harmful except carbon-dioxide which is a greenhouse gas (GHG) and can influence worldwide climate variation, but ocean thermal energy conversion systems emit less quantity of carbon-dioxide, unlike fossil fuel power plants. Also, the emitted gases maybe sequestrated in the sea or utilized for the simulation of the generation of marine biomass (Owens and Trimble, 1981; Scott, 2007; Allan et al., 2014; Simaset al., 2015). The discharge of ocean thermal energy conversion systems fluid should be done at 50m to 100m for it to have minimum influence on the ocean environment. Also, the discharges can be utilized for the sustainability of open ocean mariculture (Avery & Wu, 1994; Kennish, 1998; Masutani& Takahashi, 2001; Rod and Fujita, 2002; Vega, 2003). Also, the environmental impact is small compared to fossil fuel energy plants if the guides on the environment are planned and executed appropriately together with other studies that have pinpointed the merits of impacts of renewable energy on the environment because the demerits are minimal (Kennish, 1998;Desholm &Kahlert, 2005; Tsoutsos et al., 2005; Fox et al., 2006; Hepbashi, 2008;Rosen et al., 2008;Abbasi&Abbasi, 2012; Asdrubaliet al., 2015;Owusu et al., 2016; Connolly et al., 2016; Stoogie et al., 2018; Ahaotuet al., 2018; Adesanyaet al., 2020). However, while the auspicious opportunity for climate variation allays, difficulties subsist that diminished renewable resource maintainability together with different means doubled with laws are required in the realization of their capabilities (Panwaret al., 2011).

Why the Niger Delta and Lagos State Coastal Regions of Nigeria Needs Ocean Thermal Conversion Energy Rather than the Other Renewable Energies

The Ocean Thermal Energy Conversion System is not interrupted in as much as the difference between surface hot seawater temperature and that of the colder deep seawater temperature meets the requirement of 20°C. Also, it gives the ability for the provision of baseload energy different from dissimilar renewable energy sources such as solar together with wind that are aperiodic (Ruud & Frank, 2014). Practically, a different addition by product that is a product during open and hybrid OTEC cycle operation is portable drinkable water, and it can be utilized in the making of air conditioning, thereby making it to have preservation potentiality of around 100%. The ocean thermal energy conversion system is in the seaward and would not be in competition of the resources in the land (Osu, 2024). Furthermore, the ocean thermal energy conversion has minimal hazard to the environment where it is situated, which was the

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reason for initiating this research into the investigation of how to harness OTEC in the Niger Delta and Lagos State Coastal Regions of Nigeria.

Ocean Thermal Energy Conversion Plant Siting Criteria

Accordingly, the ocean covers two third of the universe and that is not a guarantee that the ocean thermal energy conversion plant can be situated everywhere there is the ocean. Dependable citing criteria require to be complied with before considering a buildable ocean thermal energy conversion plant in that particularized point because it requires a good position so that the usable ocean thermal energy can be extractable (Aida, 2018). The larger the temperature gradient, the larger the capable potential of the ocean energy and the standard rule of thumb is that a temperature gradient of 20^0C is the requirement to make the extractable energy attainable. This temperature gradient happens in the deep ocean on the equator where the upper-surface seawater temperature is 26^0C to 28^0C together with that of seawater at one thousand meters (1000m) depth is constant at 4^0C moderately and the coastal Niger Delta and Lagos State regions of Nigeria has a large temperature difference comparable to tidal waves thereby necessitating this thermal-based approachable research. **Figure 8** depicts the thermal distribution of possible places for building ocean thermal energy conversion plants in the world (Masutani& Takahashi, 2001; Vega, 2010;Kempener& Neumann, 2014;Lise, 2021).

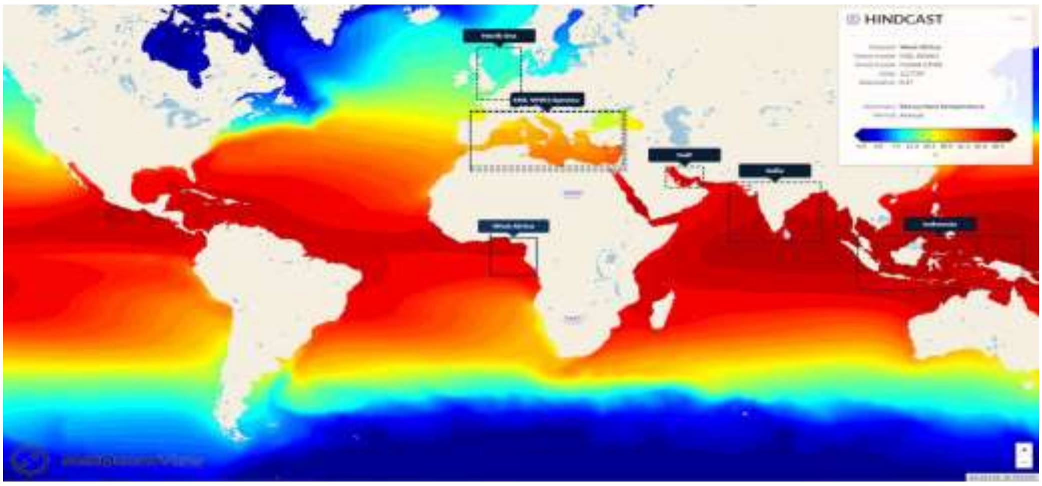

Figure 8: The possible Places in the world that OTEC Plant can be sited (Lise, 2021)

Major OTEC Technology Subsystems and Developments

Significant research and demonstration efforts over the past decades have addressed key areas like heat exchangers, working fluids and system configurations to improve OTEC feasibility (Vega, 2010). Heat exchangers: Efficient heat transfer between the working fluid and seawater streams across the temperature differential is critical to OTEC performance. Titanium enhanced surfaces can withstand corrosion and biofouling. Advanced designs using aluminum alloys feature smaller footprints while meeting structural requirements (Ueharaet al., 1999). Recent efforts have targeted improving heat transfer coefficients to over 7,000 W/m2K with nanofluids. Working fluids: The evaporating liquid must have appropriate thermo-physical properties matched to the low OTEC operating temperatures, mainly low boiling point and high vapor pressure. Beyond early choices like ammonia, more halocarbon refrigerants like R134a and mixtures are being considered to balance performance and environmental friendliness (Cao &Gulfam, 2023). Investigations into using CO_2 have aimed at improving thermal efficiency and synergy with applications like ocean carbon sequestration as depicted in **Figure 9** (Masutani& Takahashi, 2001; Igoma, 2024).

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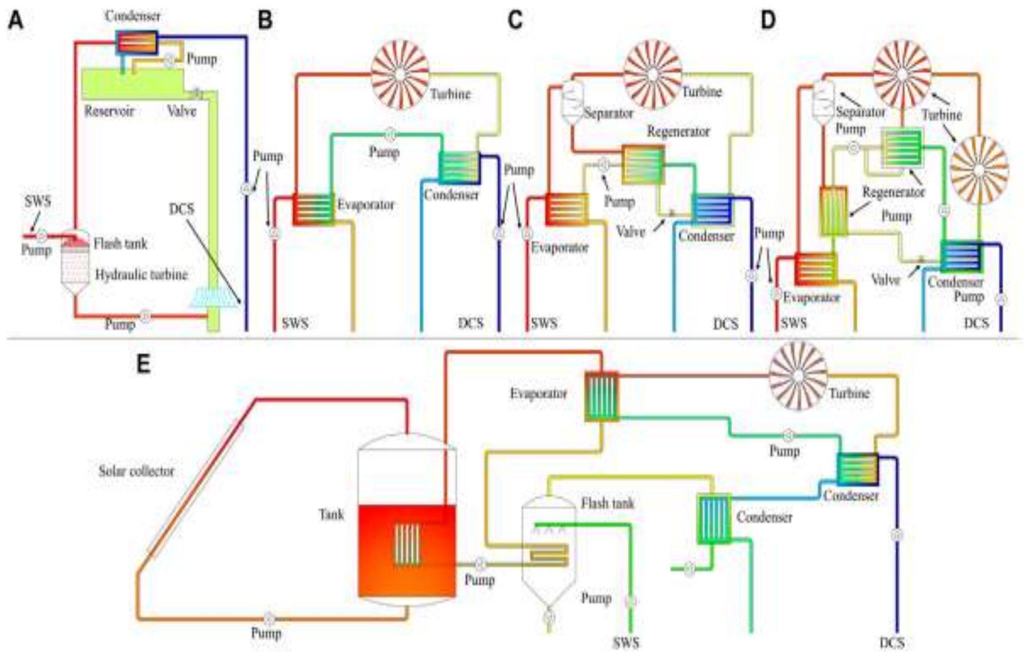

Figure 9: Different forms of cycle in OTEC power generation: (A) mist flow OTEC plant (Ridgway, 1997), (B) organic Rankine cycle (Coa& Liu,2010), (C) Kalina cycle (Kalina,1984), (D) Uehara cycle (Ueharaet al., 1999), and (E) hybrid solar–OTEC system (Park et al., 2017).

System architectures: Innovations beyond basic open and closed cycles seek to boost net power output through hybrid cycles combining features like using the seawater itself as secondary working fluid or having a bottoming organic Rankine cycle, but involve greater complexity (Vega, 2003). Advanced cycle analysis continues leveraging exergy methods and numerical simulations to weigh trade-offs. Floating platform designs also aim at cheaper OTEC construction compared to offshore sites.

Jorge et al. (2022) performed an economic feasibility study for an ocean thermal energy conversion system at San Andrés Island, and their investigation proffers the economic viability of a 2 MW open cycle OTEC system, and the system provides 6.35% of the intermediate yearly usage of electric energy needed. The obtainable results indicate that the technique is doable and the investment can be recouped in an acceptable time period.

Jessica et al. (2022) appraised the financial possibility of an ocean thermal energy conversion ecopark using Cozumel Island as a case study, and the purpose of this investigation is to display how an ocean thermal energy conversion ecopark can provide compendious, maintainable, and quality products that satiate the different demands of the Mexico seashore localities. A hybrid ocean thermal energy conversion of sixty megawatts (60 MW) was proposed, which will give portable water and power together with needed food in the seashore localities and also appraisal of the financial possibility of the system and comparable to other types of power production. It was found that the internal rate return infers that the plant will pay for itself in five years for a thirty-year life cycle, and the approachable method utilized can be applied to other seashore localities across the world.

Etemadiet al. (2011) studied electrical energy production via OTEC, which discussed ocean thermal energy conversion techniques like temperature gradient. The work also indicated that further studies and advancements need to be embarked upon in order to handle the issues of menace in the environment due to the use of fossil fuels because the OTEC is a possible avenue of renewable energy without the production of emissions that are harmful to the environment. Also, its cardinal benefit is that the technology is free of fuel doubled with low effect on the environment.

Aliyu (2013) did interactions for energy environmental capabilities together with challenges of renewable energy like the ocean thermal energy conversion in Nigeria. The work treated how to design renewable energy sources like OTEC for most of the affected Nigerian communities. Nigeria is providentially endowed with not only ample sunlight but bounteous geothermal, wood, and biomass resources more than other countries in the

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world, yet the uncertainty in the electrical energy generation scenario throughout Nigeria is only about undependable; 35% is accessible to electrical energy compared to Egypt and South Africa, which are 95% and 75%, respectively. This lamentable choice of the energy sector is affecting adversely the Nigerian economy, so establishing renewable economic appraisal of OTEC in coastal Nigeria: Bonga Offshore. The work proposes a 50MW ocean thermal energy conversion system that will be in latitude 4^o 30′ 01.5″ together with the longitude 4^o 29′ 58.1″ doubled with the seawater upper surface temperature grading 26 ^{0}C - 29^{0}C of twenty meters (20m) deepness coupled with the grading of 3.5^{0}C to 4.0^{0}C of one thousand and twenty-one meters (1021m) deepness, which utilizes the temperature gradient to generate electrical power. Also, Adesanya et al. (2020) looked at perspectives together with the economic effect appraisal of an ocean in Nigeria because of renewable energy. The study reveals that acclimatizing ocean energy in Nigeria can meaningfully generate the required energy; irrespective of the large amount it is required at the initial stage. While Jaafaret al. (2020) performed research together with design exertion of OTEC goaded design in Malaysia to encourage capable investors in transforming the ocean thermal energy to power supply or hydrogen.

Furthermore, this study will look at the assessment of OTEC potentiality in Niger Delta and Lagos State coastal regions of Nigeria thereby giving the hint for possible OTEC investment in these regions.

II. MATERIALS AND METHODS

Materials

Accordingly, this work will look at the OTEC potentiality along the coastal cities across the Niger Delta and Lagos State like Brass, Bonny, Burutu, Calabar, Ebute-Ikorodu, Esuk-Oron, Lagos, Okirika, and Port Harcourt respectively. Lagos State is included because of its peculiarity as a coastal state in Nigeria and the relevant materials utilized in this research for the data collation and analysis are:

i. The Temperature Profile of Ocean Water (**Figure 3**&**Figure 4**)

energy together with energy efficacy are dual constituents that should combine in achieving supportable energy design, and the government should make laws on power efficiency and incorporate these laws into the present power laws. While, Ahaotuet al. (2018) conducted thermodynamic development coupled with th

ii. Map of Ocean Depth (**Figure 11**)
iii. MonthlyAverageSeawaterSurfaceTemperatures of the Niger Delta and Lagos State Coastal Regions (**Table 1**)
iv. MATLAB Software
v. Bar Chat

Methods

Geographically - Nigeria appears well positioned to harness ocean thermal energy. Located on the Gulf of Guinea along the tropical belt, it meets the basic temperature differential requirement of ~20^{o}C between warm equatorial surface water temperature of above 25^{o}C and cold deep-sea bottom temperature of below 5^{o}C (Masutani& Takahashi, 2001). With an extensive 853 km coastline and exclusive economic rights to a 200 nautical mile offshore in the Atlantic, there is certainly no hindrance to ocean access (Igoma, 2024; Peter et al., 2015). Practically, data of Ocean depth as shown in F**igure 11** were collated to corroborate with the temperature profile of the ocean as depicted in **Figure 3** in order to obtain the bottom temperature, which is the cold deep seawater temperature. After the obtainment of the cold deep seawater temperature, the surface seawater temperature is used to calculate the temperature differential whether it is up to the required 20 °C for the operation of the OTEC plant. **Table 1** contains the average of minimum average surface seawater temperatures, also known as hot seawater temperatures, of all the coastal cities across the Niger Delta and Lagos State and it was taken from January to December 2024 (WST, 2024).The MATLAB software program will be utilized to present the characteristics features and the assessment of the hot seawater temperatures at each month of the year considered thereby giving the guide for OTEC potentiality assessment.

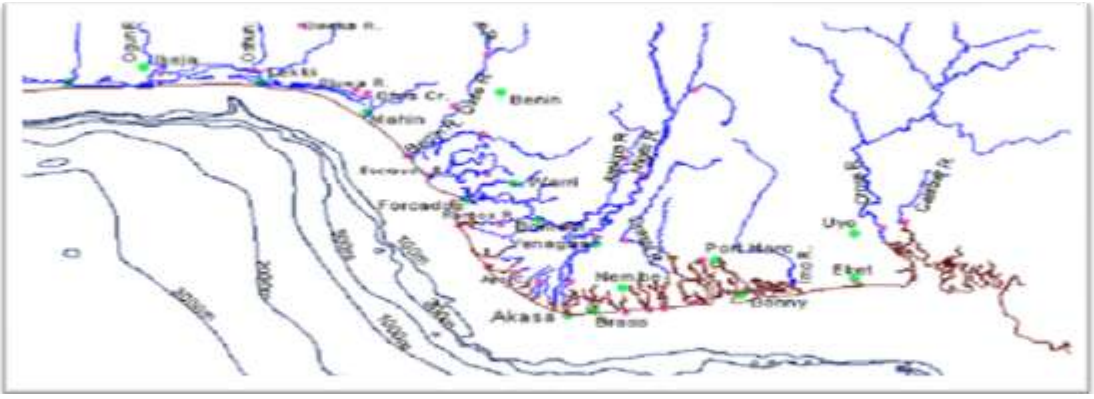

Figure 11: Map of the Coastal Nigeria Depicting the Ocean Depth at Different Areas (Peter et al.,2015)

Table 1: MonthlyAverageSeawaterSurfaceTemperatures of the Niger Delta and Lagos State Coastal Regions

S/No.	Year/Month/ Coastal Cities/ Degree Celcius	Bonny 2024(⁰C)	Brass 2024(⁰C)	Burutu 2024(⁰C)	Calabar 2024(⁰C)	Ebute-Ikorodu 2024(⁰C)	Esuk-Oron 2024(⁰C)	Lagos 2024(⁰C)	Okirika 2024(⁰C)	Port Harcourt 2024(⁰C)
1.	January	26.8	26.7	26.2	26.9	26.2	26.9	26.2	26.7	26.7
2.	Febuary	27.1	27.0	26.6	27.2	26.5	27.2	26.5	27.0	27.0
3.	March	27.9	27.8	27.6	28.1	27.3	28.1	27.3	27.8	27.8
4.	April	27.5	27.4	27.6	27.6	27.4	27.6	27.4	27.4	27.4
5.	May	28.0	28.1	27.5	28.1	27.6	28.1	27.6	28.1	28.1
6.	June	26.1	29.1	27.8	26.1	26.1	26.1	26.1	26.1	26.1
7.	July	25.3	25.5	26.1	25.2	25.1	25.2	25.1	25.5	25.5
8.	August	25.1	25.3	25.7	24.8	24.6	24.8	24.6	25.3	25.3
9.	September	25.9	25.8	25.4	26.0	24.8	26.0	24.8	25.8	25.8
10.	October	26.2	26.3	25.6	26.1	26.6	26.1	26.6	26.3	26.3
11.	November	27.1	27.2	27.5	27.0	27.4	27.0	27.4	27.2	27.2
12.	December	27.3	27.2	26.9	27.3	26.9	27.2	26.9	27.2	27.2

III. RESULTS AND DISCUSSION

Table 1, which entails the monthly averages of the hot seawater temperatures, was utilized to analyze via MATLAB SOFTWARE to get **Fig. 10** and **Fig. 11,** respectively. These two figures show that the Niger Delta and Lagos State coastal areas like Brass, Bonny, Burutu, Calabar, Ebute-Ikorodu, Esuk-Oron, Lagos, Okirika, and Port Harcourt, have OTEC potential,taking into consideration the average approximate monthly minimum hot seawater temperatures between 25^0C and 27^0C at a cold seawater depth of around 800m to 1000m, which translates to an approximate cold seawater temperature of between 5^0C and 6^0C thereby giving the basic temperature differential requirement of ~20^oC as displayed in **Figure 3, Figure 4, and Figure 9, respectively.** That means the investment of OTEC is possible.

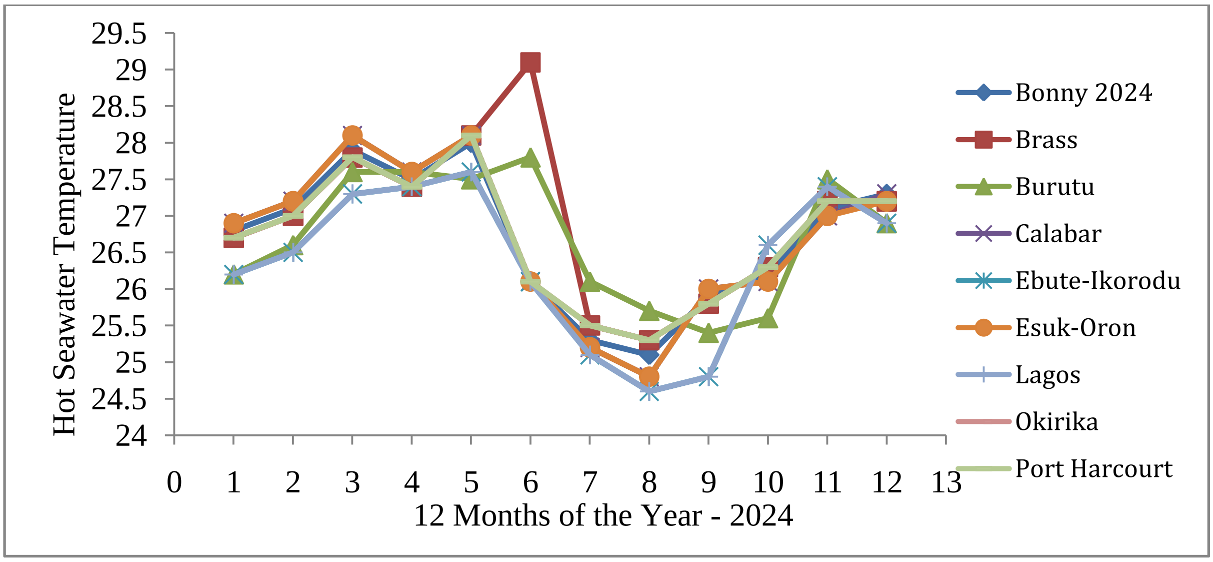

Figure 12: Characteristics Features of the Reaction of the Hot Seawater Temperatures at Various Areas of the Niger Delta and Lagos State Coastal Regions

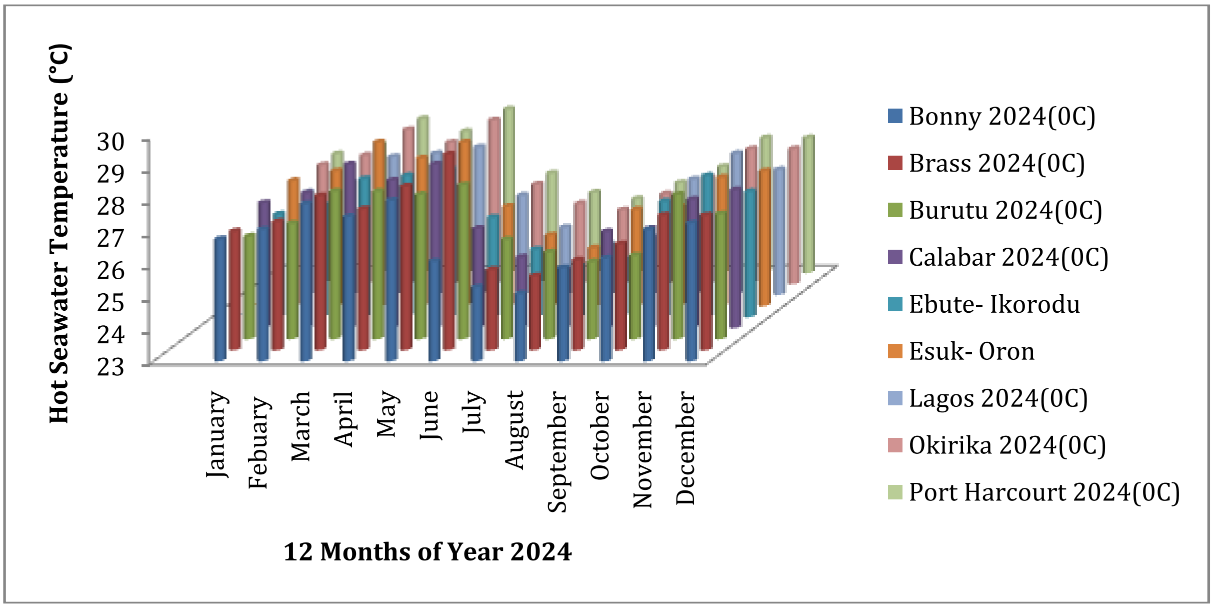

Figure 12: Bar Chart representing the Hot Seawater Temperatures at Various Areas of the Niger Delta and Lagos State Coastal Regions

IV. CONCLUSION

The gap arises as a result of the high usage together with the electricity generation, which has caused everyday epileptic power supply and dependence of stand-in electric generators that restrict productivity. Energy assurance concerns loom in the future as a result of a decrease in the production of domestic oil. Therefore, pursuing renewable source of energy like OTEC, which deals with ocean thermal gradients, can give reliable, clean energy to ameliorate the power generation. Precisely, in order to bring investment of OTEC in the Niger Delta and Lagos State coastal regions, the assessment of OTEC potentiality in these regions has been conducted. Accordingly, the work looked at the OTEC potentiality along the Niger Delta and Lagos State coastal cities like Brass, Bonny, Burutu, Calabar, Ebute-Ikorodu, Esuk-Oron, Lagos, Okirika, and Port Harcourt respectively. The results show that the minimum average approximate monthly hot seawater temperatures of these areas like Brass, Bonny, Burutu, Calabar, Ebute-Ikorodu, Esuk-Oron, Lagos, Okirika, and Port Harcourt considered are between 25^0C and 27^0C at a cold seawater depth of around 800m to 1000m, which translates to an approximate cold seawater temperature of between 5^0C and 6^0C representing 20^0C the required differential temperature thereby displaying OTEC potentiality in these

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