

## Opportunities for a Viable Commercial OTEC Technology in Nigeria

By

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## Map of Africa showing the location of Nigeria

- The country is located in West Africa and shares land borders with the Republic of Benin in the west, Chad and Cameroon in the east, and Niger in the north.



## Map of Nigeria

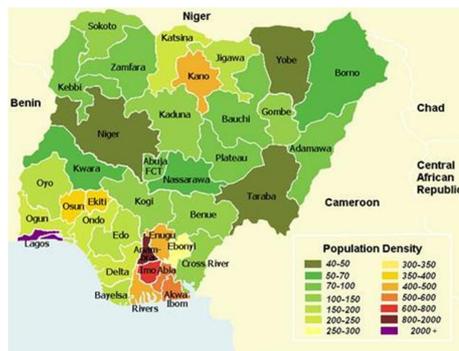


Figure 1. Map of Nigeria Showing the 36 States and the Abuja Federal Capital Territory

- Federal Republic of Nigeria, is a federal constitutional republic comprising 36 states and its Federal Capital Territory, Abuja (Figure 1.)
- Nigeria is the most populous country in Africa with a population of over 150 million people and with a growth rate of 60% between 1990 and 2008. This accounted for about 18% of the continent's total population.
- Oil and gas as non renewable energy resources mainly from the Niger Delta play a large role in the Nigerian economy, accounting for 40% of GDP and 80% of Government earnings.

3

## THE NIGERIAN COASTAL AREA AND CONTINENTAL SHELF

- Nigeria has a coastline of about 850km, from the Western boarder with the Benin Republic to the eastern boarder with the Republic of Cameroon.
- Geomorphologically, the Nigerian coast is divided into four main units: the Barrier Lagoon coast, the Mud coast, the Niger Delta and the Strand coast.
- The Nigerian continental shelf which can also be divided into inner shelf 0 to 45m water depth is narrow in the west and broadens out eastward to the Niger Delta and becomes narrow again in the east. These coastal areas extend from the shoreline to between 30 km inland to 150km in the Niger Delta.
- The middle shelf is also very narrow in the west and east but wide in the Niger Delta. The Outer shelf 80 to 100 m water depth is very narrow and steep especially in the west. Series of bathymetric steps are found in the middle shelf. Large canyons (Avon, Mahin and Calabar )canyon groove the continental shelf and slope (figure 2).

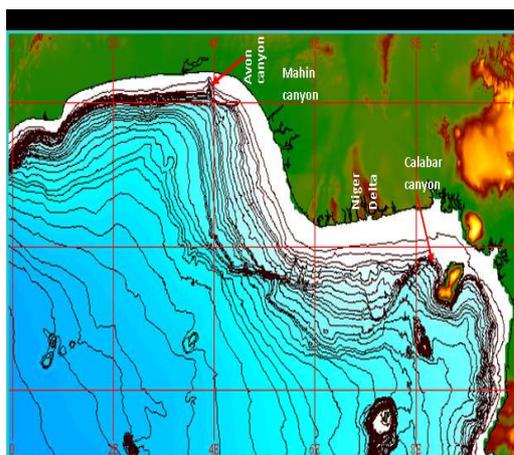
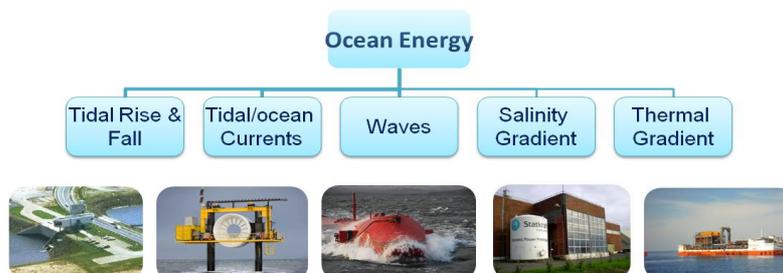


Figure 2. Bathymetric configuration of the Nigerian continental shelf

4

## OCEAN ENERGY RESOURCES



- OES covers all forms of ocean energy, including submarine geothermal, but NOT offshore wind - seawater must be the motive power
- Products can include: electricity, heat, cooling, water (drinking and pressurized), biofuels, chemicals
- Ocean energy is a nascent but truly international industry

2

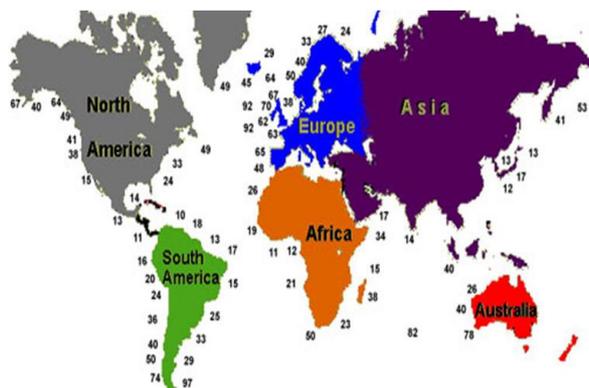
## ENERGY RESOURCES IN NIGERIA

- **Renewable**
  - **Hydro (Kainji, Shiroro, Jebba, Gurara etc.)**
  - **Solar**
  - **Wind**
  - **Wave and Tidal**
- **Non Renewable**
  - **Coal ( Enugu, Onyeama, Ogboyoga, Okaba, Orukpa, Ezimo)**
  - **Oil & Gas ( Afam, Egbin, Ughelli, Sapele, NIPP projects etc.)**

6

## OCEAN ENERGY IN NIGERIA: WAVE

### World Wave Energy Resource



Global wave power distribution in kw/m of crest length.

Source: World Energy Council. [www.worldenergy.org/wec-geis/publications/reports/ser/wave](http://www.worldenergy.org/wec-geis/publications/reports/ser/wave)

- According to the World Energy Council's wave power distribution map, the West African Coast (including Nigeria) has a wave energy regime of between 11 and 12 kw/m.
- These values are low when compared with the 40 –50 kw/m obtainable in South African Coast and the 70kw/m in the coast of United Kingdom .
- Nevertheless, the Atlantic Ocean constitutes the Southern Boundary of Nigeria. This provides opportunities for the exploration of potential Ocean Energy.

7

## Make up of the Nigerian Power Sector

- **Generation:**
  - Installed Capacity\* (name plate) 9,037.0 MW
  - Maxm. Available Installed capacity (14/01/13) 6965.0 MW
  - Maxm. Actual Generation Capability (26/12/11) 6560.0 MW
  - Peak Generation to date (23/12/12) 4517.6 MW
- **Transmission:**
  - 330KV Lines 5,000km
  - 132KV Lines 6,000km
- **Distribution:**
  - 33KV, 11KV, 415KV, 220KV 60,000km
- **NATIONAL DEMAND (estimate) 10,000MW**
- **NATIONAL GENERATION DEFICIT 5,750MW**

\* Include Privatized PHCN Facilities and IPP installations.

8

## ELECTRICITY SUPPLY AND DEMAND SITUATION IN NIGERIA

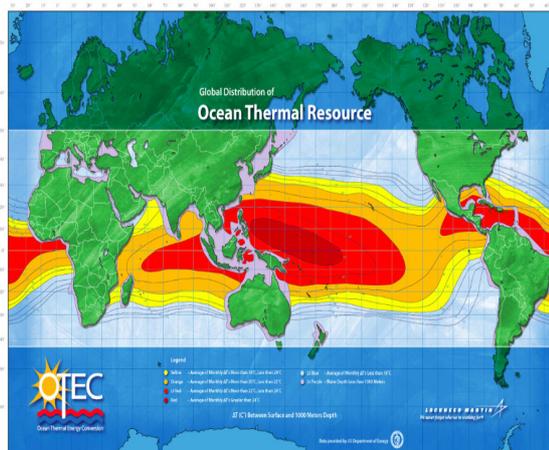
- **Situation with the existing supply of electricity in Nigeria**
  - Eight (8 nos) Government Power Generating Stations ( 3 Hydro and 5 Thermal ) that are now privatized.
  - Privatized (11 nos.) Distribution Companies
  - Four (4) Operational IPPs
  - Total Installed Generating Capacity is 9,037MW
  - Actual Generation Capability of 4391 MW (as at 6/10/13)
  - Estimated Suppressed Demand for Electricity is about 10,000MW
  - Actual demand is estimated to be in excess of 30,000 MW
- **Shortfall and Problems In National Supply of Electricity**
  - Estimated Shortfall in Current Generating Capacity is about 4646 MW
  - Non Availability of Spinning Reserve
  - Overloaded Transmission & Distribution Infrastructure
  - Irregular and Unreliable Supply of Electricity
  - Poor maintenance record of the facilities for the generation, transmission and distribution of electricity.

9

## JUSTIFICATION FOR OTEC TECHNOLOGY IN NIGERIA

- Multi-product technology.
- Facilitates water desalination (about 2 million liters of fresh water per day is produced for every megawatt of electricity generated), Hydrogen and Ammonia production.
- Base Load Power (24/7).
- Energy Security
- OTEC can produce about 3425 jobs per 100MW of electric power.
- Large Quantity of Salt (LQS), and other products suitable for the exploitation of marine resources. All these products will provide viable onshore domestic and exportable offshore products that can stimulate the economy in addition to the present oil and gas.
- Climate friendly
- Mature Offshore Industry

Image Credit: Lockheed Martin



10

## **Why NIGERIA is one of the best Country locations for OTEC Technology in the World**

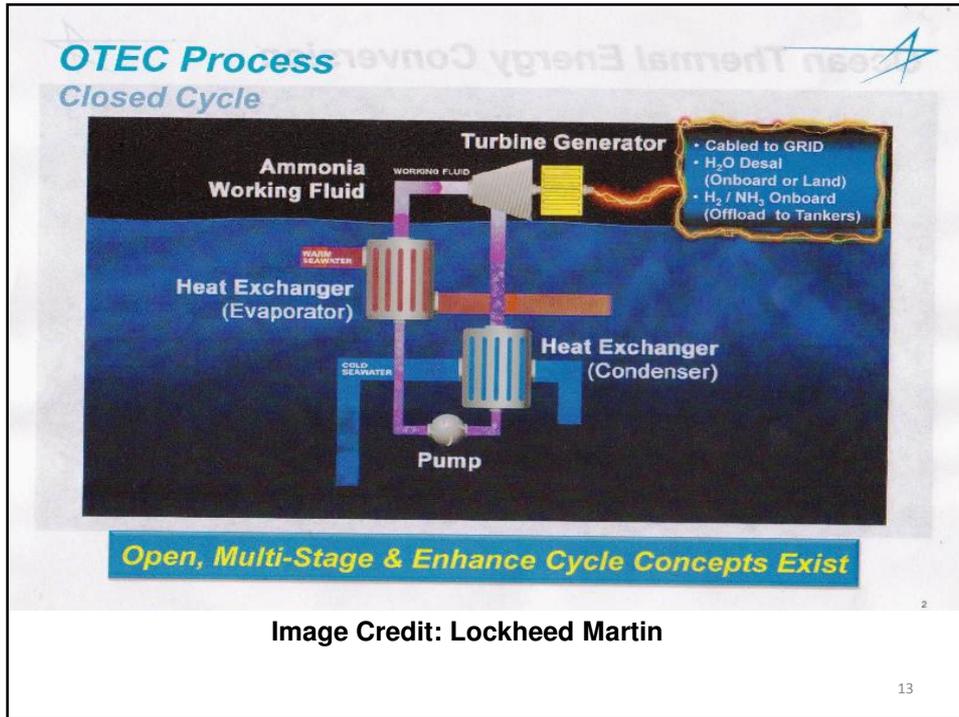
- The multiproduct and multifunctional OTEC technology is best suited for equatorial waters in countries like Nigeria where the average surface temperature of the Atlantic ocean is in excess of 25°C throughout the year.
- Nigeria with a population of over 150 million satisfies all the four requirements for favorable sites for OTEC System. These are:
  - *High thermal differences between the warm surface and the cold deep water*
  - *Low velocity water currents*
  - *Low frequency and severity of storms, hurricanes and typhoons.*
  - *Proximity to the market for OTEC products.*

11

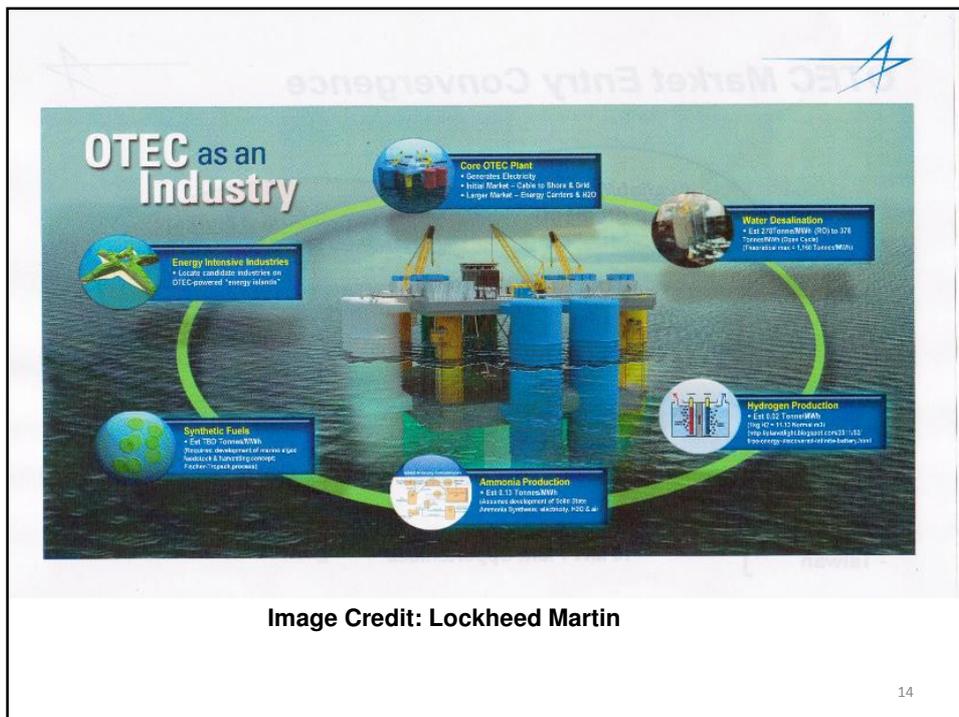
## **Principle of Operation and Developer**

- The OTEC (Ocean Thermal Energy Conversion) technology produces electricity with the temperature difference between warm and cold seawater. Cold water is drawn with a large diameter pipe from depths of about 1,000 meters or more in the ocean. Meanwhile, warm sea water is drawn from near the surface of the ocean.
- Following the Rankine thermodynamic closed cycle, the warm sea water is passed through an evaporator (heat exchanger) with a chemical that has a low boiling point, like ammonia, which creates chemical steam that operates an electric turbine. The ammonia is then condensed back to liquid form with the cold sea water.
- Scientists and Engineers have entertained the idea of OTEC since the 19<sup>th</sup> century and the American company, Lockheed Martin created a working model during the 1970s energy crisis.

12



13



14

## Multi-product Commercial OTEC Plant

21

**Image Credit: Lockheed Martin**

15

## Ocean Thermal Energy Conversion (OTEC)

**Features**

- OTEC uses standard Rankine cycle technology
- OTEC is scalable up to 500MWe or more
- OTEC can be deployed over a large geographic area
- OTEC can produce fresh water
- OTEC can use ocean thermal resources to provide energy carriers and other products
- Fuel costs are fixed

**Benefits**

- ✓ OTEC can provide reliable, base load power for utilities.
- ✓ OTEC is nonpolluting
- ✓ OTEC can create approx. 3,425 jobs / 100 MW plant
- ✓ OTEC can be used in island and developing nations making it a perfect export technology
- ✓ OTEC electricity production will not compete for water resources
- ✓ Visual impacts can be avoided with offshore OTEC
- ✓ OTEC does not crowd out valuable land uses
- ✓ OTEC solves many critical energy challenges

**OTEC Has Significant Benefits as a Clean Energy Solution**

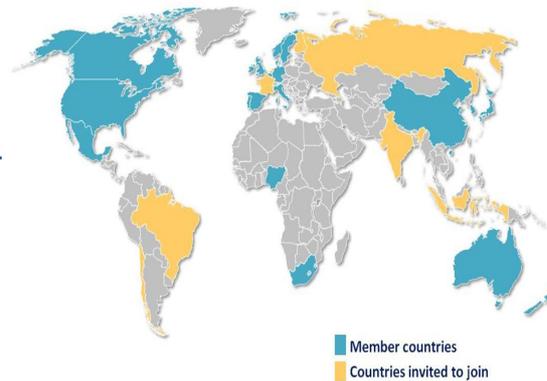
22

**Image Credit: Lockheed Martin**

16

## OES MEMBERS AND OBSERVERS

- The OES is the Ocean Energy Systems Implementing Agreement. This is an Intergovernmental cooperation between countries, operating under a framework established by the International Energy Agency(IEA) in Paris
- NIGERIA has been admitted in 2013 as the 20<sup>th</sup> Executive Member Nation of OES



17

## The OES Role



**Connect** organisations and individuals working in the ocean energy sector to accelerate development and enhance economic and environmental outcomes.

**Educate** people globally on the nature of ocean energy systems, the current status on development and deployment, and the beneficial impacts of such systems, improve skills and enhance research.

**Inspire** governments, agencies, corporate and individuals to become involved with the development and deployment of ocean energy systems.

**Facilitate** education, research, development and deployment of ocean energy systems in a manner that is beneficial for the environment and provides an economic return for those involved.

5

18

## **Conclusion**

- **Nigeria has the potential for the establishment of a viable Commercial OTEC Technology in the country**
- **In order to diversify the energy resource mix and meet the large shortfall in electricity supply, the Ocean Thermal Energy Conversion (OTEC) system is adjudged to be the renewable energy resource that is commercially available and can be successfully utilized for the production of base load electricity supply for Nigeria.**
- **The multi-product OTEC Technology will provide viable onshore domestic and exportable offshore products that can stimulate the economy in addition to the present oil and gas.**

19

***Thank You all  
for Your Attention.***

20