# Energy Generation Potential of West African Ocean Current: Peculiarities, Challenges and Perspectives

**Agbakwuru, Jasper Ahamefula[1], Nwaoha, Thaddeus Chidiebere[2]**

[1,2] Department of Marine Engineering, Faculty of Technology, Federal University of Petroleum Resources, P.M.B. 1221 P.M.B. 1221 Effurun, Nigeria .

## Abstract

*A review of the West African ocean current energy generating potential is carried out. The peculiarity of the West African ocean characteristic is discussed and the challenges noted. Based on this review, it is found that ocean current represents an alternative source of renewable energy in West Africa in a streamed regular supply. The ocean weather condition is mild and offers good benefit to marine operations with respect to renewable energy conversion system installations offshore. In the perspective of the authors, it is believed that engineering and scientific investments are necessary in order to harness the ocean current renewable source in West Africa. Suggested techniques include - Application of momentum diffusion technology to the ocean current flow system; Design of ocean current generating system whose efficiency relies more on volume flow rather than fast running fluid velocities; Investigation into reported increased velocities suspected to be due to hydrodynamic influence of discharging upland rivers into the ocean water systems. A success of such confirmation will lead to the use of conventional generating system in such locations.It is largely hoped that aggressive interests in the subject area will open wide opportunities in the ocean current renewable energy source to supplement the intense energy demand of this part of the continent.*

***Keywords-*** *Ocean; current; renewable; energy; momentum-diffusion; upland-rivers; velocity; West Africa.*

## 1.0 **Introduction**

World-wide, there has been a necessary trend of energy shift from what it used to be, to the renewable sources. The costs, depletions, environmental and green house effects of the hydrocarbon sources are some of the reasons for this shift. On the other hand, the hazard posed by nuclear power plant leak in recent time has introduced skeptics in a nuclear power source. Africa is endowed with huge energy from the sun [1]. There has been great effort in recent time to harness solar energy by corporate companies, non-profit organization and government. Good success in tapping the solar energy source has been made due to improved efficiency in solar system design [2]. In Asia and America, water current generators have received attention because water current is relatively constant compared to solar source [3] and [4]. Due to space requirement and ecological reasons, the preferred installation for water current generation is in the open ocean.

Examining developments in water/ocean current energy generation in West Africa, only minimal effort has been made despite the opportunities in the continent. Interestingly, most countries in the continent encourage and support financing of renewable forms of power generation in the country. Instances of political and economic supports as described by [5] and the National Renewable Energy and Energy Efficiency Policy of April- 2015 of the Nigerian Ministry of Power demonstrate the need to engage in sustained technology on renewable energy sources within our disposal.

The purpose of this paper is to signal the need for more research and development in water current energy generation in West Africa in order to meet the energy challenge of the continent and also further reduce the over dependence on hydrocarbon energy source with its associated green house effect that is today threatening the existence of our global world.

### 1.1 West African ocean characteristic and its peculiarities

West African ocean condition is mild in nature. Reference [6] discussed the continental shelf of the West African region between $5^{o}$ N and $15^{o}$ S. It is noted that the extreme wave condition in the West African area is quite uncommon because tropical cyclones do not occur in the South Atlantic Ocean. Reference [7] discusses that the environment of Offshore West Africa lacks locally generated storms, therefore the storm surge is minimal and tidal current dominate water level variations. A Statoil report on Offshore Nigeria points that approximately 95% of the swells come from sector, $165^{o}$ to $225^{o}$ [8].

Guinea current is the prevalent offshore current in West Africa. Reference [9] described that depending on the season, the primary source of waters for the Guinea Current is either the Canary Current or the N. Equatorial Counter Current (NECC). For example, during the winter, the NECC is very weak, while in the summer, the NECC is at its strongest.

As stated by [9], several authors ([10], [11], [12], [13] and [14]) agree that the Guinea Current experiences a minimum during November through February and a maximum during May through September.

As discussed by [13], some authors ([10], [11]) thought they had detected a reversal in current direction during the minima. They attributed this change to variations in the flow of the North Equatorial Countercurrent, the Canary Current, and the Benguela Current ([10], [12]), and to the weakening of the easterly winds ([11], [12]). However, [15] offered an alternative explanation. As the authors were studying the currents on the continental shelf of the Ivory Coast during December, they observed not only the Guinea Current, but also a current below it. This current, named the Ivoirian Undercurrent, flowed opposite to the Guinea, to the west. They also noticed that at times the speed of the Guinea Current was higher offshore than onshore. Thus, [15] suggested that the presence of a westward current at the surface near the coast could be due to the surfacing of the Ivoirian Undercurrent and the seaward displacement of the Guinea Current, not due to the reversal of the Guinea Current. Another explanation, proposed by [12] is that the apparent reversals are actually caused by cyclonic eddies between the current and the coast. Reference [12] points out that "the data on which the concept of current reversals is based are either point observations or isolated sections perpendicular to the coastline," which do not clearly depict current reversals in the alongshore direction."

The overall implication is that the West African Offshore condition is peculiar. Though suitable site of high velocity flow of current near shore is not presently identified by literatures for ocean current renewable energy generation in West Africa, it is noted that [8] and [17] for Offshore Nigeria and Angola respectively indicate current average speed range of 0.3 $ms^{-1}$ to 0.4 $ms^{-1}$ and maximum of 0.8 $ms^{-1}$ with monsoon and other seasonal effects. This excludes the hydrodynamic influence of discharging upland river systems into the ocean water which can alter these values substantially.

### 1.2 Challenges

The challenges of measuring current ranges from cost elements, measurement duration requirement and unfriendly environmental conditions and software issues. It takes some millions of United State Dollar in cost to operate a typical ocean data gathering vessel for a full year data collection. There are also local marine and environmental variations that are difficult to deal with.

The interests in the field of ocean current measurements have been majorly to predict transport of sediment, determine drift of contaminates, transport processes, determine loadings on marine structures and ocean transports [18]. The interests have minimal focus on power generation and engineering.

### 1.3 Prospects and Perspective

In general terms, the current speed/velocity in West Africa may be considered low with respect to ocean selection site criteria recently developed by [3] and [19] the consistency and regularity of the current flow is a major benefit that must not be overlooked. Scientific and engineering methods to effectively harness this energy source should be investigated and applied.

A scientific method could be the application of momentum diffusion technique to amplify flow velocities. When a streaming flow is guided by a smooth straight plate of minimal cross sectional area, a laminar flow is optimised within the guided channel. In this open system as we have in an open ocean, shear stresses and pressure variations within the flow will generate momentum change within the affected fluid. This momentum is often a higher momentum and will diffuse into the lower momentum in the direction of flow. As at today, no literature is found discussing momentum diffusion with respect to maximizing generated fluid flow forces.

Exploring this field of science is necessarily required.

An engineering method could be a design of special blades that would operate optimize volume flow energy of water in a given direction rather than the present turbine technology that depend largely on fast running fluid velocities. The result could be slow motion with large torque that can be reconverted to electrical energies. These will be examined in another paper.

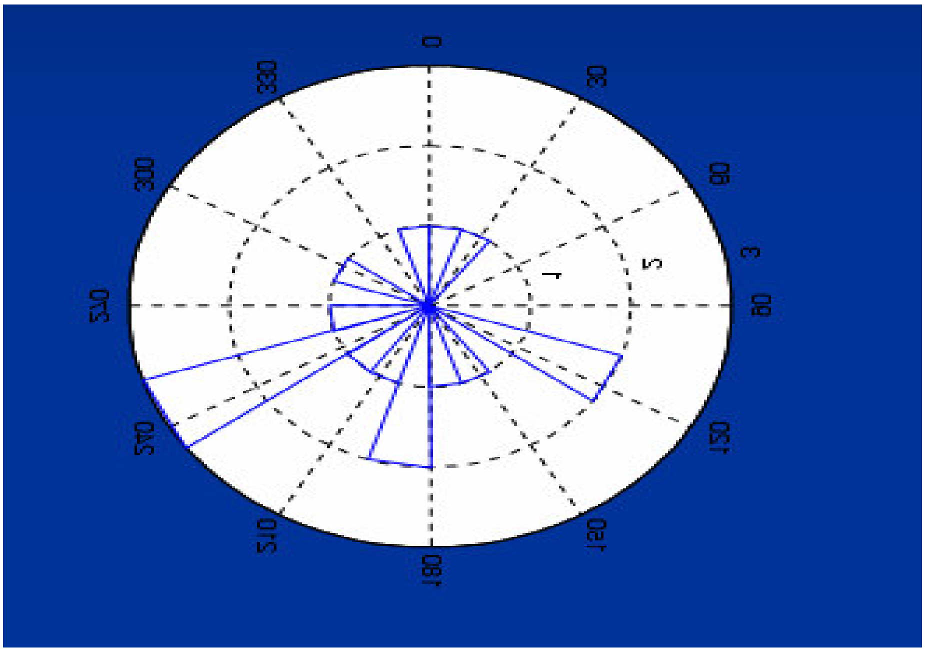


**Figure 1. High speed water current as reported by [20].**

It is suggested that the local water fluxes from discharge of upland Rivers into the ocean can contribute to this increased ocean current measurement within the estuary. In this condition, the criteria for site selection as used by [19] is well satisfied with current speed exceeding maximum velocity of 1.4 $ms^{-1}$. This is a clear opportunity that should be taken by engineers and scientists in this region for power generation. The site should be reexamined and test conducted at other ocean fringes such as Brass, Nun River, Sangan and flow speed of the Atlantic current and the in-fluxing rivers. This will need to be investigated.

## Conclusion

The West African ocean characteristic is not harsh. It is more predictable compared to the rest of the world's ocean. Therefore, installation of water current generators and energy converters will demand less engineering difficulties. This work has revealed that resource in West African ocean is beyond oil, gas, fishery and ship navigation. It is suggested that engineering and scientific research with respect to renewable energy generation from the ocean should be considered, intensified and sustained by research bodies, government and non-government organizations.

Due to global warming reports, it will benefit the continent and indeed the world to increase energy sources from renewable such as ocean current. This is because the energy demand of the developing world will continue to rise.

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