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"A CRITICAL EVALUATION OF THE PROSPECTS FOR A TRANSITION TOWARDS OCEAN BASED RENEWABLE ENERGY DEVELOPMENT IN NIGERIA"

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ABSTRACT

The move towards addressing two pertinent energy challenges that is access to electricity and climate change has seen the transition towards sustainable forms of energy including Ocean Based Renewable Energy (OBRE). However, much work remains to be done in understanding the critical success factors that could enable such potential transition, especially in the area of OBRE electricity generation. This research addresses this concern by drawing on transition theory and frameworks to critically evaluate the prospects towards OBRE development in Nigeria. The rationale for the study stems from issues around the inadequate supply of electricity, which has become a profound concern and, where its absence is mostly observed in rural and remote areas including coastal communities. Based on an interpretative philosophical stance, the study adopted a qualitative approach for conducting the research. In-depth semi-structured interviews were used to collect data from twenty-seven research participants. The research findings revealed that there is scope for transitioning towards OBRE electricity generation. However, this potential may be hindered by key features of the incumbent socio-technical regime: inconsistency of statements in formal policy documents; unclear institutional arrangements to foster renewable energy development; and lack of regulatory and market support mechanisms, which keep renewable energy development at the margins. Nevertheless, the study found certain perceived critical success factors that when considered could aid in facilitating OBRE development in Nigeria. These included, in particular, meaningful stakeholder engagement that aimed to harmonise the diverse interests of key actors' and the role of adequate political governance to facilitate OBRE design and implementation. The research concludes by developing a conceptual intervention model called the OBRE Transition Model. This model argues that through more meaningful engagement with pertinent stakeholders' and stronger political commitment, the prospect for a transition towards OBRE development in Nigeria could be accomplished. This thesis is the first of its kind to study the prospects for a transition towards OBRE innovation in West Africa. Additionally, the model that has been developed is now going to be corroborated in an OBRE project in Nigeria, thus, forming the evidence on the model's potential applicability for future study.

Keywords: Energy transition, Nigeria, Wave energy, Tidal energy, Off-grid communities, Renewable energy, Transition management, West Africa.

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ABBREVIATIONS

ACEP:	Alaska Centre for Energy and Power
BWEA:	British Wind Energy Association
CBN:	Central Bank of Nigeria
DFID:	Department for International Development
DISCOs:	Distributing Companies
ECCMP:	ECOWAS Climate Change Management
ECN:	Energy Commission of Nigeria
ECOWAS:	Economic Community of West African States
ECREEE:	ECOWAS Renewable Energy & Energy Efficiency
EREP:	ECOWAS Energy Policy
FMOP:	Federal Ministry of Power
FMOE:	Federal Ministry of Environment
GENCOS:	Generating Companies
GDP:	Gross Domestic Production
GIZ:	German agency for international cooperation
HEC:	Hydro Electric Converter
IMC:	Inter-Ministerial Committee
IPCCC	International panel for Climate Change Convention
IRENA:	International Renewable Energy Agency
KW:	Kilowatts
KW/H:	Kilowatts per hour
MDAs:	Ministries, Departmants and Agencies
MLP:	Multi Level Perspective
MW:	Megawatts

NCHRD: National Centre Hydropower Research and Development

NEPP: National Electricity Power Policy

NEP: National Energy Policy

NIOMR: Nigeria Institute of Oceanography and Marine Research

NREEEP: National Renewable Energy & Energy Efficiency Policy

NREAP: National Renewable Energy Action Plan

NSBP: Nigeria Sustainable Banking Principles

OBRE: Ocean Based Renewable Energy

OES: Ocean Energy System

OTEC: Ocean Thermal Energy Conversion

PTI: Petroleum Training Institute

REA: Rural Electricity Agency

RE: Renewable Energy

REM Renewable Energy Market

REMP: Renewable Master Plan

REN21: Renewable Energy Network for the 21st century

RESIP: Rural Electrification Strategic Implementation Plan

RETs: Renewable Energy Technologies

SDG: Sustainable Development Goal

SNM: Strategic Niche Management

TIS: Technology Innovation System

TM: Transition Management

UNIDO: United Nation Industrial Development Organisation

UNIPORT: University of Port Harcourt

UNDP: United Nation Development Programme

UNEP: United Nation Environmental Programme

UNFCC: United Nation Framework for Climate Change

WCED: World Commission on Environment and Development

CHAPTER ONE

Introduction

This Chapter introduces the research context and rationale, aim, objectives, and provides a concise description of the methodology and methods employed. Finally, the chapter presents the overall thesis structure.

1.1 Background and rationale for the research study

Access to energy remains a predominant concern for the majority of the world's population, with approximately 1.4 billion people in developing nations living without any form of access to energy (United Nations 2012; Karakosta and Askounis 2010; Mainali *et al.* 2014). The continuous and rapid deterioration in the quality of the environment because of certain anthropogenic activities, in particular oil and gas development, coal production and gas flaring, has attracted global debates in relation to climate change impact (Kern and Rogge 2016; UNFCCC 2011). Efforts are now required to remedy the environmental impact from these anthropogenic activities that cause climate change (Kern and Rogge 2016; SDG 2015; UNFCCC 2016). Consequently, this has placed pressure on individual nations to seek practical and sustainable ways in which to extend access to energy, specifically to electricity-deprived individuals/communities in developing economies, including Nigeria (Oseni 2011; Oyedepo 2014; Osunmuyiwa and Kalfagianni 2016). Indeed, the move towards addressing these two pertinent energy challenges - access to energy (in particular electricity) and the climate change impact - has seen the delivery of various global initiative agreements, including the

Sustainable Development Goals (SDG) of 2015, which seeks to address wide-ranging energy challenges from access to electricity to carbon emissions reduction (SDG 2015). Within these various global initiative agreements is the strategic action plan for the transition towards sustainable forms of energy including Renewable Energy (RE) sources (SDG 2015; Mainali *et al.* 2014). This has now led to the development of a new era of energy reform where supporting statements in policy documents, regulatory/institutional arrangements and market support mechanisms amongst other facilitating mechanisms are being designed and applied to facilitate the transition towards renewable energy technologies (RETs). However, it is anticipated that each country plays a proactive role in formulating its own RE transition path taking into account the complex nature in which RETs are to be designed, implemented and sustained. Over the years, RET market development has been carried out mainly through the employment of wide range of mechanisms such as RE policies statements, public finance programs and market incentive instruments - predominantly seen in developed economies - such as subsidies and tax incentives (Shackley and Green 2007). Nevertheless, this has not enabled the necessary boost for RE uptake, particularly in developing economies (Tigabu *et al.* 2013; Aliyu *et al.* 2015), including the West Africa sub-region (ECREEE 2014).

In the West Africa sub-region, the 2014 ECOWAS Renewable Energy Policy (EREP) directive set voluntary targets for all member states so that an ambitious 48% of the sub-region's energy will come from RE sources by 2030 (ECREEE 2012). The sub-region is particularly pursuing the use of RE in order to address its interrelated energy challenges (IRENA 2013; ECREEE 2014). These include, firstly, a pervasive absence of electricity supply and secondly the adverse economic underdevelopment, socio-political variances and environmental degradation characterized by the use of conventional energy resources (coal, oil and gas sources). These persistent challenges have been said to undermine the path towards achieving sustainable development within the sub-region including Nigeria (Shaaban and Petinrin 2014; ECREEE 2014; Oyedepo 2014).

This research study focuses on Nigeria, which acts as an archetype of the sub-region, where a limited electricity supply is strongly persistent. The country has a national rate of access of approximately 46%, with significant absence in rural and remote areas including coastal communities (Etepke 2007; FMOP 2015a). Current electricity generation is put between 3,000 to 4,500 megawatts (MW) for a population of over 170 million people, bringing significant limitation to socio-economic development (Aliyu *et al.* 2013; Emodi and Boo 2015). However, emerging trends suggest an ongoing transition within the energy sector in Nigeria (ECN 2005; Oseni 2011; Oyedepo 2014; Aliyu *et al.* 2015; FMOP 2015a; FMOP 2015b; Osunmuyiwaa and Kalfagianni 2016). According to Osunmuyiwaa and Kalfagianni (2016), two factors make this emerging trend particularly interesting: Nigeria's dominant energy system which is heavily reliant on fossil fuels has been functionally limited over the years, triggering demand for alternative sources of energy; and, the shift towards the adoption of renewable energy is not mainly driven by the Nigerian Government but the wider global communities in response to: climate change concerns and sustainability development. Therefore, the Nigerian Government has predicted that 30% of its electricity will be generated from RE sources by 2030 (AFDB 2016). Amongst the RE sources being considered in Nigeria is Ocean Based Renewable Energy (OBRE) in the form of tidal energy: as contained in the National Renewable Energy Policy (NREAP) of 2015 (FMOP 2015a). In tidal energy, there are two methods of generating electricity (Roberts *et al.* 2016). First, tidal range devices, which utilise the difference in water level between high and low tides for electricity generation. Second, tidal stream devices capture the energy of flowing water in currents to generate electricity. However, this research study will primarily focus on tidal stream devices in the form of near shore tidal current referred to as OBRE, where both can be used interchangeably within this thesis. The rationale for this prospective transition towards OBRE development stems from Nigeria's location within the West Africa sub-region where it appears that some activities linking to OBRE investigation have been undertaken including, within the broader form of ocean energy development, Ocean Thermal Energy Conversion (OTEC) and Tidal Range (OES 2013; Ukwuaba 2012).

Nigeria has a significant hydrographical coastal line covering more than 850 kilometers (km) and facing the Atlantic Ocean, giving rise to the potential to exploit OBRE for electricity generation (Ukwuaba 2012; Ladokun *et al.* 2013). Moreover, it also presents considerable potential for smaller scale (kilowatts) electricity generation when properly exploited, especially for the remote coastal communities who are situated around near-shore estuaries that flows directly into the Atlantic Ocean (Ladokun *et al.* 2013). These communities are argued to be far from main urban centralized grid with no form of electricity supply (Ainah and Afa 2013). They predominantly rely on traditional biomass (firewood) for their energy needs, but this has negative effect on their well-being (Ainah and Afa 2013; FMOP 2014a). Thus, it is fair to argue that, with careful consideration, the tidal resources of this area could be utilized to develop OBRE for generating electricity for local communities. Globally, there have been efforts, albeit relatively fragmented to develop OBRE, including within the UK (particularly in Scotland), which is seen as the forerunner of the industry (OES 2013; OES 2014). This perhaps, has been made possible with relatively strong supporting statements in policy documents, the persistent features of certain institutional arrangements and market support mechanisms (Jeffrey *et al.* 2013a; Corsatea 2014; Cowell *et al.* 2016). In terms of developing economies, countries including Indonesia (Quirapas *et al.* 2014), Chile (Aquatera 2014), South Africa (Wikus 2013) and Ghana (TC Energy 2014) are all undertaking some form of programs towards OBRE development.

In Nigeria, research towards the utilisation of OBRE has been undertaken by key institutions including the University of Port Harcourt and the National Centre Hydropower Research and Development [NCHRD], a centre under the Energy Commission of Nigeria (ECN) (Ladokun *et al.* 2013; Asiegbu 2014). Nonetheless, despite the fact that Nigeria's political aspirations and research focus may have indicated interest in OBRE development, it is however not yet clear how such a transition would be realised due to the perceived shortfalls in the past and current strategic design and implementation of RET programs in the country (ECN 2005;

Aliyu *et al.* 2015). The situation may be further exacerbated by the variation in the overall adoption of RE in Nigeria. That is, while some key political actors are championing RE through collaborative investments, research and the development of implementation mechanisms, others are still heavily dependent on fossil fuels for its main energy supply for the purpose of economic growth and development (Mas'ud 2015; Osunmuyiwaa and Kalfagianni 2016). Furthermore, the lack of requisite skills and competence of the structural institutional settings and governance amongst the key actors is worrisome. This is because they are argued to be responsible in shaping and directing the RE sector with respect to broader market growth and development through policymaking, implementation and monitoring & evaluation.

The last decade has witnessed some proliferation of RE supporting statements in policy documents issued by successive Nigerian Governments and the creation of renewable energy-based agencies, yet there appears to be limited positive impact on the broader context of RE development (Osunmuyiwaa and Kalfagianni 2016), which could negatively impact the prospects for OBRE development. Thus, the question guiding this research study is: *how and in what context can the transition towards OBRE be developed sustainably in Nigeria?* It is vital to ask this question as RE development in Nigeria is perceived to be ineffective, especially from the implementation point of view. Thus, this research question is pertinent for the coastal communities in Nigeria if they are to benefit from any form of OBRE implementation, but also for others in the West Africa sub-regions where RE is seen to play a pivotal role towards achieving some form of sustainable development. Addressing this question also sheds some light on wider questions about the prospect of expecting OBRE to drive wider system transformation in relation to RE development in Nigeria. Indeed, this research study also comes at the heels of research scholars that have provided several accounts and context for RE development where there appears to be no coherent framework/model for transitioning towards renewable electricity generation in Nigeria (Adaramola *et al.* 2011; Adenikinju *et al.* 2012; Ainah and Afa 2013; Awogbemi and Komolafe 2011; Oyedepo 2014; Oseni 2011; Aliyu *et al* 2015; Masu'd 2015).

This research study employed transition theory as a theoretical framework including its commonly used Strategic Niche Management (SNM) approach, to address the research question - *how and in what context can the transition towards OBRE be developed sustainably in Nigeria?* Transition theory provides the notion that a transition process requires the building up of a broad network of diverse actors that share the vision towards creating the enabling environment for an innovation development (Rotmans et al 2001; Van Eijck and Romijn 2007; Makard and Truffer 2008). Generally, transition theory has received increased attention over the last few years due to its relationship to global climate challenges and its various effects on the environment and on resource depletion (Falcone 2014). In theoretical terms, four different approaches are argued to have achieved some level of distinction in the transition studies (Markard *et al.* 2012). They include the Multi-Level Perspective (MLP); Strategic Niche Management (SNM); Transition Management (TM); and, Technology Innovation System (TIS).

All, in particular MLP, SNM and TM appreciate the persistent role of 'socio-technical regime systems' which may support in stimulating the development pathways towards RE sources including OBRE, as well as how conventional energy sources - oil and gas - persist (Cowell et al. 2016). Drawing on previous and ongoing research on energy transition, actors proposing change within the energy system often use structural and institutional dependencies in triggering transitions while reducing the socio-technical regime's influence (Geels 2014; Hess 2014). In Nigerian terms, such structural dependence includes the enactment of RE policies and creation of associated government agencies. However, it appears that Nigeria's current structural dependence on energy related matter is created and persistently maintained on the basis of fossil fuel rents and this in turn, could determine the ability of the incumbent socio-technical regime to favour any kind of transition or not.

The SNM approach of the transition framework provides a foundation for a favourable transition to occur through the importance of protected innovation spaces (Hoogma et al. 2002) and of user involvement in early technological development (Van Eijck and Romijn 2007). Thus, the main aim of the SNM is to create new technology niche pathways that are able to penetrate the prevailing socio-technical regime or be part of a realignment of the regime. They therefore, serve as visions and experimentations of what a transition is and should be (Smith and Raven 2012). However, niche visions and experimentations must transcend from its protected spaces to interact with and importantly overcome existing production 'modus operandi' and institutional conduct within the dominant regimes, such as -

in the case of energy - the energy socio-technical regimes (Osunmuyiwaa and Kalfagianni 2016). Accordingly, scholars argue that niches are only able to gain more traction in the transition process, while effectively influencing a broader diffusion of technologies, when they are guided and steered by expectations (heuristics and visions), social networks (constellation of actors with shared visions, forms and function), and learning (a reciprocal feedback loop on failed and on-going projects) (Van Eijck and Romijn 2007; Smith and Raven 2012). That is, despite the structural dependence argument within the regime, innovative actors can change regime structures and introduce their technological preferences by increasing their own competencies along with a broad interaction with the socio-technical regime actors (Grin *et al.* 2011; Rosenbloom and Meadowcroft 2014).

Transition theory has been widely lauded by a range of research scholars (Markard *et al.* 2012; Cowell *et al.* 2016; Strachan *et al.* 2015; Tigabu *et al.* 2013; Hansen and Nygaard 2014) and has been applied to various economic sector transformations including energy system transformation, but much of the existing literature focuses on RE projects in developed economies (Schreuer *et al.* 2010; Geels 2002; Rotmans and Loorbach 2010; Van Ejick 2007; Hekkert *et al.* 2007). Little attention has however, been paid to its use in developing economies and there have been calls (for example: Makard *et al.* 2012; Mutoko *et al.* 2014; Osunmuyiwaa and Kalfagianni 2016) to extend its application to that region. Hence, this research study attempts to extend transition theory and approaches including SNM within this research study context. Consequently, there appears to be solid grounds for applying this theoretical framework to this research in relation to the study's aim.

1.2 Aim and objectives

The aim of this study is therefore to *critically evaluate prospects for a transition towards OBRE development through identifying critical success factors as well as developing a model to effectively facilitate the transition in Nigeria*. The research study seeks to achieve this aim by deconstructing it into five objectives. The objectives of the study are as follows:

1. Critically examine the contextual factors that has triggered the transition towards renewable energy development in Nigeria from an electricity generation perspective.
2. Critically discuss OBRE niche innovation in terms of global activities, the technology devices – OBRE (tidal energy) turbines, resource potentials, market applicability and global barriers potentially hindering its wider transition.
3. Critically examine and evaluate contemporary OBRE development in Nigeria within the context of niche experimentation that promotes technology development and transition theory concepts.
4. Critically investigate and analyse the prevailing renewable energy conditions in order to assess the critical success factors that affect the prospective transition towards OBRE development in Nigeria.
5. Design a conceptual model – underpinned by the critical success factors - on how the transition towards OBRE innovation can be sustainably developed in Nigeria.

1.2.1 Research questions

In addressing the different research issues in the stated objectives, two sub-questions below, were deconstructed from the main research question stated in Section 1.1 - *how and in what context can the transition towards OBRE be developed sustainably in Nigeria?* The sub-research questions are:

1. What are the key limiting factor(s) that may hinder the transition towards OBRE development in Nigeria?
2. What are the underlying critical success factors that could be considered central to OBRE development in Nigeria?

These sub-research questions above pick up on some of the key elements surrounding the prospect of facilitating OBRE within the prevailing RE landscape in Nigeria. The sub-research questions sets out bt taking a closer look at the key existing barriers hindering RE uptake and then, goes on to recognize the potential critical factors that can be considered to enable the transition towards OBRE development, while at the same time addressing the key existing barriers. In turn, this allows the researcher to address the main research question thereby achieving the aim of this research.

1.3 Research methodology employed for the study

The study adopted an interpretative philosophical stance. Thus, it uses in-depth interview survey to generate data from the responses of key stakeholders for analysis and interpretation (Creswell 2007). The interviews were administered to selected research participants in order to gather expert view on the research question for theory development. Even though the study is qualitative in nature, it however, incorporated some elements of quantitative data as well, only from a secondary data collection point of view. The quantitative approach was employed with a view to addressing mathematical equation required for calculating the potential electricity to be generated from OBRE resources as presented in Chapters 3 and 4, respectively.

The strategy chosen to complete the selected interview method was through a case study setting. The study also employed the use of some aspects of an action research strategy, specifically during one of the pilot studies in Section 6.3.2.2. In action research,

> "the researcher works in close collaboration with a group of people (practitioners) to improve a situation in a particular setting" (Dawson 2009, p 17).

This view aligns with this research study where a prospective design and implementation of an OBRE electricity generation project[1] in Bayelsa State, Nigeria is currently being developed. A letter of endorsement for the proposed project is presented in Appendix 1. It is worth noting that within the context of this research study, the method applied to achieve the aim of the study only provides the 'transition' case for OBRE's prospective development in Nigeria. It is therefore beyond the scope of this study to provide in-depth reviews of the technical and intrinsic function of OBRE technology devices.

[1] The proposed project aim at providing ocean based renewable electricity generation for a coastal community in Bayelsa state with the United Nations Industrial Development Organisation as the implementing agency in collaboration with the Bayelsa State Government.

The study utilises thematic coding method for its empirical data analysis. After data are transcribed, codes are then developed, which are grouped together by means of a coding system into categories/concepts for the purpose of analysis and discussion in this thesis.

1.4 Research study contribution

This research study extends current knowledge and understanding of transitions in an understudied part of the world where conditions for transitions may differ substantially in relation to those present in developed economies. It thus, contributes to the currently scarce but growing literature of energy transitions in the developing economies (Makard *et al.* 2012; Tigabu *et al.* 2013; Mutoko *et al.* 2014; Wieczorek *et al.* 2015), particularly in the West Africa sub-region (Osunmuyiwaa and Kalfagianni 2016), and within the field of ocean energy development (Corsatea 2014).

More specifically, an analysis of energy transitions in Nigeria offers insights on the role of national political actors and coalitions in the transition processes and the pertinent barriers associated to the transition towards RE development. The study also offers contribution to the on-going debate within the SNM on the role of niche innovation particularly, on the relationship between niche-to-regimes characteristics in transition process (Strachan *et al.* 2015). Understanding this latter point is particularly important as previous studies argue that for transitions to be successful there must be a coherent alignment of niche-to-regimes relationships (Smith 2012; Strachan *et al.* 2015). Most importantly, this research study also developed a conceptual model that will provide practitioners within the energy/environmental policy field valuable and usable information for improving and/or enhancing energy transition processes, particularly for OBRE development in the context of developing economies.

1.5 Structure of the thesis

Chapter 1 has contextualized the study in terms of the nature, focus and scope of the topic to be researched on. The eight subsequent chapters are organised as follows.

In Chapter 2, the literature examines the nature of Nigeria's electricity sector in relation to renewable electricity generation, highlighting the rationale for the transition to RETs and how it is being encouraged. The chapter also examines the local factors, including the lack of market support and inadequate institutional planning that have limited the transition towards RE in Nigeria amidst the various governmental efforts to facilitate its uptake. Prior to this, a review of the contemporary global energy debate in relation to the concept of access to electricity and sustainable development is provided in order to contextualize the motivation for Nigeria's transition towards RETs. Additionally, following the contemporary global energy debate, a review of the West Africa sub-region's energy situation is undertaken, providing the barriers associated with RE uptake and the formulation of a regional RE coordinating institute, designed to facilitate the development of RE in the sub-region (similar to that of the EU Commission).

It is worth noting that as part of the broader spectrum of the literature reviewed within this thesis, two other sets of literature reviews were further undertaken in Chapter 3 and 4. Thus, Chapter 3 presents an extended literature review involving the broader spectrum of ocean energy with the main focus on the nature and applicability of global OBRE (tidal current) development. The Chapter also provides the factors that are considered hindering its development. Chapter 4 switches perspective towards the activities linked to OBRE transition including the broader forms of other ocean energy development in Nigeria. The Chapter also goes on to present the potential market where the application of OBRE can be undertaken and examines its prospects in one of the selected market (Bayelsa State).

Chapter 5 presents the theoretical framework used in this study. It first presents the nature and concept of transition theory and highlights the central factor within transition theory – the socio-technical regime. Subsequently, it depicts the different approaches being utilised within the theory and in so doing, introduces the Strategic Niche Management (SNM), which will be employed to analyse the current niche innovation of OBRE development in Nigeria for its prospective transition. The Chapter finally presents the applicability of the theory, and a conceptual framework is developed in relation to achieving the study's aim.

Chapter 6 provides a complete account of the methodology employed in conducting the study including justification for the research methods adopted, the sampling approach, data collection techniques, data collection process, data analysis and ethical consideration.

Chapter 7 presents analysis of the data arising from the semi-structured interviews. The Chapter illustrates and explains the findings related to the prevailing local conditions promoting RE development, as well as the prospects for a transition towards OBRE development.

Key findings are discussed and interpreted in Chapter 8 in relation to the relevant literature in an attempt to address the study's aim. The chapter also presents the emergent theory from the study in the form of a designed conceptual model – OBRE Transition model - for facilitating the transition towards OBRE development.

The thesis concludes with Chapter 9 explaining how this research study is successful in answering the research questions, which were set out in Section 1.2.1 thereby achieving the aim of this research study. The Chapter goes on to present the key contributions to knowledge, recommendations for practitioners as well as offers insight on future research direction.

CHAPTER TWO

Renewable energy development and market in Nigeria

2.1 Introduction

This Chapter provides a brief overview of existing literature on contemporary global energy debates with reference to renewable energy development. A particular focus on the West Africa sub-region is undertaken in relation to the energy debates leading to the examination of Nigeria's renewable electricity generation sector. Specifically, the chapter examines the situation and the rationale towards the transition to RE sources and the environment supporting such transition. Finally, the chapter explores the limiting factors (barriers) hindering the RE landscape in Nigeria.

2.2 Contemporary global energy / electricity debate

The interdependence between access to energy and sustainable development has made the drive towards improving the level of energy access, in particular electricity services, a global priority (Karekezi and Majoro 2002; Kaygusuz 2011). This has perhaps, created the broad relationship between access to energy and the concept of sustainable development (Kaygusuz 2011) as shown in Appendix 2. This relationship suggests that access to energy is an indispensable element of overcoming poverty, promoting economic growth, employment opportunities and supporting the provision of social services including better education, health services and small-medium enterprise formation (Kaygusuz 2011; Nouni *et al.* 2008). Therefore, it is fair to argue that access to energy services is an influential instrument for economic and social development, and no country has managed to develop much beyond a subsistence economy without ensuring at least an adequate access to energy services is provided for a broad section of its population (Bridge *et al.* 2013).

Lack of access to energy has several definitions. According to Masud et al. (2007), it is:

> *"the absence of sufficient choice in accessing adequate, affordable, reliable, high-quality, safe and environmentally benign energy services to support economic and human development"* (Masud *et al.* 2007, p8).

A narrower definition is also given by the United Nation Development Programme (UNDP). The UNDP in Gaye (2007) defines it as the:

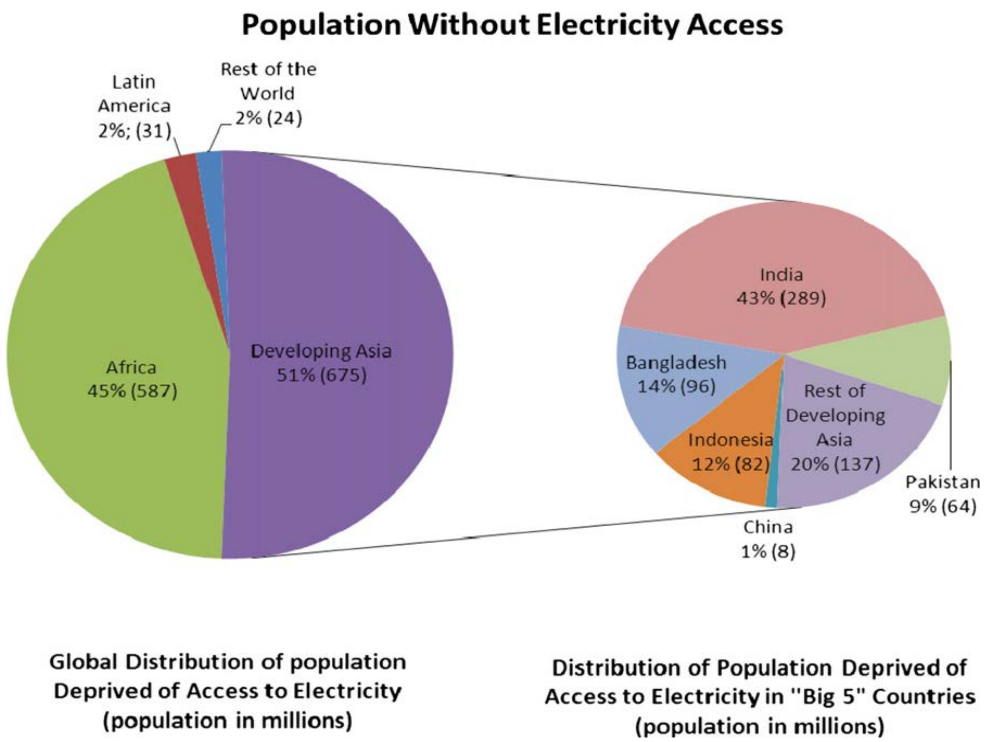
> *"inability to cook with modern cooking fuel and the lack of a bare minimum of electric lighting to read or for other household and productive activities at sunset"* (Gaye 2007).

From a slightly different context, but having similar features is the definition offered by the Asian Development Bank (ADB) in Sovacool (2013); defining access to energy as:

> *"the absence of sufficient choice in accessing adequate, affordable, reliable, high quality, safe and environmental benign energy services to support economic and human development"* (Sovacool 2013).

It could then be suggested that a deficiency in energy access had contributed to some of the socio-economic development problems within the developing world which has necessitated the growing interest in the area of 'access to energy for all' (Gaye 2007; Masud *et al*. 2007; Sovacool 2012; Bridge 2013). For instance, many developing economies face the challenge of inadequate access to energy particularly, lack of electricity generation. According to the 2010 UNDP's Human Development Report, 1.4 billion people around the world suffer from a complete lack of access to electricity where an estimate of 51% of those live in developing Asia continent, while Africa ranks second with 45%. Latin America has just 3% with the rest of the world 2% (Rehman *et al.* 2012) as provided in Figure 2-1.

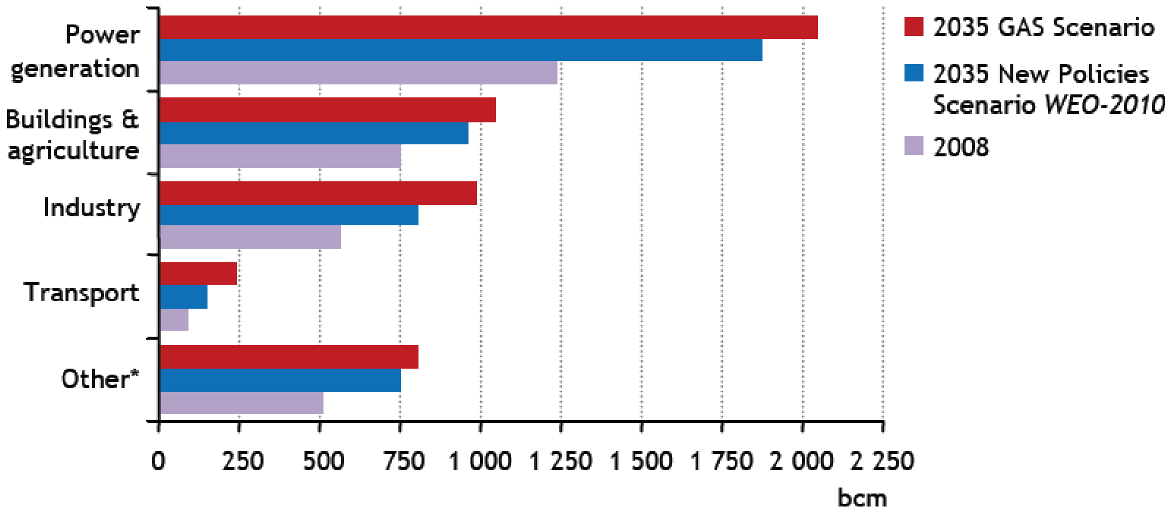
Figure 2-1: Population without access to electricity



Source: Rehman *et al.* (2012)

Thus, these economies - developing Asia continent and Africa - are considered as an ‘energy vulnerable society’. The term vulnerable society was discussed in an empirical study conducted by Garniati (2014) and found that the base load for vulnerable societies are dictated by the combination of certain limiting factors including minimum access to electricity resources, which appears to be one of the fastest growing drivers for energy demand as presented in Figure 2-2 (IEA 2013). The Figure represents gas-to-electricity market.

Figure 2-2: World primary energy demand by sectors



Source: IEA (2013)

Since the 19th century, the energy sources used to meet global electricity generation has mostly been from fossil fuels sources in the form of coal, oil and gas. Though the importance of fossil fuels is unquestionable, several negative aspects are either directly or indirectly related to their use (Karakosta and Askounis 2010; Kaygusuz 2011). In particular, some prominent concerns include its environmental impact, where carbon dioxide is emitted – cause of climate change - due to the burning of fossil fuels for electricity generation. Similarly, degradation of land and sea due to pollution from oil well development – explorations/production is also problematic. Volatility and price instability may also exist. This occurs where there is economic dependence on politically unstable countries or regions. For instance, about 56% of crude oil reserves are located in the vulnerable regions of the Middle East, which prompts the issue of price volatility and energy security concerns. The manifestation of these concerns such as the degradation of land and sea due to pollution from oil well development and burning of fossil fuel to generate electricity - on a global and local scales have given rise to a number of environmental issues (Loorbach 2007; Ebegbulem *et al.* 2013; Nwankwo 2015).

These issues include socio-economic inequalities and negative concrete influences on people's lives. For instance, the ecological devastation occasioned by oil exploration in the Niger Delta of Nigeria has rendered farming and fishing, which supposedly are main occupations of the people in this region, despairing (Ebegbulem *et al.* 2013; Nwankwo 2015). In turn, these has resulted to adverse negative impact on welfare, productivity and development (IRENA 2014a) and remains predominant in the region, including other developing economies burdened with similar situations (Karakosta and Askounis 2010; Savacool 2013). A number of global developmental initiatives are being/have been initiated to respond to the issue of inadequate access to electricity along with the environmental degradation caused by climate change sources - fossil fuel. Some of these global developmental initiatives include Sustainable Energy for All (SE4All) and the Sustainable Development Goal (SDG), which are discussed in the next section.

2.2.1 Sustainable energy for All – SE4All

This initiative as described on the SE4All (2016) webpage is about:

> "*driving actions and mobilizing commitments to positively transform the world's energy systems towards more sustainable patterns of development*" (SE4All 2016).

This strategic action is based on the achievement of three interlinked objectives:

1. ensuring universal access to modern energy services such as electricity;
2. doubling the global rate of improvement in energy efficiency; and,
3. doubling the share of renewable energy sources in the global energy mix

In order to achieve the above, a global "action agenda" was designed to guide efforts to be undertaken in supporting the SE4All initiative. The action agenda areas have been grouped into two categories – sectoral and enabling – where the sectoral action areas are envisaged to address both electricity generation and the principle sectors of energy consumption, including distributed electricity solutions and large scale Renewable Power. The enabling action areas are argued to characterise crosscutting mechanisms designed to support effective sectoral action and to address existing implementation barriers, including energy planning and policies and business model and technology innovation (SE4All 2016).

2.2.2 Sustainable development goals

The Sustainable Development Goal (SDG) programme brings together various strands and underpinnings of 'sustainable development', in particular social stability (peace and prosperity) and equity. The emphasis on sustainable development herein is defined broadly by WCED 1987 as:

> *"development that meets the needs of the present without jeopardizing future generations' growth and prosperity, and involves the consideration of social, environmental and economic resources"* (WCED 1987, p.43)

This definition suggests a concerted effort towards building an inclusive, sustainable and resilient future for people and planet. Thus, for sustainable development to be achieved it is essential to harmonise three core elements of economic growth, social inclusion and environmental protection, which are argued to be linked with growth, equity and environmental conservation (UNESCO 2007). It has also been suggested that the SDG initiative will in the next 15 years ensure the end of all forms of poverty, inequalities and environmental degradation arising from climate change concerns (SDG 2015). A persistent concern, especially for developing economies including Nigeria lies on the lack of clarity in the implementation strategy of the SDG initiative within their local landscape. This is due to the inadequacy in indigenous capability building to facilitate the SDG initiatives. However, while this may present a challenge for the developing economies, the mainstream of SDG thinking is argued to be underpinned by a collaborative and participatory approach, where strong international support from developed economies is envisaged towards supporting developing economies in achieving the SDG (Blake *at al.* 2010; Midin *et al.* 2016; SDG 2015).

Looking forward, within the frame of the SDG are the 7th and 13th goals – the SDG is made up of 17 goals - both proposing the following:

> *“access to affordable, reliable, sustainable and modern energy for all by 2030 and for this to be accompanied by a significant increase in the share of renewable energy development within the global energy mix over the same period”* (SDG 2015, goal 7); and,
>
> *“Take urgent action to combat climate change and its impacts”* (SDG, goal 13)

The perceived relationship between both goals stems from the causal effect of the current predominant energy source – fossil fuel – that accounts for over 70% of total global greenhouse gas emissions (UNFCCC 2011). Consequently, facilitating access to affordable, reliable, sustainable energy through RETs is seen as a key response to reducing the greenhouse gases that cause climate change. Indeed, this relationship between SDG goal 7 and goal 13 appears to have aligned further, in the post SDG discourse - the Climate Change Green deal. On 12 December 2015, nations convened in Paris and agreed to a ‘transformational’ action plan to promote sustainability – ongoing processes of organising across multi-level entities to enable sustainable development - in the form of a climate change green deal agreement. The key note of the agreement is the proposed goal to reduce carbon emissions suggesting a clear signal to the energy market that the era of fossil fuel energy sources dominance appears to be ending with a potential transition towards more sustainable energy forms including

RE sources. It is unlikely that fossil fuel will be phased out entirely; nevertheless, the climate change green deal agreement may aid in stimulating the much-needed transition towards RETs and perhaps, deter significant financing for fossil fuel energy development.

While these initiatives (SE4all, SDG and perhaps the Climate Change green deal) are crucial steps towards the transition to RE, it is also worth noting that their objectives (SE4all, SDG and the Climate Change green deal) in many case do not take into account the complex societal context in which they are meant to be implemented (Akinsete, Osu and Kruijsen 2015). This concern also mirrors some of the key obstacles, which includes inadequate attention given to: political governance both at the National and sub-national level, the various agencies and social innovation that are persistently limiting the delivering of an effective and viable RE development, particularly in the developing economies (IRENA 2014a). Nevertheless, beyond this concern, national statements in policy documents and implementation actions need to be increased largely towards building a potential global regime for RE development especially within the West Africa sub-region.

2.3 Renewable energy development in the West Africa sub-region

Globally RE policy has grown since early 2000s and is argued to have penetrated 138, 144 and 154 countries at the end of 2013, as of early 2014 and 2015 respectively (Ozoekwu *et al.* 2017). For instance, by the end of 2013, nearly 50% and 98% of all operational global solar PV capacity was installed since the beginning of 2012 and 2014 (REN 21).

Furthermore, RE resources met 13% of the world's primary energy demand in 2011 and by the year 2012, 14% of the total world energy demand is suggested to be supplied from RE, while 19% of global final energy consumption was also supplied from RE sources [IEA 2013; IEA 2014]. Amongst the regions widely argued to be, utilizing RE source is the West Africa sub-region. Nonetheless, RE development in the sub-region has been predominantly negligible as reported in several research studies including ECREEE (2012); IRENA (2014a); UNDP (2012); ECCMP (2015); REN21 – Renewable energy network for the 21st century.

The West Africa sub-region comprises of 15 countries whose territories span a broad swathe from the Sahara Desert to the tropical coastal lowlands and from the Cape Verde archipelago in the west to Nigeria in the east. Despite the wealth of natural resources in the sub region, its energy sector is plagued with severe challenges arising from lack of electricity access, energy security and climate change concerns (ECREEE 2012; Verolme 2014). These three interrelated challenges are discussed below, drawing upon various literature including IRENA (2014), ECREEE (2012; 2014), ECCMP (2015) and Velrome (2014).

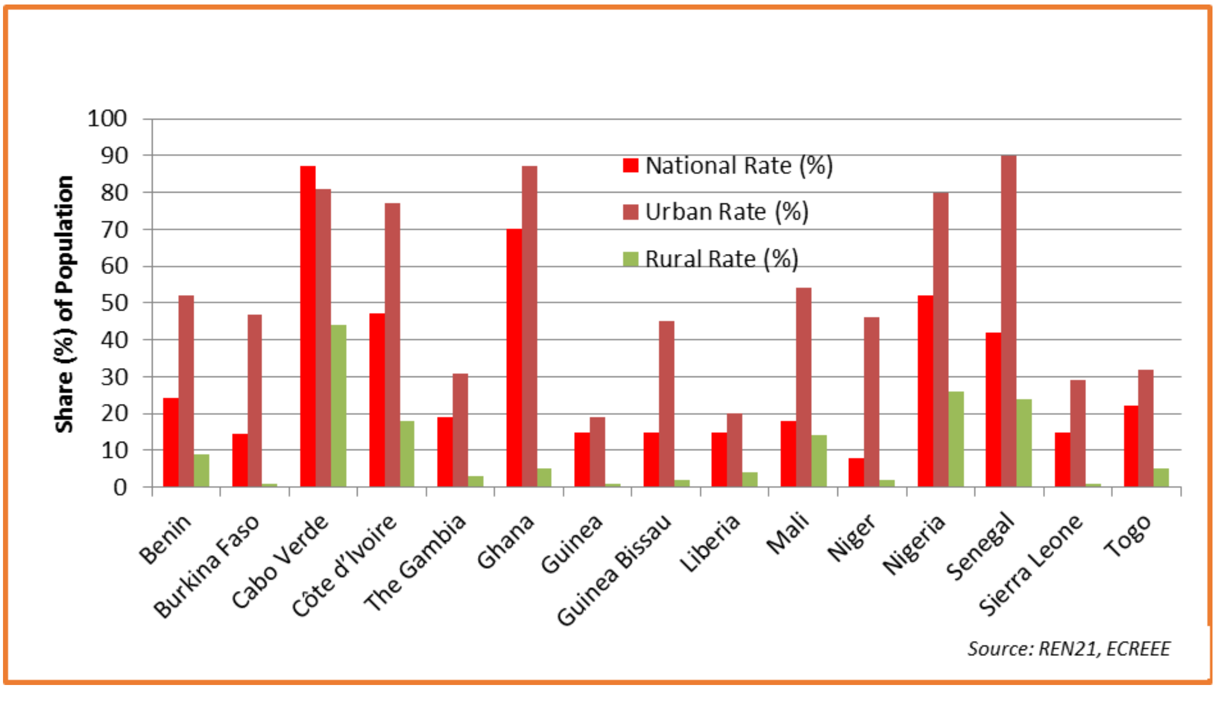
2.3.1 Energy challenges in the West Africa sub-region

2.3.1.1 Lack of adequate electricity access

According to ECREEE (2014), more than half of its total population (approximately 300 million total inhabitants) have no access to electricity with majority living in the rural area as presented in Figure 2-3.

Furthermore, per capita electricity consumption across the sub-region is estimated at between 100 – 150kWh per annum in 2012, which is argued to be one of the lowest rates in the world (ECREEE 2014). Additionally, household access to electricity across the region is about 20%, but wide gaps exist between the access rates in urban areas, which averages 40%, and in rural areas, ranging from 6% to 8% (ECCMP 2015). Thus, for those households or enterprises who can afford to shield themselves from the vagaries of the grid, the use of fossil fuel based generators becomes an alternative, usually at a high cost to both the government, which subsidizes the fuel and to the users from health related concern (Velrome 2014).

Figure 2-3: Electricity access rates in ECOWAS



Source: ECREEE (2014)

2.3.1.2 Energy security

Rapid population growth, urbanization and socio-economic activities are all leading to increased energy demand in the sub-region. A growing gap between projected electricity demand and generation capacity along with high commercial and technical losses in the sub-region's electricity sector, makes it increasingly difficult to provide reliable and affordable electricity (ECREEE 2014; IRENA 2014; ECCMP 2015). In addition, maintenance problems and sometimes destruction of infrastructure because of conflict or vandalism of supply infrastructure such as gas pipelines has also left the electricity systems at a limited or non functional capacity (Verolme 2014; PM News 2015). Furthermore, electricity supply is unreliable even in areas that have access with frequent power outages occurring during peak periods of demand or during the dry season in areas that are heavily dependent on hydropower production for electricity supply, such as in Nigeria.

2.3.1.3 Climate change concerns

The sub-region is mostly dependent on traditional biomass and solid fuels for domestic energy use particularly in the rural and remote areas. According to ECCMP (2015), 80% of total energy consumed for domestic purposes are obtained from traditional biomass (firewood). This has a significant contribution towards greenhouse gas emission and has resulted in health challenges, particularly for women and children because of the long period of time they spend in front of open fires and traditional stoves used for cooking and heating. It is estimated that around 600,000 Africans die each year because of indoor air pollution, with half of them being under the age of five (IRENA 2014a). The use of wood for cooking has also contributed considerably to deforestation as well as a decreasing supply of biomass resources (ECCMP 2015). Finally, the burning of fossil fuels for electricity and heat is also one of the dominant sources of greenhouse gas emissions in the sub-region. It has been claimed that over 80% of the sub-region's electricity generation capacity runs on fossil fuel. This also has a significant impact to climate change where temperature rise and extreme weather events such as prolonged droughts and flash floods are being observed (ECCMP 2015).

In moving forward, fundamental to addressing the negative impact of this trilemma was the need for each member state within the sub-region to undertake an energy policy and governance re-structuring, including the potential transition towards the use of RE sources (ECREEE 2012). Underlining the transition towards RE options is the central principle that the sub-region is seen as having some significant RE resource potential including (ECREEE 2012; IRENA 2014a) such as:

1. Considerable wind (onshore and offshore) and the broader ocean energy forms such as OTEC, tidal range and wave, including OBRE potentials can be found in some of the West Africa countries including Nigeria, Ghana and Cape Verde;
2. An estimated 23,000 MW of hydroelectric potential is concentrated in five of the 15 member states, of which only about 16% has been exploited;

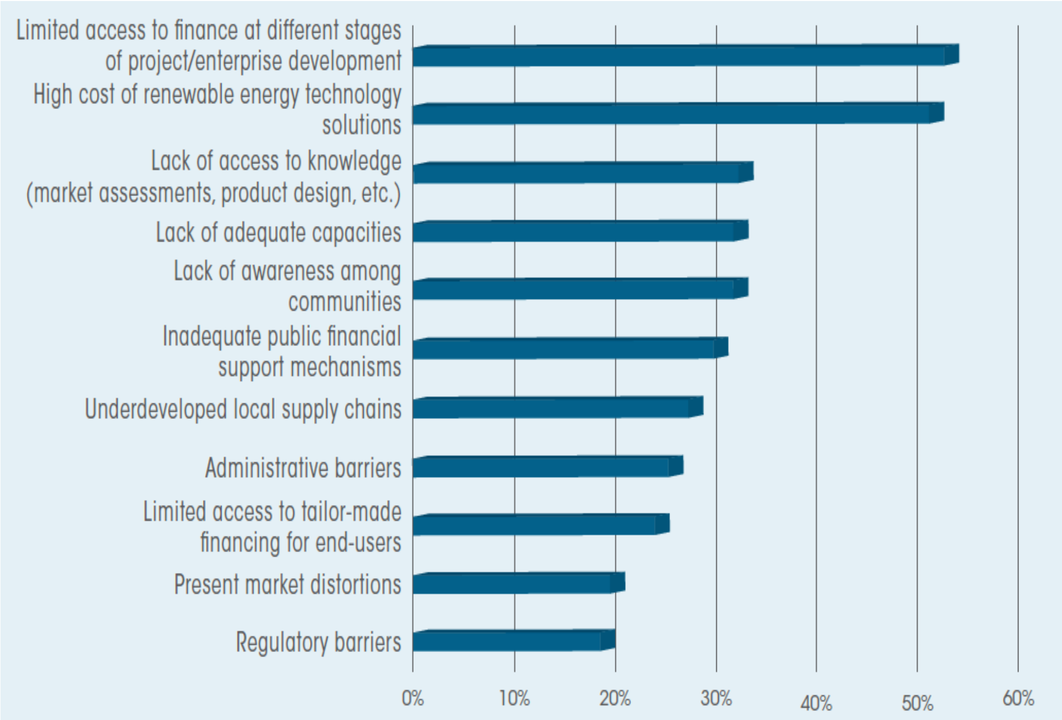
3. Vast solar energy potential with very high radiation averages of 5–6 kWh/m^2 throughout the year; and,
4. Good potential for all forms of bioenergy such as biomass, and biogas / biofuel is suggested to exist.

Up until now, the market for RE development remains generally low, suggesting that the sub-region is yet to take advantage of its RE potential as highlighted above. According to (ECREEE 2014) the reason for this low RE margin is due to the persistent barriers, which are due to multi-faceted matters spanning from political landscape preference for fossil fuel based electricity generation to inadequate and/or non-existent RE supporting policies and developmental programmes. Details of the perceived RE barriers are discussed in Section 2.4.

2.4 Barriers associated with renewable energy uptake in the sub-region

The research takes a starting point towards understanding the perceived RE barriers by reviewing the identified barriers associated with global RE uptake as cited in the 'Global Barrier to Renewable Energy Uptake Report' in particular from an off-grid perspective (IRENA's 2014a) as presented in Figure 2-4.

Figure 2-4: Global barriers to renewable energy uptake



Source: IRENA (2014a).

From the figure, various barriers including regulatory barriers; lack of awareness amongst communities; lack of adequate capacities etc. are amongst the barriers limiting global RE development. Indeed, these barriers also mirror the key obstacles to delivering effective and sustained RE development in the sub-region (ECREEE 2012; ECREEE 2014) resulting in ongoing debate on how to facilitate a transition towards RE uptake. The research study now takes a closer look at the existing barriers limiting RE development in the sub-region.

2.4.1 Perception of renewable energy sources

Renewable energy sources are still perceived as expensive within the sub-region, even though technologies such as micro/mini OBRE, solar and onshore wind technologies appear to be very competitive with conventional energy sources. For instance, generation costs for a micro OBRE development, which is argued to cost less than $0.43/kWh, compared to that of $0.81/kWh of diesel generation (Smarthydro 2016). Largely, the perceptions about the nature of RETs amongst stakeholders in the sub-region have represented a significant barrier mainly due to absence of pertinent information – lack of awareness - on key developmental components of RE including the operational aspect such as technology prices and generation cost (Verolme 2014).

2.4.2 Lack of capacity and capability knowledge or competency

Capacity and capability knowledge have been suggested to create critical development competency such as energy policy analysts/regulators, financial/ economic managers, project financiers and local developers/engineers that will be able to manage all aspects of renewable energy development stages. That is, from design to implementation to operations and maintenance. This is however, currently lacking in the sub-region. This is despite international development support being accorded to the sub-region towards developing its RE market. This support in the form of technical/financial funding from international agencies (for example, World Bank) are assumed helping address some of the persistent RE challenges in the sub-region. However, one main issue arising from this, is that the international development agencies lacks enough attention towards the role of local power and agencies and they also tend to re-design RE strategies from developed economies' perspective, to be implemented in the sub-region (Jochnick 2012; Garniati 2014).

2.4.3 Lack of tailored energy policy and supporting frameworks

Another key barrier is the lack of clear direction and governance from member states' government that is repeatedly missing, thus resulting in the ad-hoc renewable energy development within sub-region. This limits the sub-region's lack of political priority to attract investment; to ensure a market framework for investment; technical planning for investment; and, finally capacity to implement investment for renewable energy projects (IRENA 2013).

2.4.4 In-sufficient political will for implementation

Drawing from section 2.4.3, implementation of existing policies or instruments is far from being achieved in all cases within the sub-region, as practical programs to stimulate RE development such as institutional arrangement and capacity and/or capability for facilitating applicable renewable energy development are largely ineffective. This view is consistent with Rod Cargill in Verolme (2014, p10), who has suggested that:

> *"the number of failed renewable energy projects in the sub-region over the last 20 years is unacceptable" (*Rod Cargill in Verolme 2014, p10).

Cargill in Verolme (2014, p10) further indicated that these failed projects have set back development by raising aspirations and then failing to deliver. Thus, supporting statements in RE policy have largely remained broad statements of intention or aspiration as against practical implementation.

2.4.5 Fossil fuel subsidies

In some of the sub-region's countries, including Nigeria, it has been suggested that fossil fuel subsidies have also created a disadvantage for already competitive RETs thereby relegating such promising renewable energy sources to the background.

2.5 Regional institutions for facilitating renewable energy development in the sub-region.

In response to these persistent barriers above, the sub-region's energy ministers, with support from the Governments of Austria and Spain and technical assistance from the United Nations Industrial Development Organization (UNIDO) established the ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE) in 2010. The mandate of ECREEE was aimed at promoting and supporting the development of renewable energy and energy efficiency along with the reduction of climate change through appropriate mitigation and adaption measures (ECREEE 2012). It may appear that the establishment of an ECOWAS regional centre was emergent based on perceived practice from the European Union (EU) counterpart – a regional initiative called European Commission. The rationale for this set-up as identified in ECREEE's 2012 corporate handbook was that regional integration could be a useful tool to facilitate the implementation and adoption of effective policies along with robust supporting schemes towards transitioning to RET uptake.

From the research study's perspective, regional initiatives are often not the answer, as they seem not to be binding. Rather, they appear to be aspirational with the expectation that member states will be motivated towards practical implementation of the agreed initiatives. Additionally, such initiative (to be managed through national level administration) often takes little reference to countries' socio-political situation. For instance, the current EU directive requiring its members to generate up to 20% electricity from RE sources by 2020 may never happen, partly due to persistent differences in policymaking processes. A particular viewpoint to this is seen in the United Kingdom (UK), where political devolution exists and the flexibility towards facilitating RE development is very much limited due to the persistence of relatively centralized government (Cowell *et al.* 2016; Strachan *et al.* 2015). Most notable is the lack of coherent in RETs and targets seen within the broader UK setting in England and that of Scotland.

Nonetheless, since ECREEE's inception in 2010, key activities in an attempt to actualise some of its mandates, especially in the areas of alleviating the existing persistent barriers hindering the creation of a viable RE market in the sub-region is the development of a regional renewable energy policy called ECOWAS Renewable Energy and Energy Efficiency Policy (EREEEP). The basis for this is to support each member State towards designing a new renewable energy policy or updating their existing policy in line with the EREEEP. Furthermore, ECREEE adopted the three SE4All objectives as earlier presented in Section 2.2.1 in order to link it with the EREEEP strategic programme. It is also envisaged that the consolidation of both EREEEP and SE4All initiative will be taken forward towards the formulation of an ECOWAS Renewable Energy Action Plan (EREAP). The EREAP is also to be adapted by each member states towards designing an executable action plan for RE development programme (ECREEE 2012; ECREEE 2014). A review of the EREEEP document revealed two main goals within the context of promoting renewable electricity generation (ECREEE 2014):

1. Increase the share of RE to 35% in 2020 and 48% by 2030 in the overall electricity mix;
2. To facilitate access to 75% of the rural population through grid extensions; and,
3. To serve approximately 25% of rural areas using RE powered by off-grid and standalone systems by 2030.

However, a particular reflection on the second objective appears to be unrealistic. Firstly, the concern here is the embryonic nature of the existing grids within the sub-region, which may not be able to accommodate further electricity supply. Furthermore, grid extension in the sub-region appears to be a political tool where policy makers have a tendency to prioritise the extension of the grid to peri-urban areas in order to maximise political support, or to provide electricity to urban populations that are more politically active and organised than rural areas (Wiemann *et al.* 2011; ARE 2012). Secondly, rural areas are normally located far from the national grid therefore; the high cost of extending transmission lines usually makes this form of objective project unfeasible. The environmental terrain such as mountainous and sea areas poses significant barriers for grid extension. Thus, in all rationality, it may make more sense to provide electricity generation at the local rural communities using off-grid RE based solutions such as OBRE and other renewable energy sources including solar and biomass.

Turning back to the EREEEP, the design process gave rise to member states developing what is referred to as their National Renewable Energy & Energy Efficiency Policy (NREEEP) within the context of their prevailing environment. Essentially, the NREEEP document is expected to include a broad range of potential RE sources, including the strategic development programs and specific objectives towards actual implementation of those selected RE sources. For instance, Nigeria developed its NREEEP with the focus on hydropower, biomass, solar, wind, geothermal and OBRE power plants (FMOP 2015a). The next section discusses the nature of Nigeria's contemporary RE market.

2.6 Nigeria's renewable electricity sector

2.6.1 The electricity market

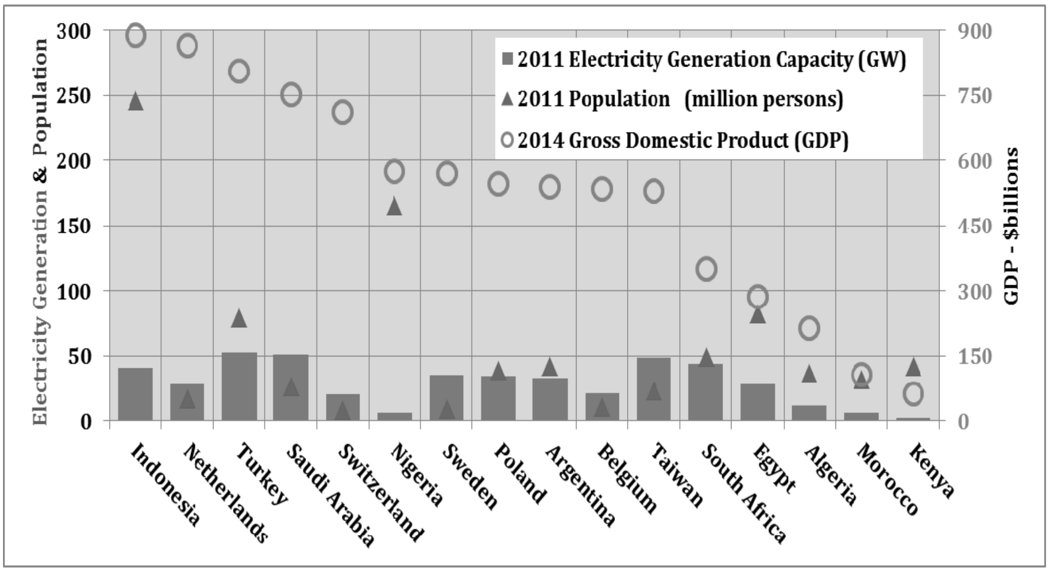
Nigeria is currently facing a massive electricity generation gap with matters reaching a crisis point in 2015 where national electricity generation fell to a low of 2,800MW. In 2016, the highest electricity generated was just over 4000 MW which was achieved in February 2016 (Nigeria Electricityhub 2016) for a population of over 170million. Further concern is the fact that the installed capacity strength of the national grid is inadequate at over

5000MW (Premium Times 2015); any rise above that threshold results in a total collapse of the grid (Premium News 2015). Indeed, this appears to be a dire situation for the country.

Nigeria's lingering electricity crisis is reported to stem mostly from local and international events that affect the country's crude oil and gas industry (Ozoegwu *et al.* 2017). For instance, according to the International Monetary Fund (IMF) report in 2014, the oil and natural gas industry in Nigeria typically accounts for 75% and 95% of total government revenue and total export revenue, making the economy vulnerable to volatility in crude oil prices despite fiscal buffers like Excess Crude Account and Sovereign Wealth Fund (IMF 2014; OPEC 2014). A typical example is the quick transition from the era of flourishing income when crude oil sold at $112.75 per barrel in December 2013 to the current era (the beginning part of 2016) of meagre income when crude oil sells around $30 per barrel (Ozoegwu *et al.* 2017). This has supposedly raised questions on feasibility of successful implementation of the 2016 budget that was benchmarked on $38 per barrel, though 19% of the proposed budget is expected to be financed by the oil sector which is a lower dependence in comparison with 48% in 2015 (Ozeogwu *et al.* 2017). Furthermore, the atmosphere of poor regulation overlooked the poor maintenance of aging oil infrastructure and operational failure that have over the decade caused oil spillage within the host communities. This has resulted in agitations and insecurity in those communities – found mainly within the coastal states of the Niger Delta region (Nwankwo 2015). This has also led to the recent rise in vandalism of the oil and gas facilities by the coastal states militants from the mid 2000s to date (Ebegbulem *et al.* 2013; Nwankwo 2015). It has been repeatedly argued that the continuation of these challenges, especially the vandalisation of gas facilities including pipelines, which transports the gas required for electricity generations, makes the supply of final energy resources far below demand (Ikeme and Ebohon 2005; Ozeogwu *et al.* 2017). Thus, it is not surprising why Nigeria's socio-economic growth indicators have been as weak as the Nigerian electricity sector over decades (Ozeogwu *et al.* 2017).

Electricity outage is frequently experienced by several cities in Nigeria, even the major cities like Port Harcourt, Abuja, and Lagos and can occur several times a day and could go on for several hours even lasting to days and possibly weeks (CASA 2012; Verolme 2013). This shortage of electricity services has affected many sectors in Nigeria, ranging from industries, private firms, banks, households and SMEs, and adversely affects the economic growth of the country. Figure 2-5 shows data on population, gross domestic product and electricity generation capacity for Nigeria and ten comparable countries in the global GDP ranking (5 above and below) as well as for five other African countries.

Figure 2-5: Electricity generation capacity, population and GDP



Source: Oladosu (2016)

From the Figure, apart from Kenya, Nigeria has the lowest generation capacity in all 16 countries, as well as the lowest generation capacity per capita (Oladosu 2016). Many individuals and organisations in Nigeria have turned to decentralised electricity supply in the form of off-grid self-generation using oil based electric generators in order to bridge the supply/demand gap.

Electricity generation in Nigeria is suggested to have a total installed capacity of about 10,000 MW as presented in Table 2-1 however, an available capacity of 6,199.2 MW is argued to being generated.

Table 2-1: Electricity generation sources in Nigeria

Generation company	Plant type	Available Capacity (MW)
Afam Power Plc	Gas thermal	987.2

Egbin Power Plc	Gas thermal	1320.0
Kainji/Jebba Hydro Electric Plc	Hydro-power	1330.0
Sapele Power Plc	Gas thermal	1020.0
Shiroro Hydro Electric Plc	Hydro-power	600.0
Ughelli Power Plc	Gas thermal	942.0
TOTAL GENERATING CAPACITY		**6199.2**

Source: KPMG (2014)

Thus, it is evident that most electricity generation comes from gas based thermal plants, which have an installed capacity of about 8,457.6 MW (81% of the total installed) but with an available capacity of 4,996 MW from table 2-1. This is actually less than 60% of the supposedly installed gas based thermal plant capacity for electricity generation (GIZ 2014). A closer examination of the gas supply landscape that is gas-to-electricity generation as discussed by (Odumugho 2010) suggests that the low gas supply challenges may have been caused by gas pipeline vandalisation as a result of communal agitation by militants against the activities of oil and gas companies within the coastal communities. Although this challenge is very critical towards the development of the gas-to-electricity market, the inadequacy or timeliness of investments in critical infrastructure with several years of unstable gas policy statements and regulatory uncertainties appears to be the key barriers hindering the development of the gas-to-electricity market (Nwaoha and Wood 2014; Odumugho 2010). From the other energy source, hydropower from only two plants accounts for only 1,938.4 MW of total installed capacity with a supposedly available capacity of just 1,060 MW (KPMG 2014). On this note, the research can conclude that both form of power plants (gas based thermal and hydropower) present capacity cannot meet current electricity demand.

A reform to revamp the electricity sector was carried out in response to this challenge, however, this transformation actually commenced in 2005 through deregulation and privatization of the sector. The aim was to create an attractive climate for investment, including the use of RE for electricity generation (GIZ 2014). The reform started with the dismantling of the main national electricity generating company (Power Holding Company of Nigeria – PHCN) into six generation (Generating Companies – Gencos), one transmission and twenty-five distribution companies (Discos) – currently only eleven DISCOs are operating in Nigeria - over a period, from 2000 to 2013 (KPMG 2014). However, evidence suggests that the reform has achieved limited success towards ensuring adequate access to electricity provision in the country, as demonstrated in the current electricity supply, which was less than 2500 MW as at the time of this write–up in the third quarter of 2016. This is in light of the considerable financial investment made during the reform process (KPMG 2014; Oladosu 2016). According to KPMG:

> *"The Nigerian Power Sector Privatisation is reputed to be one of the boldest privatisation initiatives in the global power sector over the last decade, with transaction cost of about $3.0bn"* (KPMG 2014, p6).

Little wonder, the current government has been urged to reverse the privatisation process or at least take 59% ownership, instead of the 49% in Gencos and Discos companies, in order to have control in the running of the electricity assets across the country (Oladosu 2016). According to the

Federal Ministry of Power (FMOP), "more efforts will rather be undertaken in the areas of adequate governance, performance, and efficiency" towards improving the electricity sector situation. It is still unclear on how these efforts - governance, performance and efficiency - are to be achieved, as the situation appears to be worse off each passing day.

Of all this, the most disturbing situation is in the rural and remote areas including coastal regions, where access to electricity problems have subdued the local economy (Ikeme and Ebohon 2005). A key obstacle to achieving access to electricity in the rural and remote areas is the fact that policy frameworks promoting energy access in those areas remain weak or non-existent. These set of communities tend to bridge the supply/demand gap using open burning of biomass for energy use, especially for those that cannot afford the cost of buying oil based electric generators. This concern predominantly stems from the fact that security of energy supply, markets and competitiveness is predominantly governed centrally through the federal government with limited involvement from sub-nationals. Therefore, electricity generation is suggested to be predominantly focused in urban along with peri-urban areas. Another reason is the environmental terrain (discussed earlier in Section 2.5) of these communities. For instance in coastal communities the sea or other bodies of water is seen to encapsulate the environment, making electricity grid extension unfavourable. While the adverse impacts of using open burning of biomass for rural/remote energy use have already been highlighted in Section 2.3.1.3, the former, oil based electric generators constitutes a major blight in its own right. In 2012, Nigerians spent approximately $4million on fuelling generator sets (NERC 2012); a figure which rose to an estimated $17.5million in 2014 (GIZ 2014). These diesel and petrol powered generators also constitute a major sources of greenhouse gas emissions which poses a public health hazards in addition to generating high levels of noise pollution (Komolafe *et al.* 2014). The country nevertheless, has a significant amount of other energy resources aside from fossil fuel based gas source and hydropower to draw upon, this includes RE sources that could be utilised for electricity generation. Specifically, the RE sources are yet to be fully optimised, particularly in the areas of OBRE (Ohunakin 2015; Oseni 2011; Sambo 2009; Ladokun, Ajao and Sule 2013).

2.6.2 Renewable energy market in Nigeria

According to the FMOP, the application of RE is suggested to have the potential to not only raise Nigeria's socio-economic growth but also provide adequate electricity provision especially in coastal communities in off-grid areas. It is suggested that the development of the RE sector will also create jobs, support productive uses and enhance business development as well as social service delivery (FMOP 2015a). From an off-grid electricity supply perspective, the potential of RE generation will play a catalytic role in advancing decentralised energy systems, particularly in rural and remote areas (IRENA 2014a).

The current RE sources being exploited in Nigeria; in practice include solar energy sources and onshore wind energy sources with moderate attention towards bioenergy. Solar energy sources appear to be the most debated and exploited RE sources in Nigeria and have been suggested that it can widely be utilized for several purposes, including electricity generation (Ayodele and Ogunjuyigbe 2015). For instance, solar energy can also be used for drying agricultural products. In terms of electricity generation, solar implementation is low, with the exception of its use in street lightings (seen in major cities such as in Abuja and Lagos) and sparsely in homes (FMOP 2015a). In a bid to increase solar energy, just recently (July 2016), the Federal Government signed Solar Power Purchase Agreements (PPAs) worth $1.75 billion dollars with 14 solar companies to build 1125 MW capacity of solar renewable electricity in the country (Nigeria Electricityhub 2016). Several studies have also indicated good wind potential in the country (Adaramola *et al.* 2011; Olayinka *et al.* 2012). According to the studies, good wind resource potential appears to exist in Nigeria, with main locations found in the northern and coastal areas of the country. Small-scale wind applications are suggested to be useful for off-grid electricity generation on farms, rural areas and in homes. However, similar to the solar energy implementation, no installed working unit has been deployed with only pilot studies being demonstrated, particularly in the northern region of the country where strong onshore winds are suggested to occur.

Even though evidence suggests that RE development has been significantly in- effective, the Nigerian Government believes that the development of the sector is an integral part of national development (ECREEE 2012; FMOP 2015a). For instance, the national renewable energy policy, the NREEEP and the National 'Vision 20:2020' have set targets for RE generation at a countrywide level. In terms of areas without grid supply seen in coastal communities, parastatals such as the Rural Electrification Agency which has a specific mandate to cater for electricity access in those areas has been instituted in order to promote greater private sector participation in rural electrification using renewable electricity generation systems (GIZ 2014). The Nigeria Government has also initiated several partnership projects with international development institutions/donors including the Global Environmental Facility (GEF), Africa Development Bank (AFDB) and the World Bank towards facilitating RE development.

The research now pays a particular attention to three central components – supporting statements from policies documents, institutional arrangements and market support mechanisms - that are perceived practice, as facilitating RE development in the country.

2.6.2.1 Supporting statements – policies documents

A number of mechanisms have been suggested to advance the uptake of renewable energy in Nigeria, in particular national policies (Adaramola, Paul and Oyedepo 2011). The current policy called the 'National Renewable Energy and Energy Efficiency Policy (NREEEP) was approved by the federal government in May 2015 (FMOP 2015a). This policy was based on ECREEE's mandate for each country to design a renewable energy and energy efficiency policy in order to facilitate sustainable forms of energy from a national level point of view (ECREEE 2014). Nigeria's NREEEP overall focus is suggested to provide an optimal utilisation of the nation's energy resources for sustainable development and has been regarded as an umbrella document consolidating the various past policies and strategies in one single document (GIZ 2014; FMOP 2015a). In other words, the NREEEP appears to provide the framework that could drive RE development by serving as a valuable vehicle that will enable both strategic and operational implementation. However, it is less clear about the concrete activities that will aid in facilitating such development in Nigeria, specifically through the actions of the Federal Government and in collaboration with sub-national Governments (state and local)

Policies prior to the NREEEP have also been designed to drive RE development in Nigeria. The research observed that from 2002 upwards, there has been increased interest in RE sources evidenced by supportive statements in policy documents issued by successive Federal Governments, noting the potential of the RE sector. For instance, the National Electricity Power Policy (NEPP) of 2002 set a target of 10% renewable deployment by 2020. The NEPP was designed under the assumption that the

> "*creation of an investor-friendly environment with low participation of governmental institutions and strong central regulation would help the country overcome the poor electricity services, low availability and high frequency of outages in the system*" (GIZ 2014, p67).

Following that, the National Energy Policy (NEP) of 2003 required Nigeria to commercially develop its renewable energy resource and integrate it as part of the country's energy mix. The NEP overall objective was to ensure an optimal utilisation of the nation's energy resources - both fossil fuel and RE sources - for sustainable energy development, but with active participation of the private sectors (ECN 2005). In 2005, a Renewable Energy Master Plan (REMP) derived from the National Energy Policy (NEP) was developed with the support of the United Nations Development Programme (UNDP). The REMP provided an overall goal towards the delivering of a roadmap for the effective implementation of the various RE sources including OBRE. The REMP 2005 further envisaged that the electrification demand of 14,000 MW would be undertaken by 2015 of which RE will constitute about 5% (701 MW). The REMP also alleged that by 2025, the electricity demand, which is projected to increase to 29,000 MW, would have 10% (2,900 MW) of electricity being generated by RE sources. However, the first objective of 2015 – providing 701 MW - never came to fruition.

From 2005, further design of RE policies was undertaken due to the implementation of the Electric Power Sector Reform Act (ESPRA) of 2005. The ESPRA aimed at fundamentally changing ownership, control and regulation of the electric sector due to the failure of then National Electricity Power Authority to keep pace with the increased electricity demand, resulting from population growth and economy development in the country (GIZ 2014). The ESPRA constitutes the legal foundations for all electricity-based programs including RE development, setting the following objectives amongst others: develop a competitive electricity market; establish the national electricity regulatory commission (NERC) for the licensing and regulation of the energy sector including the RE market; and, provide the legal basis with necessary enabling provisions for establishing, changing, enforcing and regulating the technical, market rules and standards of the energy sector. Nevertheless, it is perceived that the ESPRA has so far failed to provide the enabling environment necessary to develop the sector, particularly the RE market (Oseni 2011; GIZ 2014; Oyedepo 2014).

Moving on, in 2008, a National Energy Master Plan was formulated and produced the Electricity Master Plan however, no clear implementation strategy was designed towards RE uptake and it was jettisoned (GIZ 2014). Following that, a roadmap for another reform of the sector was drawn up in 2010, on which basis the National Policy and Guidelines on RE was designed to produce the Renewable Electricity Action Programme (REAP).This was however, never signed into law and appeared to be abandoned, too. In 2012, the REMP 2005 was revised to REMP 2012 with a particular focus on the economic and financial incentives to specifically reduce the initial high cost of investment in order to stimulate and enhanced the penetration of RE. Following similar trends to all the earlier mentioned policy statements, the REMP 2012 document is yet to be approved by the National Assembly and may have again become obsolete with the recent NREEEP, which was approved in 2015.

In terms of rural electrification programs, a Rural Electrification Policy (REP) was developed in 2009 as mandated in the PEARS. The REP's main aim as designed, is to encourage private sector participation in rural electrification using only renewable energy sources via decentralized energy systems (soft energy path approach) (FMOP 2015a). Following the REP design, in 2014, the Federal government drafted the Rural Electrification Strategy and Implementation Plan (RESIP) with the aim of extending access to electricity in a cost effective manner to 471,000 rural households each year; beginning from 2015 to 2020. A proposed annual addition of 513,000 rural household connections from 2021 to 2040 was also being planned, using both grid and off-grid approaches on expanding electricity access (FMOP 2015b). However, this programme may be limited and exacerbated by the functional mandate of the Rural Electrification Agency (REA), which lacks key capacity including undertaking spatial electricity planning study in a bid to give detailed analysis of which mode of electricity delivery (centralized or decentralized based) can be used in the different parts of the off-grid areas. There is also the lack of information regarding actual cost of expanding access, assuming grid connection is to be utilized to all the areas currently without access to electricity (Ohiare 2015). However, in FMOP (2015b) document, the cost of achieving this initiative has been estimated between ₦317.8 billion ($1.5billion) and ₦525.8 billion ($2.6billion) suggesting a minimum of NGN50billion ($250million) per annum. Clearly, this has affected electrification expansion planning and prioritization, specifically decentralized implementation mode in the country. On this basis, it is fair to suggest that the actual realization of the RESIP may just be another form of aspiration as mentioned earlier in Section 2.4.4.

Indeed, it can be argued that one factor perpetuating the marginal position of RE in Nigeria is the plethora of policy documents designed year after year by the Nigerian Governments with no clear direction for practical implementation. Even though, the current RE policy (the NREEEP), which may presumably stand in as a binding document was approved in 2015 (GIZ 2014), none of its strategies/objectives are yet to be implemented as at the time of this write-up. Thus, it is fair to argue that policy design does not itself bring a total transformation (though it is just one part of the transformation process) rather understanding the environment should be the first point of call prior to any strategic framework design. This notion was discussed at the 2015 annual meeting for the World Economic Forum (WEF) in Davos, Switzerland where it was suggested that:

> *"If you want to invest in this space – energy sector, you have to first survey the environmental factors beyond policies ..."* (WEF 2015).

Hence, knowing the issues and the process cycle from identification, idea generation, and problem solving and responding is one thing, but implementing solutions and tackling the issues becomes another thing entirely, especially in the context of a complex society like Nigeria.

2.6.2.2 Public authorities and other supporting institutions

The NREEEP policy has identified the Federal Ministry of Power with its functional Renewable Energy and Rural Power Access Department (RERPAD) as the coordinating desk towards policy development and implementation of RE programs (FMOP 2015; GIZ 2014). The RERPAD is argued to provide the secretariat role for a set of working group, called Inter-ministerial Committee (IMC). The IMC is comprised of all Ministries, Department and Agencies (MDAs) with mandate towards Renewable Energy (RE); Energy Efficiency (EE); and, Rural Electrification Development (RED). Arguably, the IMC working group as presented in Table 2-2 was set up in a bid to respond to the several inconsistencies associated with the level of RE development including the unstable nature of policies noted in Section 2.6.2.1, and can be primed as the overarching policy making body for RE market development.

Table 2-2: IMC working groups associated with RE development

S/N	MDAs representatives
1	Federal Ministry of Power (FMOP)
2	Energy Commission of Nigeria (ECN)
3	Federal Ministry of Water Resources (FMWR)
4	Federal Ministry of Environment (FMOE)
5	Federal Ministry of Lands, Housing and Urban Development (FMLHUD)
6	National Electricity Regulatory Commission (NERC)
7	Nigeria National Petroleum Corporation (NNPC)
8	Rural Electrification Agency (REA)
9	Standard Organisation of Nigeria (SON)
10	Nigeria Power Training Institute (NPTI)
11	Nigeria Investment Promotion Commission (NIPC)
12	Transmission Company Nigeria (TCN)

Source: GIZ (2014)

The IMC is suggested to be responsible for the planning, development, coordinating and deployment of renewable energy innovations and are predominantly public authorities' institutions active within the energy market (GIZ 2014). As indicated in Table 2-2, the IMC also appears to have a broader view towards all electricity resource generation, including the oil and gas sector. However, in an effort to support, promote and incentivize the entry of renewable energy in Nigeria, certain relevant Ministries, Departments and Agencies (MDAs) have been specifically mandated to have more focus towards Renewable Energy Market (REM) development as well as guidelines for its implementation.

Table 2-3 presents the functional mandates/roles of the actors responsible for promoting REM development.

Table 2-3: Main public authorities' actors RE mandates

RENEWABLE ENERGY STAKEHOLDERS AND PUBLIC AUTHORITIES		
MDAs	**Functions**	**Mandates in Renewable Energy Development**
FMOP	FMOP is responsible for policies, programs and monitoring of the power sector in the country.	To promote a diversified electricity mix for the country including electricity generated from renewable energy sources. Leads the Inter-ministerial Committee on Renewables and Energy Efficiency (ICREEE)
FMOE	The FMOE prepares comprehensive national policies for the protection of the environment and conservation of natural resources, including procedure for environmental impact assessment of all developing projects	Plays a secondary role, as it has no direct mandate in the power sector. It approves ESIA prepared by generation companies under the approval process for generation licenses. In addition, FMOE grants tax holiday for utility scale PV plants. However, from the researcher's point of view, administering tax holiday should be the function of NERC and not FMOE.
FMWR	The FMWR formulates National Water Resources policies towards ensuring adequate water supply for agricultural, industrial, recreational, domestic and other uses.	Role in hydro development (e.g. dam construction, hydrological activities etc.), its engagement in the near future will become more pronounced. Currently, the FMWR undertakes civil works on hydropower stations on behalf of the FMOP.
NERC	NERC is a key organisation under FMOP responsible for regulation of the power sector across power generation, transmission and distribution. NERC is responsible for the creation of a competitive power sector participated by private players; establishment of operating codes and standards; licensing and regulation of persons engaged in any of the power subsector activities; tariff determination; approval of amendments to electricity market rules; and other related regulatory functions.	Technical inclusion of electricity generated from renewable energy into the power mix of the country. Publish multi-year tariff orders for industrial consumers and regulate tariff related aspects. NERC issues generation licenses to applicants in Renewable Energy and administers and implements feed-in tariffs
ECN	ECN is the government office in	Co-ordination of National Policies in the field of

	charge of energy sector planning and policy implementation. The Commission also promotes the use of renewables and alternative energies within the electric generation mix in Nigeria. The ECN fulfils the role of for strategic overall planning, coordination and effective direction of Nigeria's national Energy strategies within Nigeria and with ECOWAS member states.	energy across all consumer sectors including industrial sector. Coordinate with all relevant agencies in defining the policy, roadmap and targets for energy efficiency in industrial sector and support FMOP in implementation of the policy recommendations for the exploitation of new sources of energy in relation to the Government guidelines on the utilisation of energy types for specific purposes; Inquire into and advise the Government of the Federation or of the State on the adequate funding of the energy sector including research and development, production and distribution; Collate, analyse and publish information relating to the field of energy; ECN also promotes the use of renewables and alternative energies within the electric generation mix in Nigeria.
NBET	NBET is a Federal Government of Nigeria (FGN) owned public liability company. It was incorporated as a trading licensee holding a bulk purchase and resale license to engage in the purchase and resale of electrical power and ancillary services from independent power producers and from the successor generation companies.	Enter into and execute Power Purchase Agreements (PPAs) with power generating companies (Gencos) on competitive basis, as required. NBET receives payments from distribution companies (Discos) for energy received and pays generation companies for bulk power sent to the grid.
TCN	Federal entity responsible for the transmission of electricity from power plants to distribution companies, eligible customers and for export. Acts as Transmission Services Provider (TSP), System Operator (SO) and Market Operator (MO).	TCN provides grid connection and ancillary services agreements as Transmission Service Provider. TCN is also the System Operator and Market Operator for which generation companies pay respective charges. It is expected that TCN will assist in renewable grid connections when applicable.

Source: GIZ (2014).

It is evident that five of the MDAs in Table 2-3 are also members of IMC – FMOP, FMOE, FMWR, ECN and NERC indicating their relevance within the REM and perhaps, in the broader strand of the energy sector landscape, particularly in the electricity generation regime. Indeed, from all indications, it is safe to suggest that the Federal Government (through these MDAs) remain the pivotal structure developing the REM. Accordingly, financial support and strategic development for the market is wholly subjected to the control of the Federal Government. Even though in the NREEP document, the involvement of state and local government levels are required to facilitate RE development, yet these stakeholder levels are conspicuously absent as evidenced in Table 2-2 and 2-3.

Evidence from literature suggests that state and perhaps local government level are seen to be incorporated into the RE deliberation on a need to know basis, in particular during the National Council on Power (NACOP) meetings – a forum where all key stakeholders' assembly in order to be provided with the activities of the FMOP on electricity matters. Accordingly, inputs from states and local government are largely absent in relation to REM development. This approach somewhat negates the NREEEP assertion on the basis that a strong level of coordination linking the federal, state and local governments, are all required as a key ingredient towards formulating REM development strategies, as well as its execution.

Although, it may seem that the Federal Government remain in control of key constitutional and financial resources in relation to renewable electricity generation, the lack of capacity and capability to foster reasonable RE development is somewhat evidenced, largely due to the MDAs strong reliance for technical/financial support from international donor agencies. These agencies are argued to design initiatives and programs towards raising awareness of the increased role of RETs in the global energy supply. In terms of Nigeria, these organisations are divided into (GIZ 2014):

1. Bilateral implementing agencies including Department for International Development (DFID), Global Environmental Facility (GEF) and German agency for International Cooperation (GIZ),
2. Development Banks including International Finance Corporation (IFC), World Bank (WB).
3. United Nation Organisations including: United Nations Development Programme (UNDP), United Nations Industrial Development Organisation (UNIDO), United Nation Environmental Programme (UNEP)

These agencies - to some extent - have failed to advance the uptake of RE in Nigeria due to their particular limitation in understanding the socio-political and cultural landscape of doing localized socio-economic projects in the country. Perhaps, again, their focus is only on formulating policy statements for RE development, but only at the National level. This leaves little scope for lobbying and extending their networks beyond the national level, leaving out the sub-national level elements. Nonetheless, while international support is indeed needed, it is only one of the pieces for effective policy implementation.

Another area of concern within the institutional/organization frame is the issue of limited multi-stakeholders' involvement where the Federal Government public authorities appear to be the predominant actors facilitating RE development. Multi-stakeholder integration and coordination are considered paramount by the literature, international organizations, and national governments towards achieving meaningful success in sustainable development projects, in this case RE development (BWEA 2002; Midin et al. 2016). Drawing from the British Wind Energy Association (BWEA) (BWEA 2002) extensive stakeholder processes on offshore wind development - a similar environment to that of OBRE - in the UK, the following pertinent stakeholders' groups have been suggested as key towards facilitating sustainable forms of electricity development:

1. Statutory categories: Statutory consultees are public authorities, agencies, groups or bodies defined in national or international legislation, which are obligated to consult with towards a proposed renewable electricity development.
2. Strategic categories: This category includes local, regional, national and international organisations, along with their representatives that have important information, experiences and expertise to contribute to the overall progress of the renewable electricity development.
3. Community categories: This category includes any individual, groups of individuals, or organisations whose lives, interests, and welfare can be affected by the renewable electricity development. They include the rural communities, NGOs etc.
4. Symbiotic categories: Symbiotic stakeholders can be owners or organisations who may have interest in or who may have mutual benefits from a co-development perspective.

2.6.2.3 Market support for renewable energy development in Nigeria

From a market support view for RE development in Nigeria, the Nigeria Electricity Regulatory Commission (NERC), which is under the Federal Ministry of Power (FMOP) have the prime role in designing market support systems. According to the REN(21), RE market support mechanisms which are in place in Nigeria are (i) Capital subsidy, grant, or rebate, (ii) Reductions in sales, energy, CO2, VAT, or other taxes, (iii) Public investment, loans, or grants, (iv) Biofuels obligation/mandate and (v) Feed-In-Tariff (FIT). It is however, suggested that the FIT appears to be the preferred market instrument being envisaged by NERC to compete with conventional electricity generation towards facilitating renewable electricity development (NERC 2014).

The FIT is a premium payment meant to guarantee reasonable returns to producers from investments in new and existing RE electricity generation technologies (Njindan 2015). It is evidenced that the success of FITs is mainly hinged on the provisions of guaranteed grid access, long-term contracts and cost-based purchase prices as seen in Germany (Otitujo 2010). In Nigeria, FITs are normally planned to be higher for costlier RE electricity technologies, for instance, the FITs laid down by NERC assigns ₦92,192 (£204) and ₦33,433 (£74) per MWh to solar PV plants and land mounted wind power plants for the year 2016 (Ozoegwu *et al.* 2017). The allocation of the FITs appears to have also become a barrier to RE development as NBET (Nigerian Bulk Electricity Trading) Plc has continued to decline the tariff structure of NERC till date (Ozoegwu *et al.* 2017).

Furthermore, considering the challenges associated with Nigeria's grid, which is considered an 'embryonic' grid system as compared to developed economies; the practicality of using the FIT becomes a major strategic concern, even though grid access is promised in NREEEP. Thus, it can be argued that FITs as stipulated by NERC, has not been given priority towards electricity generation from RE sources. In addition, NERC has not made provision for compensation for electricity produced from RE sources, which certainly cannot be sold due to the lack of priority grid access (Ozoegwu *et al.* 2017). This comes against ECREEEP's objective of 75% renewable energy grid access in the sub-region as earlier mentioned in Section 2.5. Moreover, the proposed disengagement towards the use of FIT has seen a shift to other market support instruments, including the Contract for Difference (CfD), which the UK is set to implement by 2017 (RenewableUK 2014). It may be wise not to totally discount the potential of FIT at this moment because Germany have been argued to significantly use the FIT as a market support instrument to advance its RE market (Otitujo 2010).

Many studies have tended to conclude that the successive support for RE development in Nigeria has been through the persistent features of supporting statements in policy documents and perhaps, some level of coordination from pertinent institutions (Shaaban and Petinrin 2014; Ayodele and Ogunjuyigbe 2015; Udoakah and Umoh 2014). However, analysts also have suggested that the lack of clear direction and governance from the Federal Government are repeatedly missing towards policy formulation and importantly implementation, resulting in the current ad-hoc RE development (ECREEE 2012; Oseni 2011; Oyedepo 2015). Furthermore, from the institutional perspective, analysts have claimed that the capacity and capability to effectively facilitate RE programs is currently lacking amongst the various RE institutions and agencies (ECREEE 2012; Ladokun, Ajao and Sule 2013; Aliyu, Dada and Adam 2015). Additionally, even though Nigeria's current renewable energy policy may have advocated rural electrification programme – community electricity generation, its roadmap strategy appears to lack clarity and is somewhat superficial. Hence, it is not clear whether such advocates for rural electrification is:

> *"promoting greater community engagement as a transformative project that moves towards 'soft energy paths', or suggesting what sort of stake or degree of control may be needed to make the transformative project a success"* (Strachan *et al.* 2015, p. 99)

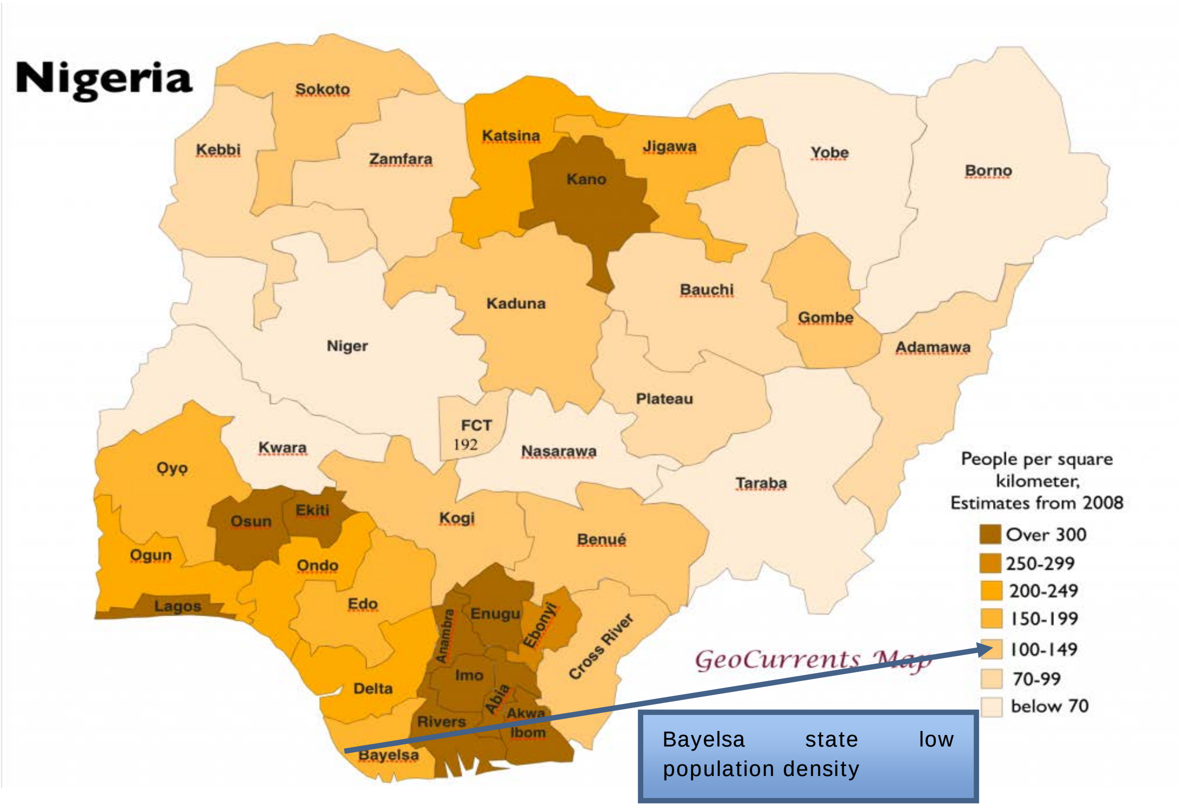
The emphasis on 'soft energy path' herein entails significant consideration towards the delivery of flexible, decentralized and locally tailored energy system, with greater accessibility to citizens, in particular remote/rural communities (Lovins 1977 in Strachan *et al.* 2015). This is because contemporary energy development path in the Nigeria has seen increased land-use planning arrangement that systematically favours large scale centralized systems, including for RE development. This has not favoured the REM (Akinsete, Osu and Kriujsen 2015).

Building further on land-use planning perspective, a key element will also include a thorough understanding of the interconnectivity that exists between environment, energy and the composition of settlements, argued to be a critical element when energy object development is required (Haefer 2014; Newman and Kenworthy 1999; Wiedenhofer *et al.* 2013).

For instance, energy objects such as renewable energy based mini-grids, which are quicker to implement as against grid extension have been suggested to be useful for low-density areas and the implementation of novel and emerging technologies such as mini-grid OBRE could be more easily achieved (Arbabi and Mayfield 2016)

Therefore, given the context of this study, (as illustrated in Figure 2-6), low population density in states such as Bayelsa reflects the prospects towards a potential mini-grid OBRE technologies utilisation. This further provides rationale towards a transition to OBRE development in Nigeria. As such, it is fair to suggest that a crucial role in any land-use planning process, in this context (energy object development) will require the formulation of practical and feasible policies and strategies that considers the intersection that exists between environment, energy and the composition of settlements both urban and rural.

Figure 2.6: Population density map of Nigerian States



Source: GeoCurrent Map (2016).

The next section discusses the barriers associated to renewable energy development in Nigeria.

2.7 Barriers associated to renewable electricity uptake in Nigeria

2.7.1 Policy, legal and regulatory framework

As the nation faces the challenges of ensuring the availability of easily sourced and competitively priced energy supply, it has been suggested that the federal government needs to create the appropriate policy framework of legal, fiscal and regulatory instruments that would attract domestic and international investments (ECN 2005). However, this deficiency is reflected in the limited or the absence of clear rules, legislation, roles and responsibilities of various stakeholders along every stage of the RE flow from supply to end-use sector (GIZ 2014; Udoakah and Uruh 2014).

2.7.2 Institutional framework

In Nigeria, the present coordination between the various MDAs, agencies responsible for REM development is argued to be very weak and rather complex. Further to this, there appears to be inadequate institutional capacity, and a lack of effective inter-sectoral communication and co-ordination to promote RE use in the country (Aliyu, Dada and Adam 2015; Mas'ud *et al.* 2015).

2.7.3 Economics and financing

Most RE development is argued to require high up-front capital cost even though they may appear to have lowered operational and maintenance cost once implemented. Apart from the higher capital cost, most of the RETs such as OBRE face another barrier, which is the perceived untested nature of the technologies, in particular within Nigeria's environment (ECN 2005). Thus, given these twin barriers to RETs, investors in Nigeria may face higher risks and uncertainties when making investment decisions. Therefore, in a capital constrained economy like Nigeria, where there are many competing demands for available scarce capital resources, the potential promoters of RET face the problems of high transaction costs and restricted access to capital. The RETs also faces some economic barriers from the end users, especially from the poor population who resides in the rural/remote communities. Given the low income and therefore limited purchasing power of the poor in Nigeria, if RE development is being considered especially in coastal communities and rural settings, then the challenge here, is to find ways to empower the poor to pay upfront costs for new RETs.

2.7.4 Capability and capacity building

Within the REMP document ECN (2005), it has been argued that human and institutional capacity building at all levels is required to sustain the skills relevant for the design, development, fabrication, installation and maintenance of RETs. In particular, capacity building in four areas appears to be most essential, training of manpower to install, operate and maintain RETs, development of manufacturing capabilities, development of a critical mass of scientists, engineers, economists for R&D, and design and effective functioning of institutional frameworks. All these appear to be predominantly lacking in Nigeria towards facilitating RE development.

2.7.5 Public awareness

Awareness of the opportunities offered by RE and their technologies is low among public and private sector stakeholders (ECN 2005; ECREEE 2014). This lack of information and awareness creates a market distortion that results in higher risk perception for potential renewable energy projects. The general perception is that RETs are not yet a mature technology, hence it is only suited for a niche market and even then will require heavy subsidies to make it viable in the long term. Again, this mind-set has even fundamentally limited the opportunities presented to mature RETs, where major focus is to enhance and further develop the more mature energy sectors including the oil and gas market.

2.7.6 Inter-agency collaboration: public-private partnership

As already discussed, the present coordination between all stakeholders appears to be weak and rather complex. This has affected the governance element from the perspective of who is responsible for RE development. Another element of this barrier identified is the coordination amongst the MDAs and the private sector. Lack of engagement with the private sector especially in the aspect of production, marketing and adoption of RETs along with creating a market environment where private firms can innovate, compete and profit from these investment is repeatedly lacking. Additionally, ECN (2005) has purported that lack of private sector participation has also seen a decrease in political support resulting from the unsuccessful nature of the sector that has created the perceived biasness towards RETs by the Federal government.

2.7.7 Research and development (R&D)

The past decades have seen the development and maturing of RETs including OBRE. This process has been largely possible through extensive global programs of research, development, demonstration and financial incentives especially in the developed countries. Most developing economies lack the requisite R&D due to the nature of their environment, and although Nigeria has two prominent renewable research institutions: National Centre for Energy Research and Development (NCERD), at the University of Nigeria, Nsukka and the Sokoto Energy Research Centre

(SERC), at Usman Danfodiyo University Sokoto, their capacity to undertake adequate R&D is very low.

2.7.8 Monitoring and evaluation.

Effective monitoring and evaluation has been perceived to be a barrier to RE development in Nigeria. It can be argued that the lack of Monitoring and Evaluation (M&E) has undermined RE development including the opportunities to review existing political strategies for future RE designs (GIZ 2014). A further insight into this element has suggested that the Energy Commission of Nigeria (ECN) should serve as the secretariat of the RE steering committee and have the responsibility of consolidating all work programs of the REM development including the M&E function (ECN 2005).

2.8 Concluding summary

This chapter has discussed the contemporary nature of renewable energy in Nigeria, highlighting key perceptions in relation to the context of the study. In the chapter, it was noted that access to electricity is fundamental and has been argued to be interlinked with sustainability. Amongst the regions saddled with lack of access to electricity is the West Africa sub-region. However, it was noted in the Chapter that efforts to combat such concerns are being undertaken with the formation of a regional institute, ECREEE, responsible for facilitating the development of the sub-region's renewable energy market. A key element to that is the design of the NREEEP that should articulate, in principle, each country's commitment and willingness to develop their individual renewable energy sector.

In Nigeria, the NREEEP has been adopted but with limited clarity on how the transition towards RETs including OBRE will be undertaken in light of the barriers underpinning the RE market. The barrier includes the inadequate policy; legal and regulatory framework; absence of capability and capacity building; lack of public awareness; amongst others, seen as limiting the development of the REM. Thus, it can be argued that the prevailing conditions associated with RE development in Nigeria could strongly limit the potential for OBRE development.

The next chapter presents the global context of OBRE development in order to appreciate its potential scope in relation to the study context.

CHAPTER THREE

Global Ocean Based Renewable Energy Development

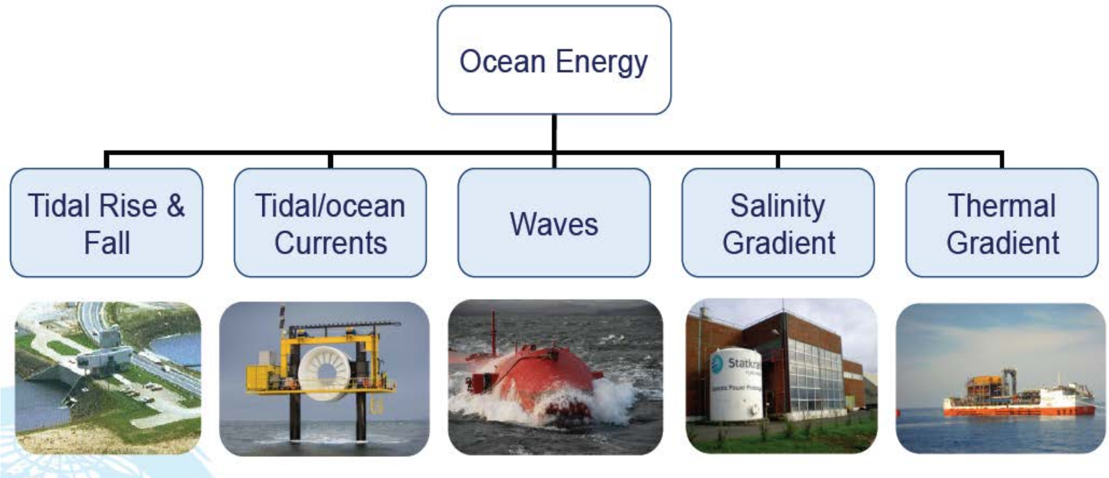
3.1 Introduction

This Chapter critically reviews the literature on OBRE as well as provides some key applicable concepts in relation to OBRE global developmental activities, in particular barriers surrounding its development. The chapter concludes with a discussion of its market applicability towards electricity generation and non-electricity use, prompting the scope for OBRE development in Nigeria.

3.2 Ocean based renewable energy – its nature and concepts

Fundamental to addressing the concerns related to contemporary energy challenges as discussed in the previous chapter is the potential transition towards renewable energy. Renewable energy is potentially seen as one of the key catalysts in achieving some degree of improving quality of life in three key ways (Karekezi and Majoro 2002; Verolme 2014). Firstly, given the rise of urbanisation, most African countries are rural and this context makes renewable energy sources appealing as they can provide cost-effective solutions to solve the issue of poor rural electrification (Deichman *et al.* 2010). Secondly, RE energy generation plays a catalytic role in the development of decentralised energy systems, particularly in rural and off-grid areas of developing nations. For instance, Balachandra *et al.* (2010) pointed out that renewable energy sources are well suited to inaccessible localities for electricity provisioning, especially for societies deprived by centralised electricity provisioning from conventional energy sources. Additionally, from an environmental standpoint, renewable energy is suggested to produce very low CO_2 emissions and tends to contribute significantly to curbing climate change compared to conventional energy sources (UNFCCC 2011; SDG 2015). While research on renewable energy has mostly focused on the development of solar, wind, and biomass sources (Pelc and Fujita 2002), proximity to the ocean environment may provide energy opportunities including electricity generation (Pelc and Fujita 2012; Hammar *et al* 2012; Kaldellis and Kapsali 2013). Many different types of broader ocean energy exist aside from OBRE (tidal current), including using wave, tidal range, ocean current, ocean thermal energy conversion (OTEC), and salinity gradient sources as presented in Figure 3-1.

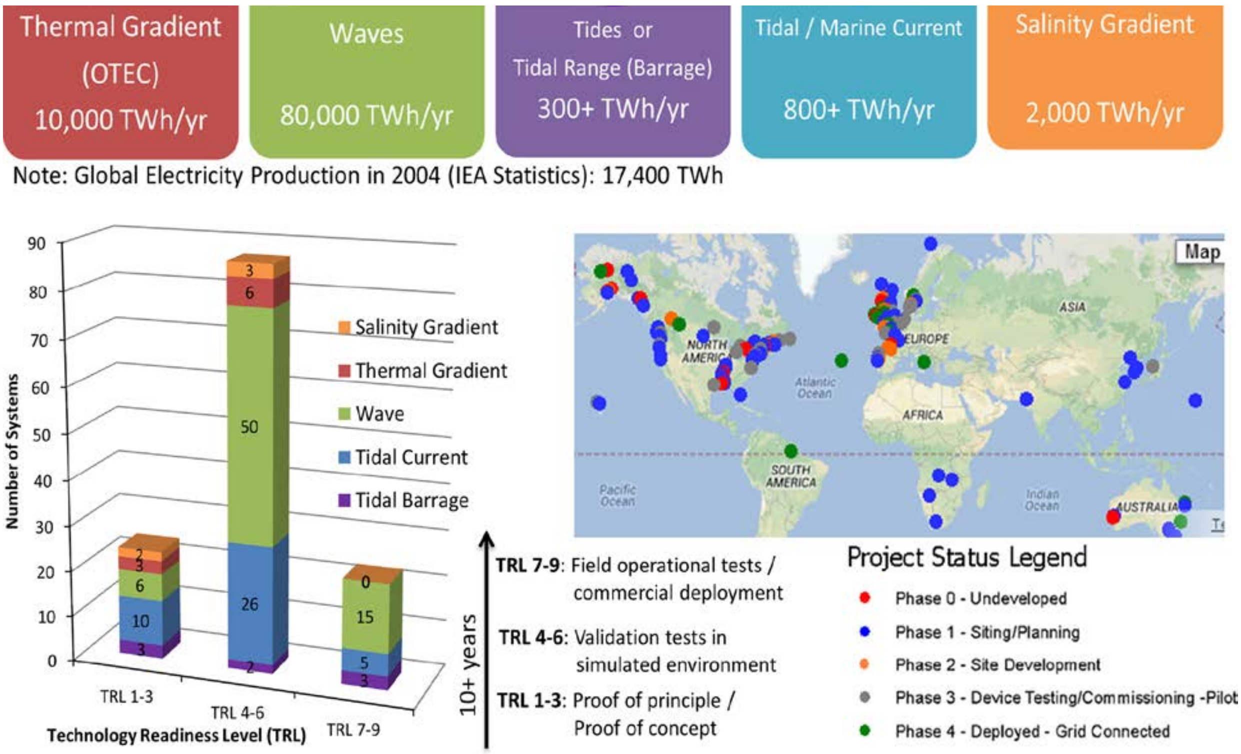
Figure 3-1: Broader ocean energy forms including OBRE (Tidal current)



Source: OES (2013)

These ocean energy forms have begun to emerge due to their large and combined theoretical resources, estimated to be in the range of 100,000–150,000 TWh/yr, with the largest resource potential from OTEC (Hammar 2014). Consequently, significant development within this field – that is the wider forms of ocean energy – is being undertaken in Europe, North American, South America, South East Asia and Africa regions (Falnes 2007; Esteban and Leary 2012; Bahaj 2012; OES 2013), taking opportunity of the theoretical resource potentials. Accordingly, activities of the broader spectrum of ocean energy, including OBRE in the different regions are presented in Figure 3-2.

Figure 3-2: Global status of the broader ocean energy forms



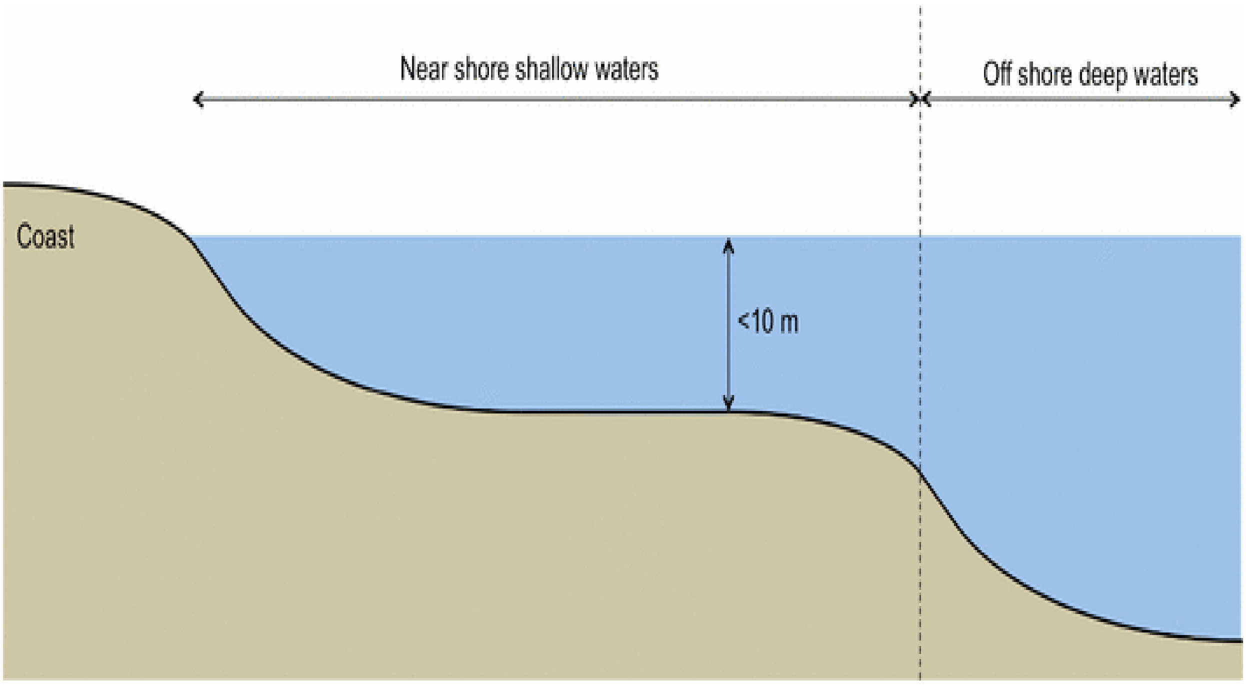
Source: Quirapas *et al*. (2014)

The figure indicates that the majority of the broader forms of OBRE are still in their nascent stages, i.e. siting and planning ohases of the process, with very few deployed projects but mostly in demonstration stages (Quirapas *et al*. 2014). This shows the emerging status of the ocean energy market, hence the increased focus for its development both in research and practice (OES 2013; Ernst and Young 2013). OBRE, as contextualized in this study as tidal current, captures energy through the process of hydrodynamics motion (Breeze 2014) resulting from local regular diurnal [24 hours] or semi-diurnal [12 hours] flow caused by the tidal cycle (Breeze 2014; OES 2011; Lewis *et al.* 2011). Tides course kinetic movement which can be accelerated near the coasts, where there is constraining topography, such as straits between islands and passes (Lewis *et al.* 2012; Robert *et al.* 2016). The movement of the water volumes, caused by these changing tides, creates the tidal current energy which can occur in fast moving waters including streams or oceans; provided there are constrictions such as straits (OES 2011). Thus, the flowing water (based on the volume and speed) creates the energy required to generate electricity (Vermaak, Kusakana and Koko 2014; Laws and Epps 2016). This makes tidal current useful for local communities that live close proximity to flowing waters, especially near shore shallow waters as presented in Figure 3-3.

Various developed and developing countries, regions and organisations have been involved in OBRE innovation working on a variety of ways of adapting the technologies to their environment for either large, medium or small-scales electricity generation (OES 2014; Kusakana and Vermaak 2013). The global installed capacity of OBRE has been put at 1.5MW (ACEP

2011). However, these installed capacities are all in their demonstration stage. For instance, in Northern Ireland a 1.2 MW tidal current technology called SeaGen, was demonstrated in Strangford Narrows in 2008. It is argued that the SeaGen is the world's first commercial scale OBRE that was developed by the Marine Current Turbines company with a flow of 2.4m/s (5 knots) (OES 2014; Ernst and Young 2013). OBRE are mostly being exploited in developed economies, with much of the activities in the European countries, including the UK (RenewableUK 2013; OES 2013).

Figure 3-3: Near shore water location for potential OBRE development

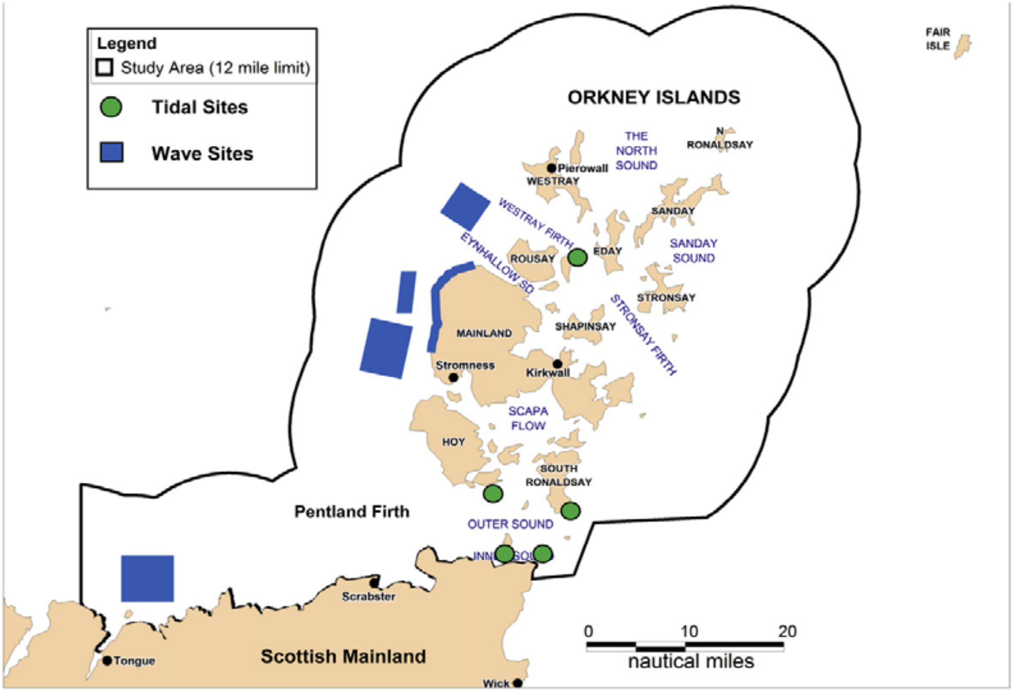


Source: Robert *et al*. (2016)

The current development trend of OBRE has seen many different types of promoting mechanisms beginning to emerge through various supporting statements in policy document; regulatory and institutional frameworks; and, developmental strategies/market support (Bahaj 2012; Falnes 2007;

Esteban and Leary 2012). These mechanisms, all operate to attract investment towards its development (Bahaj 2012; OES 2014). In terms of development capacity, the European countries as earlier mentioned appear to be the forerunner with the UK seen with more OBRE developmental activities. (Renewable UK 2013; OES 2013). For instance, taking the UK as an archetype of the OBRE market: the UK is seen as the vanguard of the industry due to the combinations of political support, significant resources and technical expertise (Renewable UK 2013; Renewable UK 2014). Furthermore, significant research studies have been embarked in the UK including: Bahaj 2012; Bryden *et al.* 2007; Dacre 2007; MacDonald 2012; Lovdai and Neumann 2011; and, Jeffrey *et al* 2013b, all in a bid to accelerate its development towards commercialization. Additionally, the majority of the OBRE developmental activities have been undertaken in Scottish Waters at Pentland Firth and Orkney Waters (PFOW) illustrated in Figure 3-4. Specifically, the circles in green depicts where OBRE (tidal current) is being developed.

Figure 3-4: PFOW – OBRE development areas



Source: Carbon Trust (2011).

A grid connected test centre for OBRE development is also located at the Pentland Firth (Carbon Trust 2011). Accordingly, operational activities, and testing or location centres have also been established in the UK. This includes EMEC in Scotland and Wavehub in South West England, as well as drive-train test facilities at the National Renewable Energy Centre (NaREC) in England. This is in line with the Marine Energy Action Plan and Scottish Marine Energy Roadmap, both emphasizing the significant function of a test facility in supporting the development of OBRE in the UK (Jeffrey *et al.* 2013b; Aquatera 2014). The test facilities are presented in Table 3-1.

Table 3-1: Test centres facilitating OBRE development in the UK

Test Centres	Functions
The European Marine Energy Centre (EMEC).	Opened in 2004 on the Orkney Islands in Scotland. Extensive research and full scale testing of both wave and OBRE devices is conducted in this centre.
Wave Hub.	Located in Cornwall, South West England, the centre's main objective is to provide an offshore facility for arrays of wave energy converters. The intention is that after single prototype devices have been tested at other facilities such as EMEC or Galway Bay, developers can test arrays at Wave Hub
New and Renewable Energy Centre.	Located in Blyth, Northeast England, and dedicated to accelerating the deployment and grid integration of renewable energy and low-carbon generation technologies using wind, wave, OBRE solar photovoltaic, and thermal power.

Source: Aquatera (2014)

The test centres are suggested to have played a significant role in accelerating OBRE technology development by: helping to reduce the costs of developing prototypes and providing the means to demonstrate the potentials of OBRE towards electricity generation. This has resulted in the increase of Hydro Electric Conversions (HECs) efficiency and reliability (Aquatera 2014). It has been suggested that the test centres may have contributed to the less design varieties observed with OBRE as most prototype designs are based on horizontal axis turbines (axial flow). Its being suggested also that 77% of companies' research seemed oriented towards the horizontal axis design (Corsatea 2014). Though, UK is not the only country that has test centres to facilitate OBRE development, other countries including the United States (Florida Atlantic University Center for Ocean Energy Technology), Canada (Fundy Ocean Research Centre for

Energy (FORCE) have also deployed some form of test centres to aid their OBRE development programme (Aquatera 2014; OES 2014). Knowledge development has also been fundamental in developing the industry, in form of capability and capacity building, which have been established in academic institutions and industrial centres such as the Industrial Doctoral Centre for Offshore Renewable Energy (IDCORE) in the UK. This institute is a doctoral training centre designed to specifically train professionals in the ocean energy development (Jeffrey et al. 2013a).

From a global perspective, other regions such as North America, especially in Canada, are suggested to be strongly involved in OBRE development activities (OES 2013) and have also put in place developmental programs (aimed at stimulating and promoting OBRE development) similar to that of the UK (Quirapas *et al.* 2014). For instance, the establishment of test centre in the US and Canada as earlier mentioned. Also, in Asia continent, resource characterization and formulation of supporting policies are ongoing (OES 2014) with some level of small-scale demonstration; particularly in Indonesia are being undertaken (Quirapas *et al.* 2014). For the African continent, studies on OBRE (tidal current) development have been conducted in areas such as in South Africa (Wikus 2013) and the West Indian Ocean region (Hammar *et al.* 2012). The study was based on the physical preconditions for broader ocean energy forms including OBRE development in the West Indian Ocean region comprising of 13 countries such as Tanzania, Mozambique, Kenya and Madagascar. In Hammar *et al.* (2012), a theoretical resource assessment was undertaken in order to elucidate the potential for OBRE resource with other forms such as tidal range, wave, offshore wind and OTEC in the region. From OBRE (tidal current) viewpoint, the findings from the results appeared to show a significant potential of tidal current in countries such as Kenya, Tanzania and Mozambique (Hammar *et al.* 2012). It is hypothesised that the assessment could instigate some form of political guidance for a possible transition towards OBRE development in those countries.

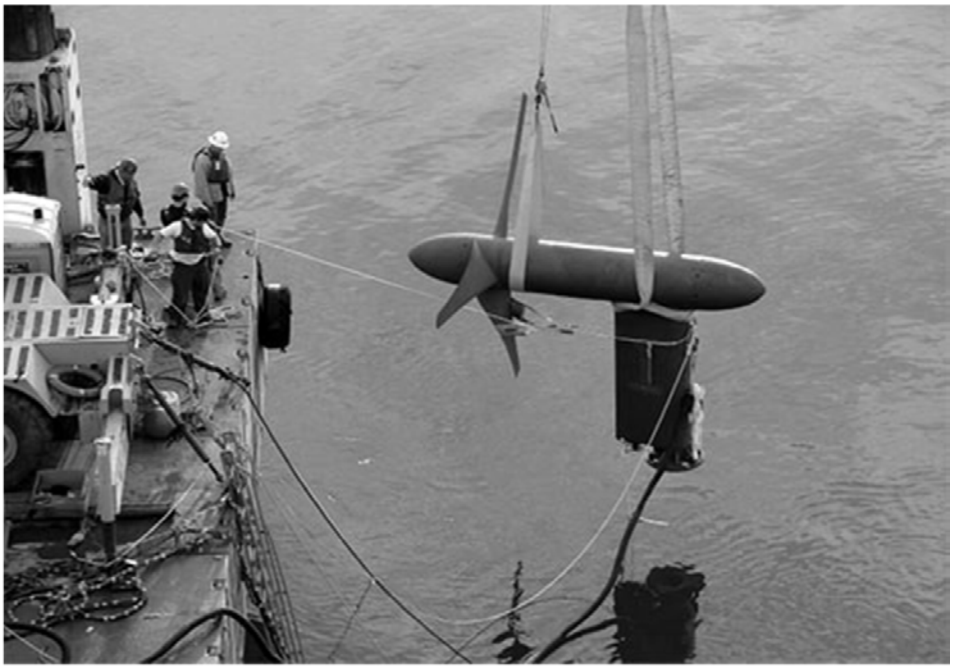
Furthermore, in order to increase global OBRE development processes, institutional settings and collaboration have also been formed. Such collaboration spans Regional settings as in European Ocean Energy Association (EU-OEA) and internationally, through the international Energy Agency's Ocean Energy System Implementing Agreement. In terms of collaboration, for instance, during an Ocean Energy System conference in Canada, November 2014, a joint consortia building workshop brought together Canada and the UK in a joint bid proposal towards facilitating a project called: '*In-Stream Tidal Energy: Advancing environmental monitoring, sensing, and instrumentation technologies in high flow marine environments'*. This suggests the growing interest for strategic collaboration as a potential requirement to facilitate the growth of OBRE development, globally.

Private investors have further fuelled the growth of OBRE industry especially with the growing number of multinational companies within the sector (Ernst and Young 2013). Since 2011, an increasing number of acquisitions have taken place in the OBRE field. For instance, Siemens AG has reinforced its participation in Marine Current Turbines Ltd by acquiring a 55% stake in the tidal stream technology section, in February 2012. In

March 2012, Andritz Hydro GmbH acquired a 22.1% stake in Hammerfest Strom AS, a Norway-based developer of marine current turbines. Several other private investment activities are ongoing within the sector with a view of actualising commercialisation by 2020 (Ernst and Young 2013).

In terms of technology development, a number of different technological concepts for OBRE have been proposed in recent years (Kolliatsas 2012; Vermaak, Kusakana and Koko 2014; Robert *et al.* 2016; Waters and Aggidis 2016). The major differences between the technology concepts lie in the method of securing the turbine in place, the number and orientation of blades and rotors, and how the pitch of the blades are controlled (Rourke et al. 2010; Laws and Epps 2016; Waters and Aggidis 2016). OBRE development are generally integrated for commercial purposes, hence are deployed in ‘arrays’ in order to achieve a significant combined energy output (similar to the offshore wind approach), mainly found in developed economies (Rourke *et al.* 2010; Robert *et al.* 2016). Deployment of single OBRE devices can also be used for commercial operations, depending on the installed electricity capacity. However, single devices are much used for small-scale purposes, which are meant for smaller scale use such as in remote rural areas (Guney and Kaygusuz 2010). OBRE devices are generally referred to as Hydro Electric Conversion (HEC) or Marine Hydro-kinetic (MHK) technologies in the form of a turbine as presented in Figure 3.5.

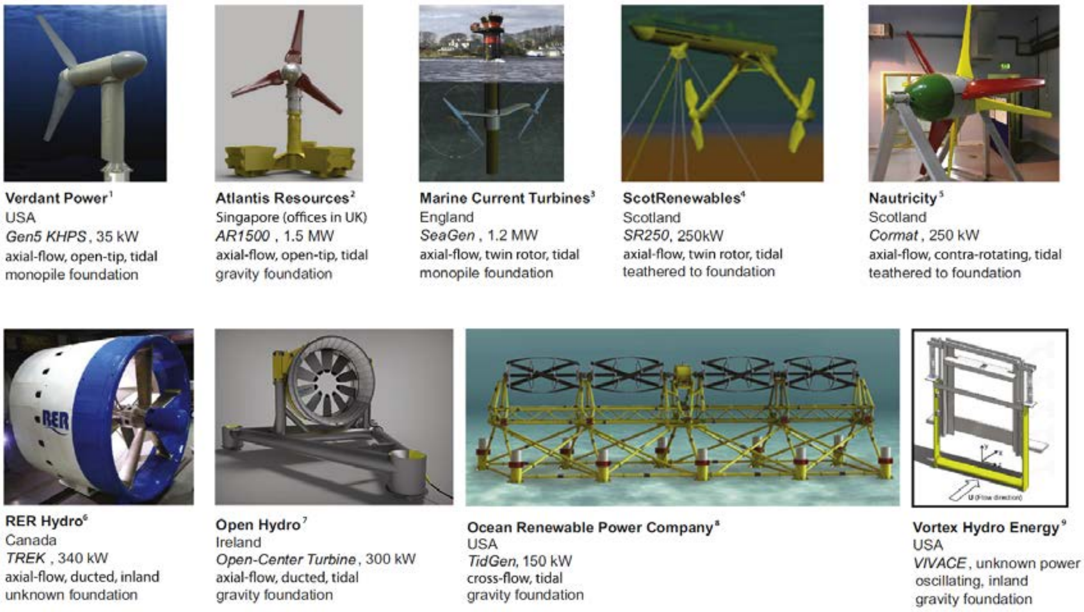
Figure 3-5: Hydroelectric conversion device [Turbine]



Source: Vermaak, Kusakana and Koko (2014)

These turbines arguably can be used for converting hydrokinetic into mechanical energy, which can drive an electric generator to produce electricity (Kumar and Singal 2015). Typically, turbines schemes can be grouped into the following categories: Horizontal axis turbines, Vertical axis turbines and Oscillating hydrofoils with the first two being the most popular design as detailed in Figure 3-6 (Laws and Epps 2016).

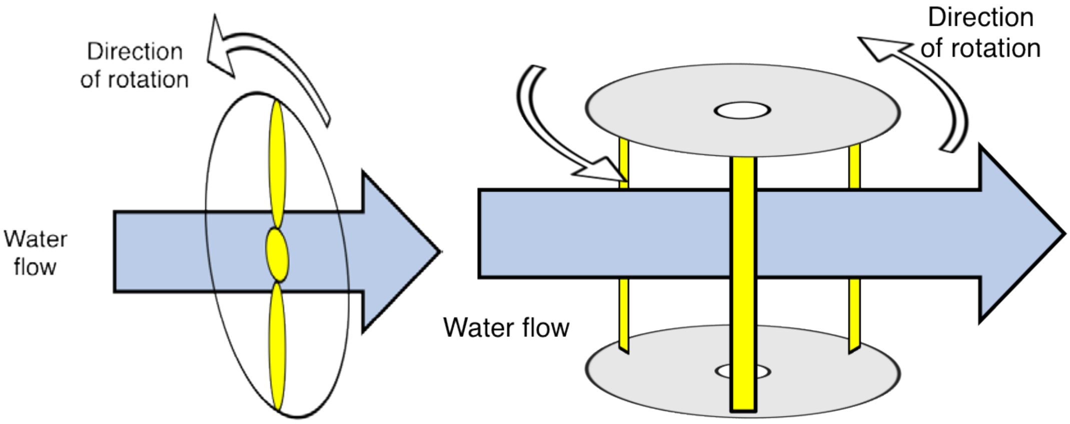
Figure 3-6: OBRE turbines technologies design



Source: Laws and Epps (2016)

Figure 3-6 presents some of the OBRE designs within the industry, which have been used for demonstration towards electricity generation purposes (Li *et al.* 2010). These turbines can be classified according to their rotor design as either axial-flow or cross-flow. Axial-flow turbine rotors sweep through a circular area of water by rotating about an axis that is parallel to the water flow direction. Cross flow turbine rotors sweeps through rectangular areas by rotating about an axis that is perpendicular to the water flow, flowing across each blade twice (Robert *et al.* 2016; Laws and Epps 2016; Lago *et al.* 2010, Lewis *et al.* 2012; Vermaak, Kusakana and Koko 2014). Both models as represented in Figure 3-7 can be designed and configured based on the nature of the resource to be exploited thereby lending itself to either small scale or large scale electricity generation application (Vermaak, Kusakana and Koko 2014; Robert *et al.* 2016).

Figure 3-7: OBRE turbine rotor types



(a) Axial-flow turbine. (b) Cross-flow turbine.

Source: Robert *et al.* (2016)

OBRE extract energy from a moving fluid consequently, they are somewhat analogous to wind turbines. However, there are major differences between the two technologies. The most immediately obvious are physical differences between the fluids; the density of seawater is approximately 1025 kg/m^3, compared with around 1.25 kg/m^3 for one atmosphere of air at room temperature, for offshore wind. According to literature (Kim et al. 2012; Li et al. 2010), the minimum velocity of water current required for electric power extraction is typically from 1.03 ms^{-1}, which depends on the efficiency of the OBRE technology utilized (OBRE HEC efficiency is put at 80%). OBRE technology improvement has made it possible to harness electricity from tidal current with speeds as low as 2 knots (1 m/s^{-1}) to 4.12 knots (2.06 ms^{-1}), while the best optimal velocity are in the range of 5.14 knots (2.57 ms^{-1}) to 7.2knots (3.6 ms^{-1}).

As a result, electric power from OBRE can be expressed as $\boldsymbol{P = 1/2\ C_P \rho v^3 A_s}$ where (Breeze 2014; Robert *et al*; 2016)*;*

P = Power to be generated

C_P = Power coefficient (how efficiently the HEC converts the energy in the water current into electricity.

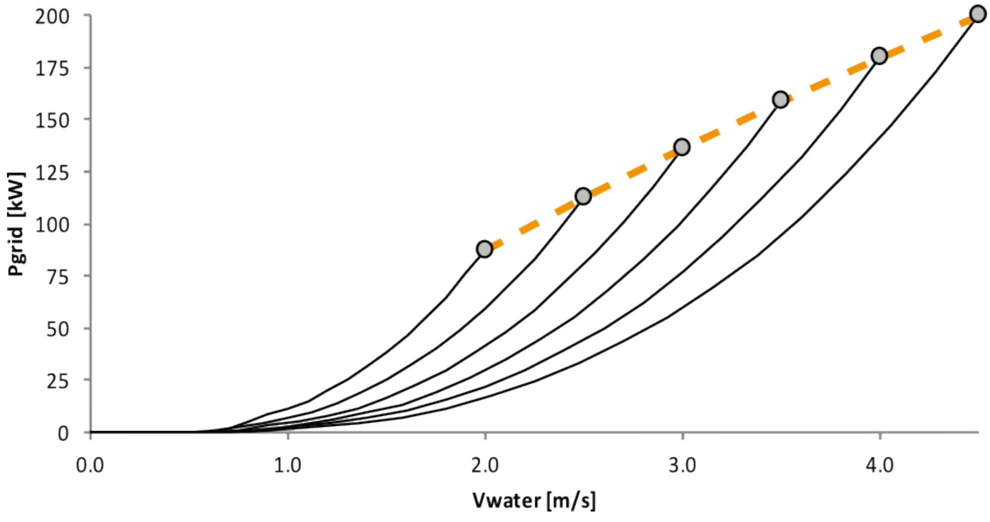
A = cross sectional of the stream/river/channel

ρ = density of water (1025 kg/m^3)

v^3 = average water current speed (m/s^{-1})

Thus, the available electricity of an OBRE technology is a function of the density of the moving water, the cross sectional area of the flowing water channel or the turbine rotor and the speed of the water or current. Accordingly, OBRE developers including Tocardo Tidal turbines in the Netherlands (Tocardo Tidal 2016) have simulated different current speed towards generating possible electricity power as presented in Figure 3-8.

Figure 3-8: Electricity power curve



Source: Tocardo (2016)

From the Figure, an instance of such simulation is observed in the power curve graph where different tidal current velocities can potentially generate electricity of 1 KW to 200 KW. This generation also depends on other dynamics such as, the design and configuration of the HECs and the site characterization – resource assessment (ADEME 2009; Smarthydro 2016).

HECs are characteristically installed following a defined design and development phase beginning with a site characterisation via a Resource Assessment (RA) program (Laws and Epps 2016; ADEME 2009). Usually, RA program are specific to a particular location or site presenting a clear idea of the energy distribution and resource potentials for any prospective electricity generation. It has been argued that the result of one OBRE site cannot be used to inform other potential sites for development. RA is underscored by the following four parameters as presented in Table 3-2 (Mark *et al.* 2010; Lewis *et al.* 2011).

Table 3-2: Resource assessment parameters

RA parameters	**Definition**
Theoretical potential	The theoretically extractable amount of energy at a certain geographical location.
Technical potential	The amount of energy that can be extracted by a practically feasible technology such as OBRE HEC, including the storage and supply infrastructure.
Exploitable potential	The part of the technical potential that meets the environmental, legislative and social constraints.
Economic viability potential	The part of the exploitable potential that is cost-effective as compared to other potential energy sources including fossil fuel and non-fossil fuel based.

Source: Author generated.

Thus, a resource assessment process typically acts an input to all other phases of OBRE development from system design through installation and finally to decommissioning (Laws and Epps 2016). However, prior to any RA activities, discussion and negotiations with national and local authorities in the territory of interest are undertaken towards obtaining planning and development consents for an assessment to be undertaken (DECC 2012; Bahaj 2012). Following the site characterization through RA, the HEC's performance, reliability and economics is studied through a process of modelling and optimisation. Overall, the anticipated performance of the characterisation, modelling and optimisation conditions the techno-economic viability of the OBRE development (ADEME 2009) with limited social consideration. A practical demonstration of the overall design phase is necessary to highlight the estimated production cost price (economic viability potential), which must be competitive to the current cost of fossil fuel and other forms of contending RE sources. A fundamental element within the whole development process is for the OBRE to be embedded into the social system, be it small or large-scale development type. This ensures OBRE's sustainability and viability beyond the technological design phase, that is ensuring that OBRE is accepted by the broader social system in which it is to be utilised (ADEME 2009).

Indeed, there is a need for the social system (comprising of the following characteristics: market, user preferences and competencies amongst others) to co-evolve with the techno-economics processes - characterisation, modelling and optimisation (Laws and Epps 2016). This co-evolving process is argued to take certain time (transition phase) but should involve concrete as well as remote interactions between the technology device element of OBRE and the broader society system. It is expected from the co-evolution that a prospective adoption of the technology by the broader society system may result (Kemp and Rotmans 2005; Strachan *et al.* 2015). Accordingly, in Strachan *et al.* (2015), they pointed out that to understand energy transition – in this case, OBRE – one needs to explore the needs and requirement of social actors and not simply the technological element alone (Smith 2012).

Typically, absence of this co-evolution persistently presents key barriers to its development. For instance, with all the global developmental activities, no fully integrated OBRE power plants have yet been built at commercial scale, even in the UK (OES 2014; Quirapas *et al.* 2014). Though it is assumed that the SeaGen is the first commercialized OBRE device however, it is currently being decommissioned (Energytoday 2016). Put succinctly commercialisation is defined as:

> *"the creation of self-sustaining markets that thrive – without any kind of favour – in a level playing field with other competing technologies"* (Jacobsson and Bergek 2004).

This is however missing within the field of OBRE. Commercialisation is often suggested to involve considerable amount of innovation which has been regarded as a complex issue involving much more than a new idea (invention) to be realised, sometimes even the reconfiguration of the prevailing environment (Foxon 2007; Geels 2002). For instance and using UK as an example, Cortesa (2014) argued that knowledge creation and diffusion along with entrepreneurship experiments such as conferences, publications and test centres, have made critically less contributions for OBRE to surpass the pre-commercialisation stage of development. Specifically, Cortesa believed that early stage research in OBRE only allowed technology development rather than the co-evolution between the technologies and the wider socio-political settings. It may appear that in the latter stages of OBRE development that is, transition for market adoption is limited with significant suboptimal levels of acceptance due to certain barriers or persistent problems (Bahaj 2012; Renewable UK 2013; Jeffrey et al. 2013a). These are however, yet to be addressed systematically as Cortesa concludes that the major barriers associated to this sub-optimal level of acceptance are:

> *"the absence of coordinated plans and the poor connectivity between industry and decision-makers ..."* (Cortesa 2014 p.692)

This view appears consistent with Cowell et al. (2015) argument on the 'poor fit' of institutional governance towards RE development, in particular the UK. Additionally, Strachan *et al.* (2015) acknowledges the need for industry developers to work with the broader policy makers in order to create window of opportunities for sustainable form of energy development. Leete *et al.* (2013) also conducted an empirical study on the barriers associated with the OBRE sector on investors' opinion on why OBRE is yet to be commercialised. The predominant response from Leete *et al.* (2013) research study revealed investors' perceptions stating:

> *"... there is a push to try to commercialize too quickly at a large scale. It would be better to get smaller devices in the water and generating to provide a record of accomplishment of performance. "Investors wants to see a positive history of performance"* (Leete et al. 2013, p 871).

This argument seems in line with Kaplan (1999) as quoted:

> *"Commercialisation of new energy technologies using large-scale, large-investment promotion may be counterproductive and that greater success in innovation can be found through the sum total of smaller successes" (Kaplan 1999).*

Indeed, these arguments becomes a key factor to be considered perpetuating the limited development of OBRE, globally amongst other factors to be discussed in Section 3.3. The next section discusses some of the barriers associated with global OBRE development, as perceived in research studies. However, these barriers are mostly within the scope of developed economies OBRE activities such as in the UK, where it appears that significant exploitation towards OBRE development can be observed.

3.3 Barriers associated with OBRE development

Research studies on OBRE have suggested several barriers are associated with the OBRE industry. These include stakeholder perceptions and responses towards OBRE innovation; unavailability of grid infrastructure in areas of OBRE resources (Bahaj 2012); unstable enabling regulatory frameworks (Wright *et al.* 2016); perceived high capital cost/investment (Jeffrey *et al.* 2013a); and, unknown environmental impacts of the technology devices to deliver consents for development (Macgillivray *et al.* 2013; Macdonald 2012). IRENA (2014b) have also identified four key challenges: technical; socio-economic; environmental; and, infrastructural barriers. IRENA (2014b) have emphasized that these barriers may only be addressed through effective interactions amongst all pertinent stakeholders and the need to reconsider the scale of the HEC designs.

Magagna and Uihlein (2015) also pointed out that four main bottlenecks are currently limiting OBRE development: technology development; finance & markets; environmental & administrative issues; and, grid availability. However, they also suggest that at present, technological barriers appear to represent the most important issue that the sector needs to address in the short–medium term. They went on to argue that overcoming the technology issues is fundamental towards identifying solutions to the other perceived barriers including financial and market barriers as discussed further in the next Sections.

3.3.1 Technical barriers

Despite recent progress in OBRE development, it has been repeatedly argued that no OBRE HECs has so far achieved the level of technological readiness required to be competitive with other RETs or sufficient to ensure commercialisation of the technology. One of the key concern is the reliability and the performances of these devices, which are supposedly designed to operate in demanding aquatic environments. It has been suggested that only few OBRE devices such as the Sea-Gen have proven extensive operational records. In light of this argument on technical barriers, Robert *et al.* (2016) has proposed that this concern could be addressed if little consideration is given to exploring the potential of smaller scale OBRE power. Their point is that small devices would by definition be cheaper to build and install than their larger counterparts (Bryden *et al.* 1998), and devices in near-shore shallow waters would be more accessible, allowing easier installation and maintenance.

3.3.2 Finance and market

The unproven status of the HECs combined with the high costs associated with OBRE technologies for large-scale development appears to have also hindered investors' confidence in the sector (Leete *et al.* 2013). It has been suggested that more than fifty percent (50%) of global Research Development & Demonstration (RD&D) investments are in the EU, with half coming from industry and about a fifth from EU funds (Magagna and Uihlein 2015; Jeffrey et al 2013b). Seventy percent (70%) of EU R&D funding were being dedicated to technology R&D where OBRE, alone attracted forty-two (42%) of corporate investments (Corsatea and Magagna 2013). According to Badcock-Broe (2014), securing investment for demonstration and pilot arrays remains one of the main challenges in the sector, mainly due to the large-scale developmental projects, particularly seen in most developed economies including the UK. This may appear consistent to Robert *et al.* (2016) arguing for a re-focus towards small-scale OBRE development.

3.3.3 Environmental and administrative issues

The nascent status of the OBRE sector yields a number of unknowns/uncertainty about the potential environmental impact that the HECs may have on the surrounding ecology. The uncertainties in identifying and mitigating ecological and socio-economic impacts constitute some of the environmental barriers to its development. However, it has been suggested that OBRE devices have very low ecological impact (Guney and Kaygusuz 2010; Kusakana & Vermaak 2014), it is argued that developers still face stringent and costly monitoring requirements, particularly in relation with the size of the project (DECC 2011). Additionally, OBRE deployments could further experience significant delays and opposition from local communities within the environment of development if they are not correctly engaged. According to ADEME (2009), OBRE technologies must show that they can be optimally integrated into the environment of their natural surroundings and can even benefit local, regional and national socio-economies.

That is, OBRE development must consider certain environmental drawbacks that will need to be overcome if they are to be adopted within the receiving environment; hence, landscape planning becomes pivotal in this instance. According to Robert *et al.* (2016), they pointed out that:

> *"HECs devices in shallow waters will pose more of a navigational hazard to commercial and recreational marine traffic and, positioned close to shore, they may also impact water users such as swimmers, and be more visible on land, potentially leading back to issues with NIMBYism"* (Robert et al. 2016).

Building on the environmental drawbacks, attempts to address environmental concerns within the broader offshore renewable energy development projects was observed in the Risk Based Consenting For Offshore Renewables (RICORE) project, which ran between January 1st 2015 to June 30th 2016 (ricore-project.eu 2016). The project aimed at establishing:

> *"a risk-based approach to consenting where the level of survey requirement on the environmental sensitivity of a development site, the risk profile of the technology and the scale of the proposed project"* (ricore-project.eu 2016).

The project aimed to reduce the time and cost involved in consenting arrays including reducing the amount of survey data required prior to the deployment of relatively small arrays, of known technology in areas of low environmental sensitivity (ricore-project.eu 2016). Three key activities towards achieving the set aim of the RICORE project were undertaken:

- To understand what happens in different Member States regarding the consenting process of legislation and any legal barriers to the application of risk based approach;
- To examine the potential for developing and using risk profiles in different partner countries;
- To build the case for more standardization in post deployment environmental impact monitoring to allow developers, scientists and regulators to better understand the environmental effects of different devices.

Here again, the research study perceives the European bias towards technology innovation where limited attention to other potential market - such as in the developing economies – through wider scope for information dissemination in interactive arenas (such as OES) is being ignored.

From an administrative perspective, procedures to obtain full consent are often lengthy, delaying the project development, specifically in the EU countries where there is a lack of uniform procedures about licensing and consenting for OBRE development (Macdonald *et al.* 2012). However, this non-technological obstacle recurs across several renewable energy supply chains, globally. An important underlying element within the administrative process is the focus on legal and regulatory element for OBRE development. Legal and regulatory issues are continually cited as a major non-technical barrier to the development of OBRE (Wright *et al.* 2016). The International Network for Social Studies in Marine Energy (ISSMER) confines legal issues to 'dealing with uncertainty and planning processes'. While undeniably important, Wright *et al.* (2016) has also suggested that they only form part of a much broader and complex legal situation for any ocean energy issues including OBRE. This complex legal situation includes: policy environmental governance; patterns of resource use; conservation values and distribution of ownership rights are considered to be within the legal frame of issues to affect OBRE development, and as such are part of the administrative concerns associated with its development (Wright *et al.* 2016).

3.3.4 Grid availability

One of the raising concerns for OBRE development is the availability of grid in the proximity of proposed projects. Often, it has been suggested that remote areas lack suitable grid infrastructure or even total absence as in the case of developing economies like Nigeria. Therefore, OBRE development will require either network upgrades or the construction of new network gridlines, whose costs may fall on the developers (ARE 2013). However, grid issues may not be critical in all OBRE markets. For instance, countries within the European region such as France, Portugal, Spain and the Netherlands may have an advantage in developing ocean energy projects since grid infrastructure is available and close to ocean energy resources along their coasts. This may not be the case in many developing economies such as the West Africa sub-region like Nigeria. Hence, grid availability becomes part of the barriers associated with OBRE if grid-enabled OBRE design is being favoured against decentralized mode of energy delivery, often termed as the hard path of energy development (Strachan *et al.* 2015).

Taken together all the various barriers, Lovdai and Neumann (2011) have argued that of all these barriers, the need for supportive political schemes to attract investment within the sector and funding to implement the investments are the two main barriers confronting the uptake of OBRE. It can also be argued that a significant and persistent problem emanating from literature (drawing on section 3.3.2 and 3.3.3) is the attention to large-scale technology development. It is fair to argue that this has actually led to a failure to develop commercially competitive and cost-effective systems that should attract investment at a purely business level, rather than be a spotlight for research grants as observed in Section 3.3.2. This has necessarily ignored the potential of smaller sites such as developing economies, which requires smaller kilowatt systems serving as a potential 'niche' market for developers/investors.

To further assess the argument above on the barriers associated with OBRE development; this research undertook an empirical pilot study to further determine the perception from key industrial actors on the main barriers associated with global OBRE development. This is presented in Section 6.3.2.2.

3.4. Market applications for OBRE innovation

Three key market applications for OBRE have been identified: centralised (grid-connected electricity), decentralised (off-grid electricity for remote communities) and other socio-economic uses (desalination, aquaculture, and irrigation) (Aquatera 2014; OES 2013; Lewis *et al.* 2011; Kusakana and Vermaak 2013). Accordingly, this study categorizes the application into electricity and non-electricity market applications and discusses them further.

3.4.1 Grid-connected electricity – centralised

The expected dominant market for OBRE HECs is its application in the electricity generation market due to its primary market being situated in developed economies. Grid-connected electricity generation is suggested as the key delivery mode especially for utility-scale OBRE technologies (ADEME 2009; RenewableUK 2014; OES 2014). This argument is evidenced from the global practice towards OBRE development especially in the European and North America regions (RenewableUK 2013; Marine Renewable Canada 2013) as earlier discussed in Section 3.2. Additionally, increasing demand for low-carbon renewable electricity is supporting the use of OBRE for electricity generation as legal obligations to meet carbon reduction targets through RE sources including from OBRE (Renewable UK 2014).

3.4.2 Off-grid electricity - decentralised

Off-grid energy systems with their ‘lean’ infrastructure and proximity of generation to demand sites are seen as a potential and ideal platform for OBRE application in remote areas where centralized electricity systems are not economically viable (Wiemann, Rolland and Giania 2011; Kirubi *et al.* 2008). For instance, current means of extending access to electricity in the developing economies is via centralised generation, often seen as a precondition for development and paving the way for socio-economic growth and human development (Kirubi *et al.* 2008). This energy development path (hard path) took no account of its appropriateness towards certain constraints such as a dispersed population and difficult terrain (Kirubi et al. 2009; Wiemann, Rolland and Giania 2011) in these areas such as coastal communities. Dealing with issues such as lack of access to this difficult terrain (such as the coastal locations and high mountainous areas) have resulted in high capital outlay and increased operating costs, if centralised grid is utilised (Kirubi *et al.* 2008). Indeed, this remains an uphill task in some of the developing nations, including in Nigeria. Hence, a shift towards more decentralised systems of electricity generation and distribution may afford a logical solution to improving electricity delivery in those areas. In this case, OBRE becomes a potential energy source for such initiative.

Research has established that OBRE could be designed and implemented for decentralized electricity generation solution particularly for coastal communities (Robert *et al.* 2016; Bryden *et al.* 1998; Kusakana and Vermaak 2013, Ladokun, Ajao and Sule 2013). One major reason for this prospect is that OBRE conversion systems can be designed to accommodate electric power, ranging from 1kW to 500kW, making it suited for small-scale decentralized electricity generation system (Kusakana & Vermaak 2014; Robert *et al.* 2016). A key reason for this is that limited load growth associated with smaller communities within the rural/remote areas are more adaptable to decentralized electricity configuration, especially in developing economies (Wiemann *et al.* 2011; Kusakana and Vermaak 2014).

3.4.3 Non-electrical market application

OBRE may also serve other uses apart from electrical application. These include fabricated irrigation for agricultural purposes, desalination for drinking water and in the area of aquaculture – fish farming. There are many coastal markets for such applications including in the West Africa, South East Asia and South America regions. For instance, in Chile, where several coastal industries are found, mechanical power generated from OBRE devices is being considered for large and small salmon farming (Aquatera 2014).

Generally, many routes appear to be possible for converting OBRE sources into energy services for both electrical and non-electrical options, however such choice of conversion route fundamentally depends on the nature of the resource exploitation measurement, the demanded energy requirement within the applicable society and perhaps, most importantly, the national priorities of key stakeholders towards a selected energy development path (hard or soft energy development path).

3.5 Concluding summary

This chapter introduced the nature and context of OBRE, from a global perspective. Thus, it presented the baseline information of its development with reference to technology devices, development characteristics and processes and barriers associated with its development. The Chapter identified the UK (particularly in Scotland), as the forerunner of the industry with developments in other regions including Africa. However, the bulk of OBRE research and development appears to be naturally focused on developing larger scale schemes and devices in a bid to harness the greatest resources (Robert *et al.* 2016). This indicates the rationale for its predominant development within developed economies, for instance in the Pentland Firth off the northeast coast of Scotland and Bay of Fundy in Canada (Jeffrey *et al.* 2013a; Renewable Canada 2013). Therefore, it is fair to say that relatively little consideration has been given to exploring the potential of smaller scale OBRE, especially in the developing economies including Nigeria.

Additionally, OBRE's market applicability as identified in this Chapter is suited for both electricity (grid based and off-grid based) and non-electricity market. However, barriers hindering its global development included technical, finance, market and administrative factors.

Overall, this Chapter has helped towards informing the energy transition path for OBRE development in Nigeria. That is, knowledge of the global OBRE development elements will help towards understanding how Nigeria can effectively integrate OBRE into its renewable energy developmental strategy.

The next chapter presents OBRE development and the potential state in which OBRE can be applied in Nigeria, towards renewable electricity generation.

CHAPTER FOUR

Ocean Based Renewable Energy development in Nigeria

4.1 Introduction

This Chapter presents literature on activities linked to the potential transition towards OBRE development in Nigeria. Included in this chapter is also a brief examination of two other forms of the broader ocean energy that were initially investigated. This includes OTEC and tidal range, further underpinning the justification to evaluate the prospects for OBRE electricity generation. The Chapter further gives an overview of the hydrological landscape that is enabling this prospect, along with experimental work towards OBRE development. Finally, the chapter then examines the potential market for its application in Nigeria.

4.2 Broader ocean energy development in Nigeria

Ocean energy development in Nigeria was anticipated to commence in 2007 as indicated in the REMP document (ECN 2005) following policy statement:

> *"power from the coastal region, especially from the ocean ought to be part of the long-term energy vision for the country"* (ECN 2005, p9).

It was on this basis that the REMP document provided the development agenda for ocean energy development including OBRE. The agenda highlighted a short (2006 – 2008), mid (2008 – 2015) and long (2016 –

2020) term developmental program (ECN 2005). For instance in the short-term plan, the following activities with their estimated cost were to be undertaken, as illustrated in Table 4-1.

Table 4-1: Short-term developmental agenda

Activity Area	**Project**	**Description of Activities**	**Year**	**Estimated Cost (₦'m)**
R&D centres	Ocean energy R&D centres	Identification of appropriate R&D centres	2006	₦5million (£17, 250)
Proposal development	Ocean energy R&D centres	Development of proposal for Ocean R&D by identified research centres and Energy Commission of Nigeria	2006	₦2million (£6,900)
Appropriation	Ocean energy R&D centres	Inclusion of R&D developmental programme in 2007 appropriation bill	2006	Not applicable
Project Budget line	Ocean energy R&D centres	Budget line for R&D developmental programme	2007	Not applicable
Research commencement	Ocean energy R&D centres	Commencement of Ocean R&D research	2007	₦10 million (£34, 500)
Total Cost for agenda	**Ocean energy R&D centres**			**₦17million (£58,650)**

Source: ECN (2005)

However, up until now, none of the agenda have been implemented or further developed. Moreover, the current RE policy, NREEEP failed to build upon the REMP 2005, though it also indicated that OBRE source is amongst the focused RE to be exploited in relation to electricity generation. The NREEEP asserted this:

> *"relevant agencies are encouraged to ensure data and information relating to OBRE resources are obtained through research and development programs with a view to immediately commence using this resource to provide electricity supply..."* (FMOP 2015a p.17)

Furthermore, according to Ocean Energy System (OES), a draft policy roadmap is being suggested with the intention of setting up a capacity-building centre called Centre for Ocean Renewable Energy Resources – CORER. However, contrary to the argument made by OES (2013), no form of supporting statements on OBRE development has been sighted or made public by the Federal Government representative on marine and ocean matters – Nigeria Institute of Oceanography and Marine Research (NIOMR), as at the time this research study was being conducted. OES assertion herein is not being disputed as information regarding national plans/strategies towards ocean energy development are suggested to be occasionally sent through by national representatives' to the OES council for publication, in this case, for Nigeria, it falls on NORM.

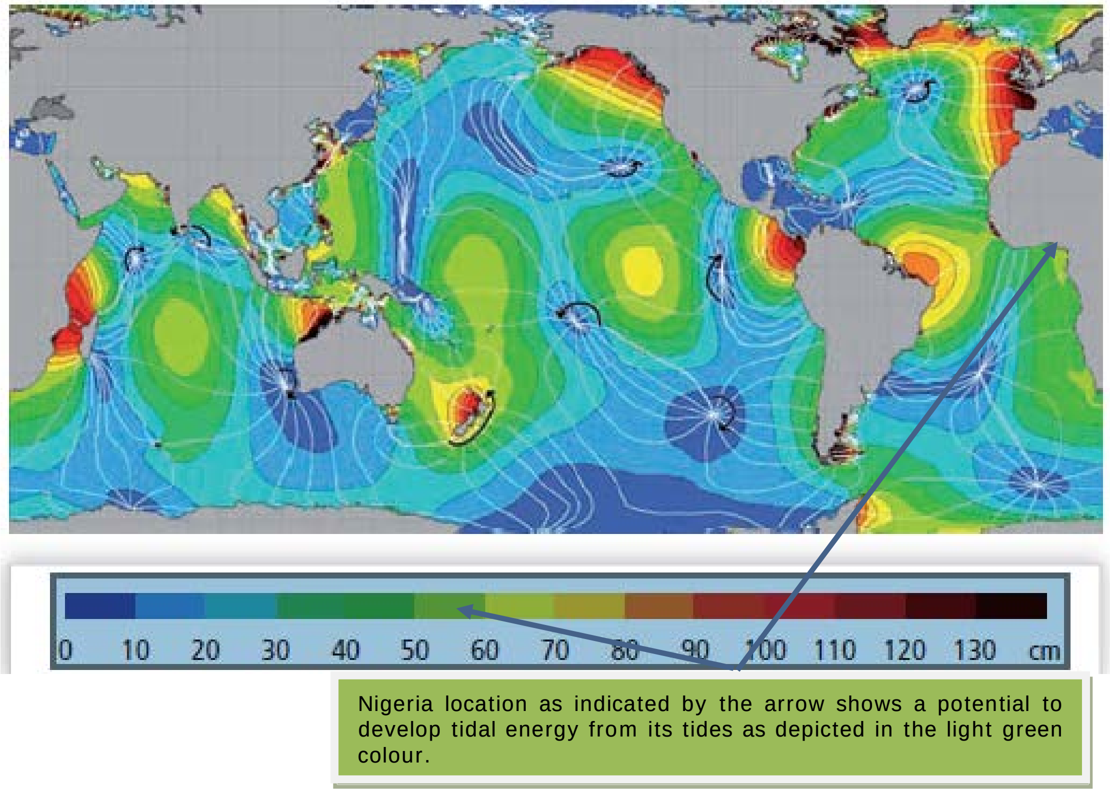
In practice, most research studies on RE in Nigeria are being conducted on land-based landscapes. Notable among these are the work of Udoakah and Umoh (2014) on meeting the energy needs of Nigeria using RE and the work of Shaaban and Petinrin (2014) on tapping of renewable energy potential for development of useful and stable electric energy supply. Other studies include Ayodele and Ogunjuyigbe (2015) on the utilization of solar energy as a renewable energy option, and Abila (2014) on the potential of bioenergy resources for power generation. Additionally, various work on wind energy potentials in different parts of Nigeria have also being undertaken (Ohunakin and Akinnawonu 2012; Adaramola *et al.* 2011). The closest study to OBRE development in Nigeria from the context of offshore-based renewable energy development is the offshore wind studies. For instance, Oluleye and Ogungbenro (2011) conducted an investigation on the suitability of two coastal stations – Lagos and Calabar - in Nigeria for offshore wind energy generation. Thus, very little study on OBRE has been done in Nigeria, though evidence from literature studies on the broader ocean energy forms including OTEC (OES 2013) and tidal range (Ukwuaba 2012) suggests some form of theoretical resource assessment have been conducted. The research reflects on these two ocean energy forms briefly - OTEC and tidal range before turning its attention to the study's focus (OBRE).

According to OES (2013), Nigeria, through NIOMR, may have undertaken an OTEC research through a feasibility study that explored the suitability of harnessing OTEC within the marine space of Nigerian's Continental shelf. OTEC typifies a technology innovation that uses the temperature difference between near-tropical surface seawater by converting the difference in temperature between the surface and deep layers of the ocean into electrical power. Thus, tropical waters found in coastal countries such as in the West Africa sub-regions may have the right conditions for its deployment, including Nigeria. However, the extent of OTEC's study in Nigeria remains very indistinct as a further review of NIOMR's website: http://www.niomr.gov.ng/, showed the absence of any OTEC data/activities relating to OES's assertion.

On the other hand, in 1983, the United Nation Environmental Protection (UNEP) assessed the tidal range potential in the West Africa sub-region. UNEP (1983) claimed that favorable tidal range resources especially within the Niger Delta region of Nigeria existed. The principle behind tidal range is to trap a fraction of the tide and keep it out of phase with the natural tide, hereby creating a difference in water level (head) between the enclosed water and the sea. Then, the water levels are allowed to even out by passing through low head turbines thereby generating electricity (Hammar *et al*. 2012). Perhaps, building upon UNEP's investigation, the Petroleum Training Institute (PTI) undertook an investigation on the applicability of tidal range towards generating electricity for the coastal region of the Bonny estuaries (Ukwuaba 2012). PTI postulated that the potential for tidal range to generate electricity in Nigeria is reasonably feasible with an average of 6.9 MW, possible over a period of three years. Global tidal energy resource map (OES 2013) suggests a relatively good potential for Nigeria as illustrated in Figure 4-1.

Thus, countries such as Nigeria, have THE potential to generate some level of tidal energy for mini electricity generation as small barrage designs. This may imply easier construction work and a less severe manipulation of the natural tidal regime (Clark 2007; Wang *et al.* 2011). Conventionally it is been assumed that a mean tidal range of at least 5m is necessary for tidal barrages to be economically viable (Rourke *et al.* 2010; Jefferey *et al.* 2013b) which may then, not suit Nigeria's terrain.

Figure 4-1: Global tidal energy resource – Nigeria's potential

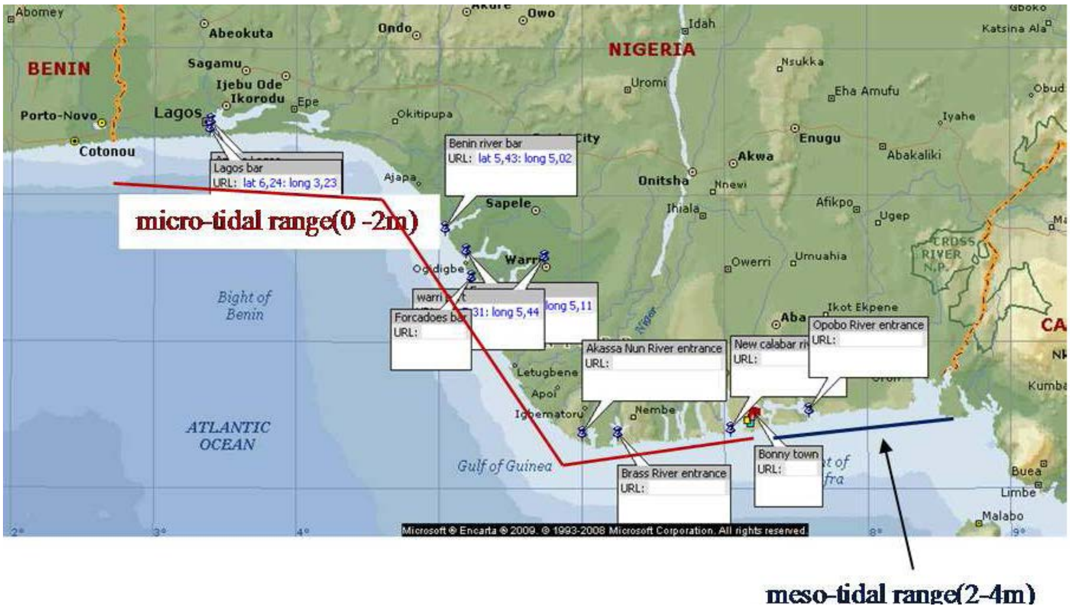


Source: OES (2013)

Nonetheless, the Russian Kislaya and Chinese Baishakou tidal barrage power plants have been operating in 2.4m mean range for many more decades (Rourke et al. 2010; Waters and Aggidis 2016). Figure 4-2 presents details of Nigeria's tidal energy in the form of micro-tidal range (0-2m) from Lagos to Bonny, and the meso-tidal range (2-4m) from East of Bonny to Nigeria/Cameroun coastal boundary.

Furthermore, modern low-head turbines, with high efficiency even below 2m head, can be used for tidal range in relatively low tides and this has actually been overlooked by ocean energy analysts (Johnstone et al. 2013; Waters andAggidis 2016; Khan et al. 2017) and can be explored for development in developing economies having moderate tidal range potentials as seen in Nigeria.

Figure 4-2: Tidal range resource in the Bonny estuary region of the Niger Delta



Source: Ojinnaka (2006)

From the review above, it is fair to explore research on OBRE (tidal current), as the claimed activity on OTEC along with the tidal range (which underpins tidal current formation), investigation by PTI may suggest some level of certainty that indeed, Nigeria could have a good prospect for ocean energy development, including OBRE form. The next section now discusses the hydrological settings enabling the exploration of OBRE. The section also includes the experimental work undertaken on its development.

4.3 Nigeria's hydrological setting as resource for OBRE development

Nigeria is located in the tropical zone of West Africa between latitudes 4°N and 14°N and longitudes 2°2'E and 14°30'E with a close network of significant hydrological settings including sea and ocean resource, offering multiple cases and sites for different ocean energy forms including OBRE (BIPA 2014; Ladokun, Ajao and Sule 2013; Asiegbu 2014). The hydrological patterns of the water shed in Nigeria are argued to be in three forms (Zarma 2006; Ladokun, Ajao and Sule 2013).

The first consists of short, relatively swift waterways and estuaries (for instance Bonny estuaries) which are found mainly in the coastal region of the Niger delta, flowing directly into the Atlantic Ocean. The second category are mainly of the middle-belt plateau and north which usually have one main peak flood and a flow pattern corresponding to the single maximum rainfall season common in the northern part of the country. The third hydrological pattern is found in the catchments of the Rivers Niger and Benue. This pattern is observed to be long watercourses, each with several tributaries, with complex flow pattern of two floods (the white and black flood) whose characteristics are dependent on rainfall outside Nigeria (Ladokun, Ajao and Sule 2013). However, the hydrological pattern being considered in relation to this research is the first form that typically flows directly into the Atlantic Ocean and is argued to be mainly found in coastal communities of the Niger delta region, where Asiegbu (2014) undertook OBRE investigation.

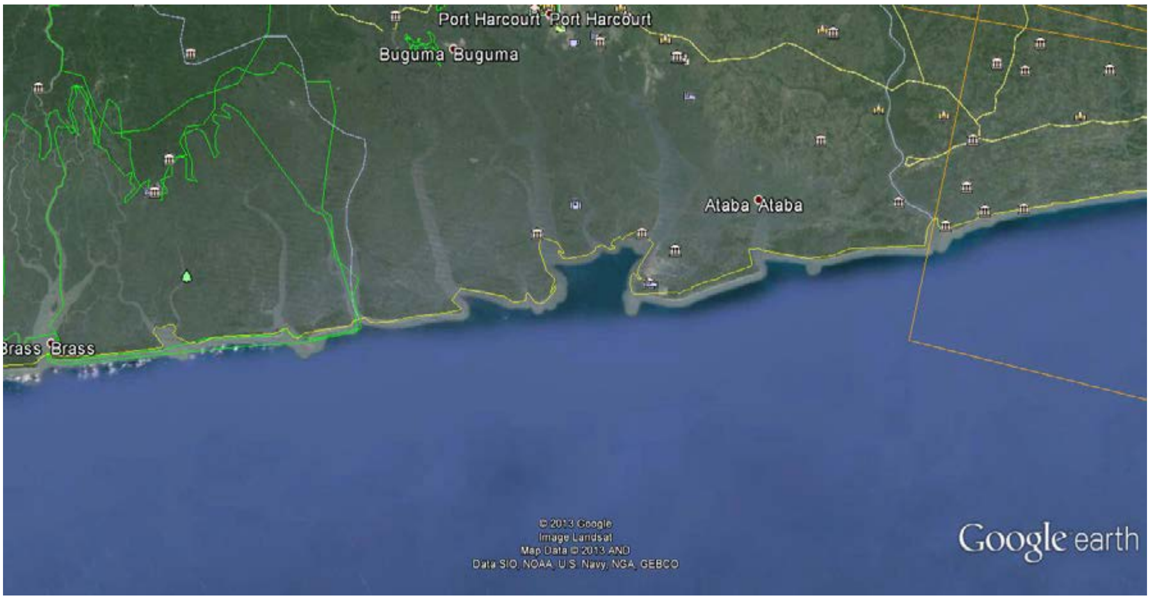
4.3.1 OBRE investigation in Nigeria

Asiegbu (2014) studied the potential for renewable electricity generation in Bonny, Andoni, Okrika and Opobo/ Nkoro Local Government Areas as shown in Figure 4-3, through the design of a hybrid conversion system from the different ocean energy forms including OBRE. Her study entailed achieving the following set of objectives:

1. Performing resource assessment within the Bonny coastal estuary in Niger Delta region;
2. Selecting the most suitable form of HEC systems towards electricity generation of 500MW with supply steady mean (average) of about 128.4MW; and,
3. Undertaking a techno-economic analysis of the OBRE HEC and comparing it with the cost of grid power supplies.

Asiegbu's study revealed that the Bonny estuaries appears to be feasible for OBRE electricity generation as the water currents had a maximum flow speed of more than 4 knots ($2 m/s^{-1}$) thus, having a practical applicability for development (Kim *et al.* 2012; Li *et al*. 2010).

Figure 4-3: Diagram depicting Bonny coastal estuary in Nigeria



Source: Asiegbu (2014)

The result also showed that OBRE can be used to supply electricity based on the proposed steady mean power of 128.4 MW and that the potential cost of the generated electricity was put at the rate of ₦17/kWh (0.03£/kwh)[2]. This is perceived to be cheaper than the average cost of electricity in Nigeria which is currently at ₦24/kWh (0.05£/kWh), after subsidies have been applied (NERC 2014). Therefore, it is fair to suggest that there exist the scope for OBRE in Nigeria based on Asiegbu's techno-economic analysis.

However, Ladokun *et al.* (2013), in their investigation of hydrokinetic HECs application for Nigeria highlighted the significant challenges OBRE could

[2] Conversion rate utilised is a pound is equivalent to four hundred and fifty Naira [£1 = ₦450]

face in the event of its development in Nigeria. They argued that barriers including inadequate research and development, lack of awareness creation and lack of policy and regulatory framework could potentially hinder its development. These barriers appear to be consistent with earlier barriers associated to RE development mentioned in section 2.7. They also suggested that activities including comprehensive national resource assessment should be carried out to determine areas where OBRE could be developed and government with other relevant agencies should promote policy, plans and incentives towards investing into OBRE technologies in key coastal markets.

The next section discusses the coastal market where OBRE can be developed towards electricity generation.

4.4 Potential market for OBRE development in Nigeria

It has been suggested that the first important niche market for OBRE will be in the coastal communities', where energy cost, especially in electricity are high and incentives for self-subsistence could be relatively strong (Bryden 2010; Hammar et al. 2012). The Niger Delta region of Nigeria is situated at the coastal region of Nigeria comprising mainly of the following states: Abia, Akwa Ibom, Bayelsa, Cross-River, Delta Edo, Imo, Ondo and River states (National Planning Commission 2009). The region occupies a total land area of about 112 square kilometers with just about 7% of land mass, with majority being wetlands covering 70,000sqm (Beluga 2006; Etekpe 2009; Nseabasi 2010). The region has an estimated population of about 45million people representing 24% of Nigeria's total population with more than 200 different dialects being spoken (NBS 2012). The population density is among the highest in the world, with 265 people per square kilometre, according to the Niger Delta Development Commission (NDDC 2015). However, lower population densities in remote riverine communities are observed in States such as Bayelsa State as illustrated in Figure 2-6.

The Niger delta is perceived to have abundance of human and physical resources, including the majority of Nigeria's oil and gas deposits, specifically in Bayelsa, Delta and River states (Ebegbulem *et al.* 2013; Nwankwo 2015). The region is argued to contribute over 80% of Nigeria's gross domestic products (GDP) and over 85% of the National budget (Ebegbulem *et al.* 2013). Yet, the region houses some of the poorest and most under developed communities, lacking basic survival necessities including basic electricity supply (Ayodele 2010; Nwankwo 2015). This has left the communities, especially in Bayelsa, Delta and River states, to face more costly options for lighting as well as powering of productive activities and amenities (Ainah and Afa 2013). These options include kerosene, candles and batteries for lighting, and petrol or diesel powered generator sets for electricity supply, most of which are poorly maintained and inefficient; releasing disproportionate levels of green house gas (GHG) emissions (Ainah and Afa 2013). In light of this, the potential to provide electricity for the Niger Delta region using OBRE, particularly those closest to the coast (Bayelsa, Delta and River State) becomes an attractive proposition. The research study however, focuses on Bayelsa state, where a distinctive feature for OBRE development is being envisaged for development.

4.4.1 Prospect for OBRE in Bayelsa state

Current electricity generation in Bayelsa state is estimated in the region of 70MW, which appears to be coming from three major sources via the centralized transmission grid. There is the 40MW from the Okilo Gas Turbine power plant; 20MW from Kolo Creek Power Station; and, the 10MW bulk purchase from PHCN (BIPA 2014). This implies that communities far from the grid may not have access to the electricity being supplied. Anyway, at the time of this research, the Okilo Power Station has been non-functional leaving the state with just 30MW. Even at the 30 MW capacity, the electricity supply is virtually non-existent with adverse and lengthy power outages (Ainah and Afa 2013). According to the Bayelsa State Electricity Board, the state currently requires an installed power capacity of about 400MW to meet current energy demand. Though, a projection made by BIPA (2014) predicted that electricity consumption capacity is expected to also increase to 500MW in the next five years.

In response to the electricity shortage and expected demand growth, current strategy by the Bayelsa government is to use gas resources to generate and supply electricity via existing centralised grid infrastructure (BIPA 2014). This is on the premises that the state has abundant gas reserves, which are yet to be fully optimised (BIPA 2014). However, a critical reflection on this plan suggests that it is unlikely that any grid infrastructure extension may be undertaken to those communities living very close to the coast such as the Akassa nun river communities – where, till date, no form of transmission grid has been deployed. This is as a result of the nature of the terrain where the sea tends to cover almost the entire community. Additionally, as earlier mentioned, the potential high cost of grid extension along with future maintenance obligations makes the prospect of grid extensions to those remote coastal areas unfeasible. This may suggest the reasons why centralised rural electrification based projects are being abandoned or are not priorities for most state governments within the coastal regions. Bayelsa state government has now targeted OBRE (largely due to its myriad of estuaries along the Atlantic Ocean) as an investment opportunity towards providing electricity to those remote coastal areas (BIPA 2014).

However, no clear and defined roadmap for such development has been presented by the state on how it will go about developing its OBRE resources. This concern appear to mirror the over reliance on the Federal Government for key constitutional and resources use, particularly in the area of REM development. Additionally, evidence suggests that no formal engagement – policy networking - has ensued between the state and other associated main actors including the Federal Government on this initiative, which appears to be a persistent occurrence within the frame of the REM (ECN 2005; Oseni 2011; Ayodele and Ogunjuyigbe 2015). In terms of 'policy networking', this is a theme regarded as:

> *"how constellation of actors encourage or resist energy transition at a particular scale"* (Cowell *et al.* 2016 p. 4);

Aligning the definition above from an OBRE perspective, it is fair to suggest that OBRE development could be a complex construct producing a multidimensional matrix of risks, benefits, barriers, drivers and priorities

(Kruijsen et al. 2012; Owen and Garniati 2012). This complexity includes the existence of 'customary waters' areas, local tourism and economic values (conversational sites) as presented earlier in Section 3.3.3 (Wright *et al.* 2016), which are often found to create overlapping leaderships and conflicts of interests. Therefore, against these various complex constructs, effective policy networking in relation to the prospect to develop a practical and sustainable OBRE programme is strongly required.

In practice, OBRE development has one of the prevalent gaps in knowledge and experience compared to other RE resources globally, especially in developing economies. However, it is indeed one sector of RE resource that many societies with developing economies of the world have access to, and the opportunity to close the knowledge gap is there for the taking (Garniati 2014). This has occasioned the steps towards instigating a potential OBRE research project demonstration in partnership with the Bayelsa State Government (BSG) including Federal Government in realising the opportunities OBRE implementation could bring to coastal communities.

4.5 Concluding summary

This chapter introduced the various developmental programs stimulating the prospects towards a transition to OBRE development in Nigeria. From the literature reviewed, Nigeria has put in place a developmental agenda to exploit its OBRE resources, since 2005. However, successive policy makers as evidenced in the current renewable energy policy – NREEEP, did not build on this even though it was considered as part of the anticipated RE sources to be exploited for electricity generation. Likewise, research studies have made it substantive that OBRE can be exploited towards electricity generation, where its market potential is in the coastal region of the country. For example, Bayelsa state in the Niger Delta region. The Bayelsa state government has targeted OBRE as an electricity investment opportunity for its coastal communities where it is unlikely that grid extension will deployed but with no clear development plan.

The success of OBRE implementation must take into account the renewable energy sector landscape as discussed in Chapter 2 and the nature of the global OBRE developments as discussed in Chapter 3. Therefore, in order to properly address these interdepencies, new political and institutional approaches need to be developed which takes into account the inherent nature and context towards transitioning to OBRE. That is to say, only through shared strategies and collective long-term societal goals can a potential transition be established and achieved at the level of individuals, organization, communities and ultimately the whole of society (Kemp 2011; Loorbach 2007). However, organizing and coordinating such transition process poses an enormous and inspiring challenge, especially in the field of energy transition within a complex society like Nigeria.

The next chapter presents the theoretical framework underpinning the study – transition theory, which provides key insights on transition concepts, processes and principles.

CHAPTER FIVE

Theoretical Underpinning: Transition theory and frameworks

5.1 Introduction

This Chapter discusses transition theory and frameworks used as the theoretical underpinning for this research study. The different approaches being utilized within the framework are discussed, particularly the Strategic Niche Management (SNM) concept, which constitutes the analytical lens for investigating the prospect for OBRE development in Nigeria. The Chapter takes stock of the principles reinforcing transition theory and framework. Finally, the rationale/applicability for adopting the transition theory is discussed.

5.2. Theoretical discussion: concept and nature of transition theory

Transition as a subject has been studied within several disciplines (Loorbach 2007) and the term in literature is argued to be useful when managing change processes towards sustainability (Kemps and Rotmans 2005; Twomey and Gaziulusoy 2014) as it:

> *"brings into focus the new state, the path towards the end state, the transition problems and the wide range of 'internal and external developments' which aids in shaping the outcome of the proposed process"* (Kemps and Rotmans 2005 p 36).

However, it is argued that this area of study had actually received increasing attention since the 1980s when the World Commission of Environment and Development introduced the concept of sustainable development, opening new interests aimed at investigating transitions towards sustainability (Falcone 2014). Defined succinctly by Geels (2010) in Falcone (2014, p 63):

> *"transitions tends to be different from simple changes as it is often policy aimed at addressing strategies and decisions of actors towards achieving societal objectives"* (Geels 2010).

Originally, the term transition first occurred in the 19th century when Alex de Tocqueville coined such a word to depict a revolutionary change in low relationship between master and slave (Lachman 2013). During the last 50 years, the concept of transition has assumed greater relevance in other areas, such as political and power relations in order to identify the changes that have taken place in economics and the social views regarding such changes (Falcone 2014). In the 1990s, researchers involved in socio-technical theories in relation to environmental issues borrowed the transition concept especially within the field of sustainability, governance and policy formulation (Rotmans *et al.* 2001; Rotmans and Loorbach 2001). They argued that the concept is rooted in theories about the behavior and dynamic of complex adaptive systems, illustrated by three levels at which this complexity manifests itself. These three levels are suggested to be the level of society as a whole, of the problems facing the society and of dealing with these problems (Loorbach 2007).

Indeed, trends such as globalisation, internationalisation, integration and individualisation have led to the emergence of a broader network-society typology that has significantly increased societal complexity (Castells 1996). This has also increased the level of complication involved in transition processes with such complications suggested to be unsolved with simple, short-term solutions because of their nature of manifestation (Loorbach 2007). These complications are also argued to be unstructured and highly complex because they are rooted in different societal domains (economy, ecology, institutions, technology), occur on varying levels and involve various actors with dissimilar perspectives, norms and values (Loorbach 2007). Scholars such as Hisschemöller (1993) in Loorbach (2007) have termed such complications as persistent problems limiting any form of transition. For instance the current emerging trends that suggests an ongoing transition in the global energy landscape as discussed in Section 2.2 and the persistent problems associated with any form of transition (See Sections 2.7 and 3.3).

Dealing with such challenges often requires approaches that give special attention to learning, interaction, integration and experimentation, since every implemented solution – in this case, OBRE - appears to lead to changes in the societal structures, in turn transforming the challenges itself (Loorbach 2007). Additionally, it may also entail a re-evaluation of the basic values and standards of societies at all levels in relation to the following: how cooperation, innovation and modernisation are undertaken; the collective awareness and sensitivity towards environmental and societal issues; and, what values and qualities are to be preserved and developed for the future (Loorbach 2007). The complexity of achieving sustainability during a transition process may perhaps, imply that it has a multitude of driving factors and impacts. Thus, in order to structure such complexity and be able to analyse transitions as a basis for improving societal transition[3], general patterns of systems dynamics are taken as a starting point (Rotmans *et al.* 2001). However, this raises the question whether to analyse the societal system from an individual or a societal perspective, or to find an adequate way to combine both perspectives into a coherent systems-wide analytical process for knowledge understanding (Grin *et al.* 2010).

Transition theory analysis have been studied from a variety of system-perspectives – as they either assess coordination and organisation failures of existing governance systems or postulate ideas for improving them - and are predominantly built on two main analytical concepts: multi-level and multi-phase (Geels 2002; Hoogman et al. 2002).These two concepts are suggested to be closely related and both tend to be combined to help in investigating the underlying dynamics and the temporal dimension towards transition (Geels and Kemp 2005; Geels 2002) as illustrated in Figure 5-1 and subsequently discussed in Sections 5.2.1 and 5.2.2.

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[3] Defined as a process of change that structurally alter the culture, structure and practices of a societal system (Loorbach 2007; Rotmans et al. 2001)

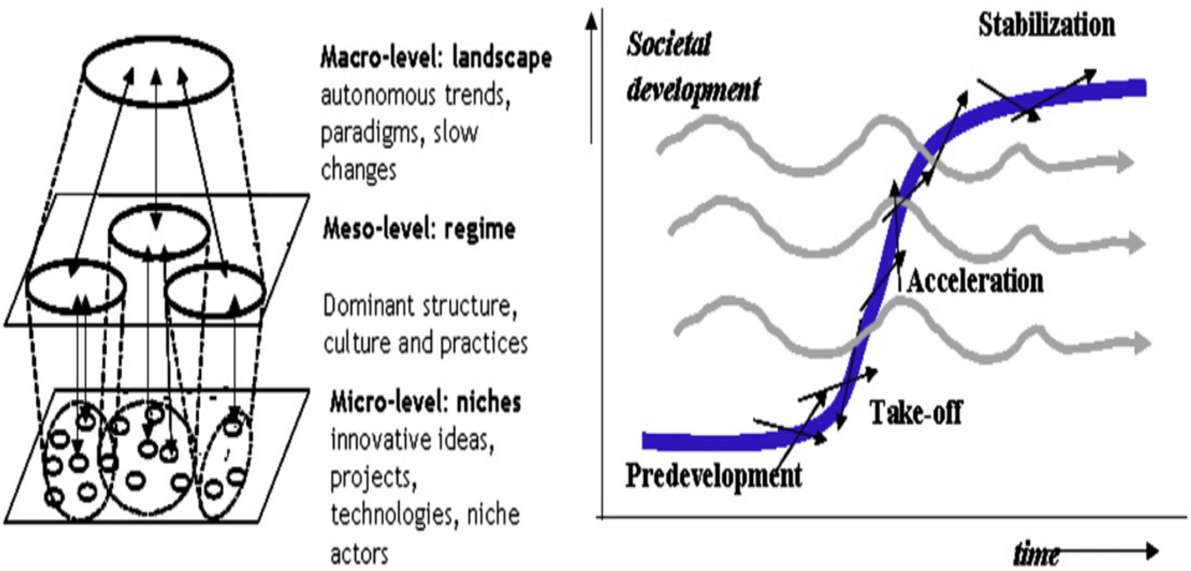
5.2.1 Multi-level concept

The multi-level concept introduces the idea that complex societal systems can be studied by differentiating between the micro-level at which innovative practice is developed; the meso-level that provides the structure and stability to a system; and, the macro-level, which comprises the long-term trends and exogenous events (Geels 2002). The strength of the multi-level perspective is that transitions can be explained by the interplay of the stabilising mechanisms at the meso-level, combined with destabilising pressure from the macro-level and innovations system at the micro-level (Geels 2011; Geels and Schot 2007; Kern 2012). Accordingly, a typology of five transition pathways have been discussed in relation to how the three levels are configured towards facilitating transition; differing in both timing and nature (Shacley and Green 2007; Geels and Schot 2007; Falcone 2014):

1. Reproduction: on-going processes of change within the meso level that is not involving the interaction with the macro-level or micro-level
2. Transformation: processes of change that arise from the interaction of an evolving macro-level with meso level but not with the micro-level
3. Substitution: replacement of one dominant technology within the meso-level by another as a consequence of interaction between all three levels

4. De-alignment/ re-alignment: interaction between the three levels which results in competition between a dominant technology within the meso-level and a number of other competing options that have different performance, characteristics, and eventually resolved through emergence of a new dominant option.
5. Re-configuration: the replacement of a set of inter-locking technologies by an alternative array of inter-related technologies, which fulfils the same or similar functions.

Figure 5-1: Multi level and multi-phase concept



Source: Grin et al. (2010)

5.2.2 Multi-phase level

From the multi-phase level concept, chronological studies of societal transition (Geels 2011; Grin *et al.* 2010; Geels 2006) have also suggested that a transition can be described through time as an S-shaped curve that goes through four phases as presented in figure 5-1. The multi-phase explains that transitions do not tend to occur according to a linear and predictable path but instead, transitions tend to have different phases (Rothmans et al. 2001; Smith et al. 2010). The four phases are explained further in Sections 5.2.2.1 to 5.2.2.4.

5.2.2.1 Pre-development phase

In this phase, small changes are going on in a system but in the background, are not (predominantly) visible. Here experimentation with new ideas, technologies and essential practices takes place. There is not yet much societal impact, but through pilot demonstrations – projects experience, improvements and societal acceptance of innovation are potentially argued to increase. If successful, the next phase brings about the take-off phase.

5.2.2.2 Take-off phase

In the take-off phase, structural changes gain momentum such as actors, actors' networks and interactions. It is assumed to be the start of a transition. Here the innovation(s) is being persistently used and adopted through replication or upscaling from initial pilot demonstration, increasingly gaining positive societal impact.

5.2.2.3 Acceleration phase

Structural changes increase and become visible during the acceleration phase. Additionally, there are collective learning, diffusion and institutionalization processes in which the transition processes increase and spread rapidly with various societal domains beginning to reinforce each other.

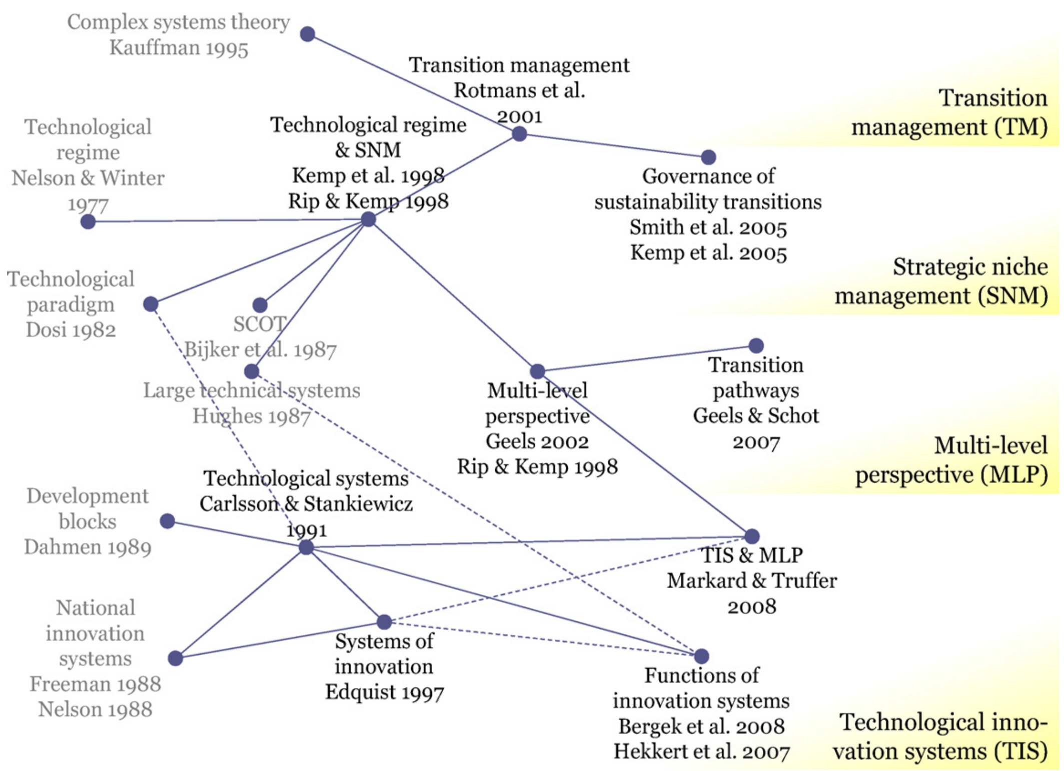
5.5.2.4 Stabilization phase

Here, it is suggested that the speed of the societal change decreases and a new dynamic equilibrium is reached within the stabilization phase. It is at this point that the 'societal change' has occurred and the transition process tends to end as it loses momentum and becomes embedded within the social system.

Turning back to transition theory, four conceptual frameworks are argued to have achieved some prominence in transition studies (Markard *et al. i*2012). These include the Multi-Level Perspective (MLP) (Geels 2002; Smith *et al*. 2010), Strategic Niche Management (SNM) (Kemp et al. 1998; Raven and Geels 2010), Transition Management (TM) (Smith and Kern 2009; Rotmans *et al.* 2001), and the Technological Innovation Systems (TIS) (Bergek *et al.* 2008; Hekkert *et al.* 2007). Figure 5-2 depicts the four frameworks and the core research strands in the field of transition studies.

The SNM and TM approaches emerged partly from MLP and are suggested to have a more normative and governance orientated focus for supporting niche innovations such as OBRE and system transformations (Twomey and Gaziulusoy 2014). Each of the four approaches as indicated in figure 5-2 may appear unique in its own style of contribution towards achieving transition nevertheless; they all seem to be skewed towards a single conclusion: transition occurrences are a result of a complex set of relationships among actors within the systems (Twomey and Gaziulusoy 2014).

Figure 5-2: Map of key contributions and core research strands.



Source: Markard et al. (2012).

They are however, further divided into two complementary bodies of transition perspective: the socio-technical transitions system compromising of MLP; SNM; and, TM; and, the technological transition system comprising of TIS (Twomey and Gaziulusoy 2014). The difference between the two transition perspective is summarised in Table 5-1 (Twomey and Gaziulusoy 2014).

Table 5-1: Transition theory and concepts perspectives

	Technology transition system	**Socio-technical transition**
Focusses on:	Prospects and dynamics of a particular innovation (technology)	Prospects and dynamics of broader transition processes/variety of innovation (technologies)
Concerned with:	Successful diffusion of a particular technology or product	Successful transformative societal processes, diffusion of a particular technology or product

Source: Twomey and Gaziulusoy (2014)

From the table, the socio-technical transition system differs from the technology innovation system in that they include changes within the broader society which includes users' practices and institutional (e.g. regulatory and cultural) structures as well as the technological dimension that the technological transition tends to focus on (Markard, Raven and Truffer 2012).

Thus, the current research study analysis the transition prospect towards OBRE development through the socio-technical transition perspective using the SNM's approach as the analytical lens to critically evaluate the prospect. The emphasis on development here stems from the viewpoint that OBRE development can be regarded as a type of innovation, where innovation is defined as:

> *"a complex phenomenon involving the production, diffusion and translation of technological knowledge into new products or process for societal beneficial use"* (Samara *et al.* 2012, p 624).

Theoretical understanding of SNM suggests that by evaluating the initial technological niche – in this case, OBRE - activities and processes, it will be possible to identify the important critical success factors that can aid in facilitating transition including the barriers that could limit the prospect for the same transition (Van Ejick 2007). However, ongoing transition processes have been found limited and the various frameworks, especially MLP have been criticized for the lack of attention to agency, power and politics (Shove and Walker 2007) and insufficient attention to social innovation (Seyfang and Hexaltine 2012) as presented in Strachan *et al.* (2015). Prior to examining the SNM-socio-technical transition approach, the research starts by taking a closer look at the contextual nature of socio-technical transition perspective.

5.3.1 Socio-technical transition approaches

The socio-technical transition perspective is argued to be a heuristic framework that has been part of ongoing research program pioneered by Dutch researchers (Elzen *et al.* 2004; Kemp 1994; Geels 2005; Rotmans *et al*. 2000). The concept has evolved into a tool used to support the formation of transition policies and governance for the promotion of more sustainable forms of energy (Lizuka 2015; Cowell *et al.* 2016). Conceptually, the socio-technical transition is suggested as clusters of aligned elements, such as technical artefacts, knowledge, markets, regulation, cultural meaning, rules, and infrastructure (Geels and Kemp 2005; Geels 2012; Kern 2012). The approach could also be described:

> *"as the set of institutions, which jointly and individually contribute to the adoption of new processes, services or products; and provides the framework within which strategies are designed and implemented in a bid to influence the transition process"* (Samara *et al*. 2012 p. 625).

It may also consist of the following: an external environment, the actors, organisations and institutions with different interactions and influences, thereby forming a structure that uses knowledge aimed at socio-economic and human development gains (Varblane *et al.* 2007). Within the socio-technical transition is the persistent role of the socio-technical regimes systems, seen as dynamically stable, sustaining and sustained by incumbent actors (Geels 2012; Strachan *et al.* 2015).

Recent studies on the persistent role of the socio-technical regime system, in particular from an energy transition perspective have been undertaken, particularly in developed economies. These includes: rescaling the governance of renewable energy (Cowell *et al*. 2015); promoting community renewable energy in a corporate energy world (Strachan *et al*. 2015); understanding the regional process of energy transition (Ruppert-Winkel *et al.* 2016) and moderating the pace of governed energy transition (Kern and Rogge 2016). They all posit the significance of the socio-technical regimes towards a successful energy transition. For instance, Strachan *et al.* (2015) pointed out the need of niche actors to have the ability to influence the wider policy setting by taking cognizance of how technology innovation niches should intersect with the socio-technical regimes. As a result of that, they point out that the:

> *"Niche-to-regime relationship requires more investigation..."* (Strachan *et al*. 2015, p. 97)

This relationship with the institutional arrangement of the socio-technical regimes may deliberately change or adapt existing institutions or create new ones (Markard and Truffer 2008). Thus, it can be argued that the socio-technical regime could present a barrier to transition, including new technological and social innovations such as OBRE (Kemp *et al*. 1998;

Markard and Truffer 2008). That is, it is at this level that a lock-in may take place, creating barriers or system failures for a potential transition to occur (Woolthius 2005). Lock-in refers:

> *"to a complex composition of causes, not only does it concern the shift to a new single technology but it also acknowledges the interconnectedness of that technology with its social and economic environment" (Woolthius 2005, p 612).*

This means that technological alternatives (such as OBRE generation) must not only compete with components of an existing technology (fossil fuel based energy generation), but with the overall system in which it is trying to be embedded (Woolthius *et al.* 2005). For instance, lock-in can lead to strong network failure, lack of complementary cooperative relationships (weak network failure). It can also be a simple lack of technological and organisational capabilities within the institutional/organisations themselves (capability failure) (Woolthius et al. 2005) or a mindset towards a particular energy pathway for developing RE sources (Strachan *et al.* 2015). Other forms of failures as asserted by Woolthius *et al.* (2005) due to the lock-in pattern are presented in Appendix 3. It can be argued that the success of any technological innovation including OBRE, to be adopted appear to be largely determined by how the broader socio-technical regimes system functions and interact with each other as elements of a collective system of knowledge creation and use (Geels 2005; Smith *et al.* 2010). Taken together this knowledge, the research study argues that the current lows development of RETs in Nigeria may be as a result of the limitations within the socio-technical regime. Again, this research study can equally argue that, for instance, current global development of OBRE innovations, especially in the UK, has failed to give rise to commercialization due to the lack of effective niche-to-socio-technical regime engagement.

This research now turns its attention to the SNM-socio-technical transition framework that serves as the analytical lens.

5.3.1.1 Strategic niche management framework

Strategic Niche Management (SNM) highlights the importance of protected innovation spaces and of user involvement in early technological development and has emerged as a research model and policy tool to manage technological innovation within the four transition phases (Kemp *et al.* 1998; Schot and Geels 2008. 1998). Though the SNM is argued to be draw from MLP (Kemp *et al.* 2001), its aim however, is to create new technology niche pathways that are able to penetrate the prevailing socio-technical regime or be part of a realignment of the regime (Kemp *et al.* 1998).

The approach was partly inspired by historical studies showing that many successful innovations started as a technological niche and only gradually complemented a dominant regime or served as an alternative (Schot and Geels 2008). The same historical studies have also shown that valuable technology innovations have often failed to develop fully, or to catch on in the market, even though they may have had superior performance characteristics (Twomey and Gaziulusoy 2014). Thus, SNM attempts to purposefully construct and guide niche innovations having promising technologies to develop through societal innovation experiments (Raven and Geels 2010). Thus, SNM can be defined as:

> *"the creation, development and controlled break-down of test-beds (experiments, demonstration projects) for promising new technologies and concepts with the aim of learning about the desirability (for example in terms of sustainable development) and enhancing the rate of diffusion of the new technology" (Weber et al. 1999).*

It can then be argued that the purpose of SNM is to learn more about the technical and economic (techno-economic) feasibility and environmental gains of technological options. That is to learn more about the social desirability of the options and to stimulate the further development of promising technologies including OBRE (Van Eijck and Romijn 2007; Van Eijck 2007). The result of this process is expected to give rise to cost efficiencies for replication or upscaling and the development of complementary infrastructure and skills that are important for the wider diffusion of the new technology (Hoogma *et al.* 2002; Van Eijck 2007). The SNM therefore presents technological niche levels in which space is created for experimentation (resource assessment and technology demonstration) and innovation activities and practices are undertaken towards when the niche becomes entrenched within the society (Kemp et al. 1998) as illustrated in Table 5-2.

Table 5-2: Transition phase and niche relationship

No	**Transition phase**	**Niche Role**
1	Pre-development	The technology niche is still in a very early stage of development with some functional developmental activities such as prototypes design, knowledge communication and potential interactions with the socio-technical regime

2	Take-off	The niche starts gaining some pushing incrementally and radically till it reaches the regime where it is institutionalised, experiments and demonstration are undertaken
3	Acceleration	This is a period of successful demonstration and implementation (users' acceptance) and socio-technical regime begins to lock-in in the new system.
4	Stabilization	The niche becomes entrenched within the society and finally the speed of the process decreases and becomes secured forming a new socio-technical regime

Source: Developed from Rotmans *et al.* (2001)

Also, within SNM, there appears to be much less co-ordination among niche actors, but allowing for the emergence of new interactions between the niche actors and regime (who may support the innovation and the transition process) (Hoogma et al. 2002). Three internal niche-level processes (as illustrated in figure 5-3) within the SNM approach is argued to influence the viability of niches in relation to achieving stabilization as per table 5-2 (Kemp, Schot and Hoogma 1998; Van Eijck and Romijn 2007). The three internal niche levels are discussed:

1. **Shaping and alignment of expectations:** Increasing alignment of expectations involves niche-level actors increasingly sharing similar visions, beliefs and interests. Following Hoogma et al. (2002), a high level of alignment expectations is generally conducive for niche development, although envisioned opportunities need to become more specific and rely on positive, tangible results.
2. **Formation of a social actor network:** This consists of the formation of a constituency behind a new or alternative socio-technical trajectory that consists of a network of engaged actors. It

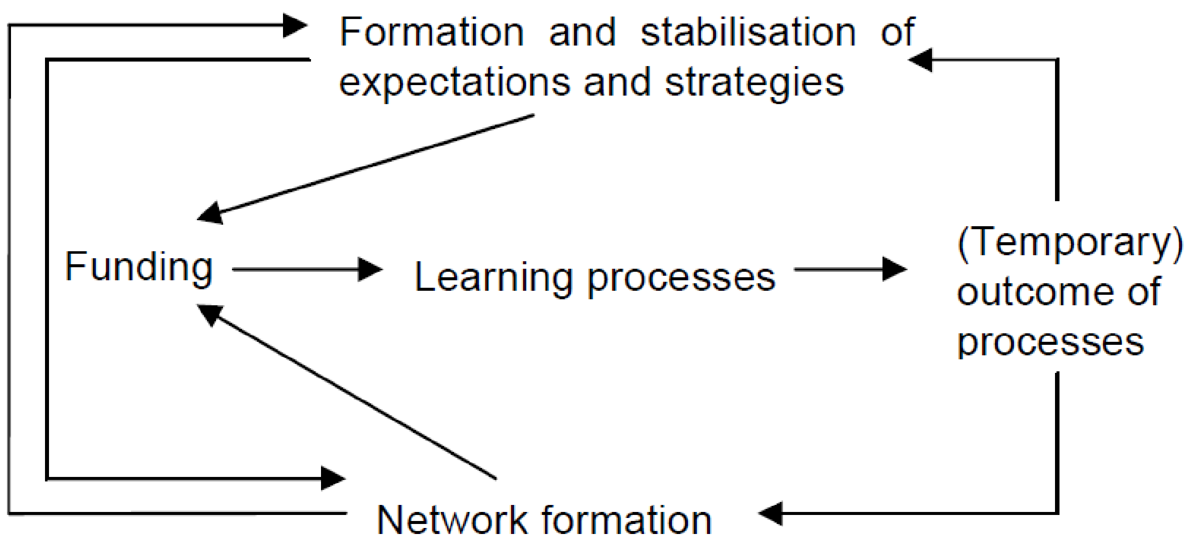
is generally assumed that in SNM that the formation of close social collaboration and regular interaction among actors stimulates niche development. Additionally, the involvement of a broader and more varied actor network promotes niche development (Coenen, Raven and Verbong 2010).

3. **Learning processes:** This involves learning about the various niche–level experiments, including resource assessment, technical design, functionality and performance. Thus, it involves the process where the various actors and the society, learn about the many aspects of the technology, including regulatory conditions, user preferences, institutional and environmental aspects within the frame for a potential transition.

From the Figure 5-3, expectations can change due to a different composition of the network, but they can also change due to the outcome of learning processes (Van Eijck 2007). When a certain new technology performs well in the experiments, and the users are satisfied, the expectations around the technology will rise and become stronger (Van Eijck 2007).

This will facilitate the expansion of the actor network. Because of these higher expectations and the expanded network, more money will or may become available for further learning processes. Eventually a new stable socio-technical regime will/may appear (Raven 2005).

Figure 5-3: Linkages between the three internal niche processes



Source: Adapted from Van Eijck (2007)

The expansion of the actor network is important because participation in the niche from a wide set of actors is needed if the lessons are to be effective (Hoogma *et al.* 2002). Thus, the quality of niche processes is increased by initially widening the actor network, which increases the connections/collaboration within the network providing wide learning opportunities such as learning by doing, learning by interaction and learning by using. This ultimately may increase the overall quality, robustness and specification of expectations. It can be argued that when the niche processes proceed well, they will/may ultimately culminate in a change of the socio-technical regimes as mentioned earlier in section 5.3.1.

Another angle of the SNM approach that may not culminate in a change of the socio-technical regimes is the intended role of actors for undergoing niche development within a societal transition as posited by Doci *et al.*

(2015). In Doci *et al.* (2015), they asserted that niches created by market actors who want to invent and develop new technologies for later socio-technical regime use are different from social groups, which have specific needs that cannot be satisfied by incumbent regime products. The purpose of the latter is to nurture innovations that are able to meet their special needs, and it is possible that they only aim at internal use of the innovation. This may perhaps, be called grassroots communities niche creation and in terms of energy, community energy (Strachan *et al.* 2015). Consequently, a distinction can be made according to the orientation focus of niches innovation: externally and internally oriented niches and their application focus (Doci *et al.* 2015). The externally oriented niches are organised around a technological innovation while in the internally oriented niches, the emphasis is not on the technology itself, but the technology serves more as tools that actors use for their special purposes within the social group settings. This distinction between internally and externally oriented niches fits well in Witkamp *et al.* (2011), in that most social niches are internally oriented whereas market and technological niches are typically externally oriented. Thus, a policy approach with a greater focus on the role of external niche processes usually culminate in a change of socio-technical regime, which tends towards a transition, aligning to the nature of this research study (Van Eijck and Romijn 2008).

SNM has however, not been without criticism though, with a major criticism being too much of a bottom up strategy and focusing on niche innovation such as techno-economics at the expense of broader innovation processes (Berkhout *et al.* 2004). Furthermore, Caniëls and Romjin (2008) asserted that there is scant evidence of consciously designed SNM initiatives becoming major learning vehicles for wider change towards new socio-technical regimes; thus, most SNM experiments have remained at the stage of single activities. Nevertheless, SNM is still viewed as a useful framework for generating learning about needs, technology imperfections and strategies to overcome them, and for building actor networks towards innovation adoptions (Nill and Kemp 2009) which lends itself to the goal of this research. The study now takes an overview of the other existing transition frameworks in order to illustrate their theoretical value in the field of transition studies, and within the research context.

5.3.1.2 Multi-level perspective framework

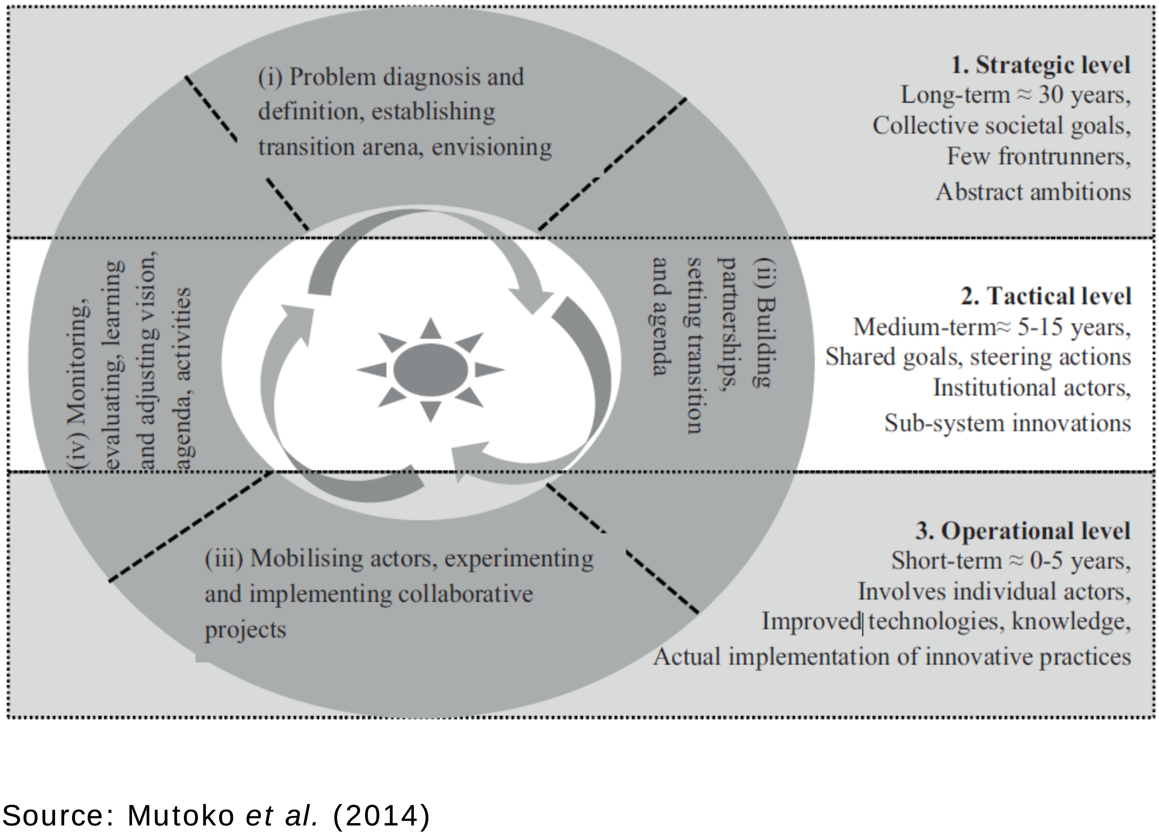
The multi-level socio-technical perspective explains the dynamics between technology, institutions, norms, markets and society. The framework has been significant in analysing changes and stability within socio-technical transition systems (Geels 2002). The literature on MLP divides energy transitions across three different levels as earlier discussed in Section 5.2.1, in which the interaction between these three levels may trigger transition (Geels 2002; Grin *et al.* 2010; Markard *et al.* 2012). Central to the MLP is the persistence of the socio-technical regimes (as discussed earlier in Section 5.3.1), which sustains incumbent actors and structures the scope of change or transition (Geels 2002; Geels and Schots 2007). Socio-technical regime analysis within the MLP has often focused on interactions between actors and their systematic co-option of technologies or the creation of inertia via selective resistance to pressures from niches (Berkhout 2004; Geels 2011; Falcone 2014). Furthermore, critical to regime interactions is the presence of structural relations and dependence among actors in determining the selection and co-option of technologies (Meadowcroft 2011; Rosenbloom and Meadowcroft 2014). This dependence is created by power relations among actors (Geels 2014), fostered by a coalition of “lock-in,” and relational networks within the regime. In this regard, dependence is fostered both by a mutual exercise of power (horizontal), and by the exercise of power by one actor over another (vertical) (Osunmuyiwaa and Kalfagianni 2016).

Geels (2002) further pointed out that, within the socio-technical regime, several sub-regimes representing different social groups appear to be linked to each other by a semi-coherent set of rules. These rules are suggested in determining the development pathway of any innovation thereby providing stability to the regime and the required resistance to innovation. Thus, the MLP allows appreciation of the complexity of change, including roles of different actors in a transition, policy mechanisms, market design and incentives and the potential barriers (Geels 2005; Verbong and Geels 2007; Shackley and Green 2007; Strachan et al. 2015; Osunmuyiwaa and Kalfagianni 2016; McCauley and Stephens 2012).

5.3.1.3 Transition management

The transition management approach adopts a broad systems perspective that embraces all three levels of the MLP framework. It is particularly concerned with the dynamics of structural change in society and the nature and timing of the transformation to be initiated, facilitated and shaped. As in SNM, the importance of experimenting and learning is central which implies that the novelty of TM approach originates at the micro-level of local actors and practices (Rip and Kemp 1998). However, the starting point of TM is not a technological innovation but a societal challenge, balancing environmental issue with social concerns and economic growth (van der Bosch and Rotmans 2008). Thus, TM aims to steer transition, in particular the socio-technical regimes towards desirable social outcomes, through two key analytical lens: a descriptive distinction into strategic, tactical and operational innovation spheres and a prescriptive cyclical framework of co-evolving activities that connect these spheres (Loorbach and Rotmans 2010; Roorda *et. al.* 2014), depicted in Figure 5-4.

Figure 5-4: Transition management framework



Source: Mutoko *et al.* (2014)

The framework tries to utilize bottom-up developments in a more strategic way by coordinating different levels of government and fostering self-organization through new types of interaction and cycles of learning and action and the change process (Loorbach and Rotmans 2010). Additionally, the framework is suggested to have been developed through an action research and participation process from various regional and national policy projects and made operational towards problem structuring and envisioning within a multi-stakeholder arenas; developing new coalitions; implementing agendas in experiments; and, evaluating and monitoring the transition process (Loorbach 2007).

The TM concept was first formulated in collaboration between Rotmans, Kemp, Geels, Verbong and Molendijk – Rotmans et al in 2000 but was essentially developed by both Rotmans who brought in the multi-phase concept, and Kemp, who brought in the multi-level concept. In a later phase, TM evolved into an operational model (Loorbach and Rotmans 2006) and policy practice (Rotmans and Loorbach (2010). Simultaneously, TM is currently being utilised as both governance theory as well as an operational governance approach within transition processes (Loorbach 2007). Thus, the TM concept is argued to contain new forms of governance involving actors' network management, interactivity, heterogeneity, multi-level focus and social learning, involving participations from government, societal organizations, companies, knowledge institutes and intermediary organisations (Rotmans *et al.* 2001; Rotmans and Loorbach 2010). Because of this participation at various levels, a multi-level network emerges within which different themes are discussed and tackled (Loorbach 2004).

Indeed, justifying the role of TM within the transition frame stems from the classical top-down steering by government ('the extent to which social can be effected by government policies') as well as the liberal free market approach ('the extent to which social change can be brought about by market forces'). Both approaches are argued as ineffective management mechanisms to generate sustainable solutions at societal level emerges (Scharpf 1994, March and Olson 1995). The inadequacies and problems of such forms of governance are exposed when considering current government failures in shaping and directing transition processes, especially in developing economies (Hooghe and Marks 2001, Teisman 2005). This failure is also emphasized in light of increased societal complexity and the unstructured nature of policy-making processes (Hisschemöller 1993; Sabatier and Jenkins-Smith 1999); pointing out the impracticability of classical top-down governance. Many researchers therefore argue for new forms of governance to reduce, or better still, eliminate this lack of direction. Hence, the need for new management frameworks to give such assumed direction towards enabling sustainability achievement in this case, the use of TM (Rotmans *et al.* 2001; Loorbach 2007; Rotmans and Loorbach 2010).

5.3.1.4 Technological innovation system

The central idea behind the innovation system (IS) approach is that the determinants of any transition are found also in a broader social structure around entrepreneurs (Carlsson and Stankiewicz 1991; Freeman 1987; Lundvall 1992). Innovation System (IS) can be analyzed on technological, sectoral, and national levels in which the emphasis and unit of analysis is technology, industry and geography (Carlsson and Stankiewicz 1991; Bergek *et al.* 2008) However, since the research study is on OBRE technology, the technology strand of the IS is reviewed and referred to as Technology Innovation System (TIS). A TIS is defined as:

> "*a set of networks of actors and institutions that jointly interact in a specific technological field and contribute to the generation, diffusion and utilization of variants of a new technology and/or new product*" (Markard and Truffer 2008, p. 611).

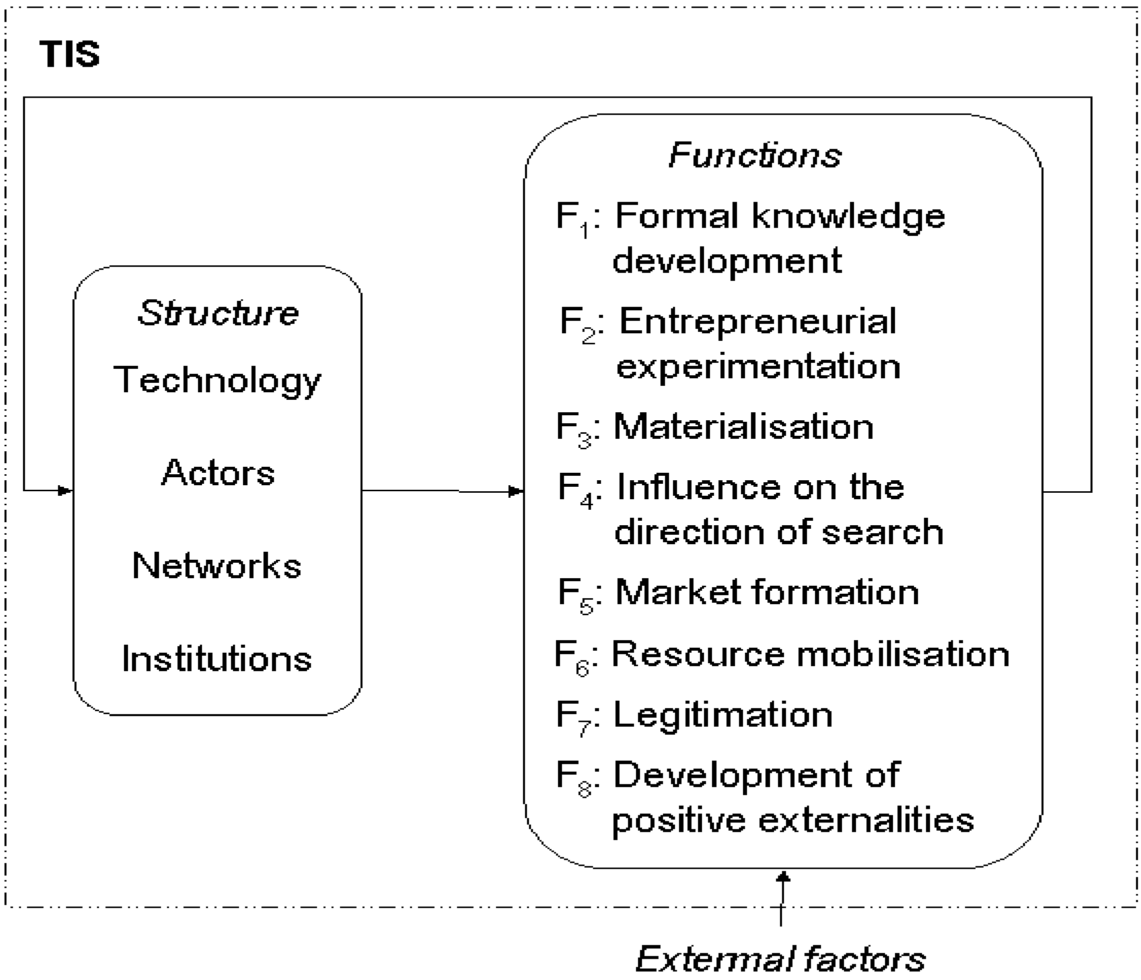
This approach has emerged over the past few years as an analytical tool to study the dynamics of new and emerging technology fields (Carlsson et al. 2002; Hekkert *et al*. 2007; Edquist 1997). TIS consists of four types of structural dimensions, which considers all the activities that contribute to the development, diffusion and use of a technology. These activities are referred as functions of innovations and are argued to be linked with the four structural dimensions to form the TIS framework (Negro et al. 2008). This is illustrated in Figure 5-5.

From the Figure, the TIS appears to consist of actors, institutions, specific infrastructures and the network of relations through which they are connected by the performance of functions of innovation (Hekkert et al. 2007; Bergek et al. 2008). However, the focus of use in many research studies is on the Functional dimension of the TIS that are suggested to be performing the following roles (Hekkert *et al*. 2007; Wieczorek *et al*. 2013):

1. promote the development and potential commercialization of emerging technologies, if performed adequately.

2. provides guidance to actors towards the use of the new technology, resources for its diffusion and adoption, market space that protect it from the competition of existing and mature alternatives

Figure 5-5: Technology Innovation System framework



Source: Hekkert *et al.* (2007)

The next section discusses the pertinent theoretical principles within the transition studies, seen as being central towards a societal transformation.

5.4. Contemporary principles underpinning transition theory

The following contemporary principles have been theorised towards achieving societal transition. Accordingly, it is suggested that the following principles are necessary to be considered within transition processes (Twomey and Gaziulusoy 2014; Rogers 2003; Woolthius *et al*. 2005; Geels 2012; Loorbach 2007; Rotmans *et al*. 2010; Hekkert *et al*. 2007; Hoogman *et al*. 2002):

5.4.1. Multiple actors and networks

Transition theory has moved towards the recognition that innovation is a joint activity involving a large number of actors with different interests, perceptions, capabilities and roles and takes away the preconception that innovation is entirely made of entrepreneurs. In particular, the transition approach pays much attention to understanding the structure and networks of actors and institutions. The heterogeneity of actors and institutional behaviours, including differences in risk averseness, perceptions of the economic environment and imperfect abilities to imitate the innovations of others, also provides a theoretical basis that underpins the explanation of why there is any innovation at all.

5.4.2 Interactivity, feedback and complexity

An important feature of the transition theory and concepts is the interactivity among actors at different multi-levels and feedbacks between different stages of the transition processes (Kline and Rosenberg 1986). This argument tends to resonate strongly with the field of complexity science, which considers how relationships between parts give rise to the collective behaviours of a system (Mitchell 2011). This argument further supports earlier claims by Gibbons, Limoges and Nowotny (1994) on the growing relevance of the interactive, collaborative and inter-disciplinary characteristics of transition process for the creation of knowledge.

5.4.3 Institutions and culture

Transition theory thinking gives institutions a central role in enabling, constraining and shaping behaviours and practices and facilitating innovation development. Aligning this to the OBRE development, it may be argued that many of the limitations of the sector, as perceived in literature study may be due to lack of meaningful analysis of the institutional environment in which business and policy decisions are taken (Foxon *et al.* 2005). In socio-technical terms, it brings to bear the dominant and incumbent actors (socio-technical regime) that govern – in this case – energy development. Institutions are typified into hard and soft (Woolthius *et al.* 2005). Hard institutions are explicit and codified and include laws, rules, regulations and instructions. Soft institutions include customs, habits, routines, established practices, traditions and ways of conduct, norms and expectations. Transition theory also takes into consideration the role of culture - the ideas, customs and social behaviour of a particular people or society for innovation development. Transition theory puts forward the idea that people are born with given preference functions or behavioral practices that are historical and culturally conditioned, which tends not to be open to changes (Ormerod 1998).

5.4.4 Co-evolution

A co-evolutionary approach to transition is an overarching principle in transition study. Co-evolution occurs when different sub-systems have mutual interactions, which affect the development of each system. In particular, analysing transition pathways calls for a co-evolutionary understanding of the development of technologies, institutions, social practices and business strategies (Geels 2005; Foxon 2011). It stems from the evolutionary economics concept, which provides powerful concepts for studying emerging technologies and their role as a potential source of disruption necessary for a transition to occur (Kemp and Rotmans 2005). Sartorius (2006 p274) states that

> *"co-evolution implies that successful innovation in general and successful sustainable innovation in particular, has to acknowledge the involvement of, and mutual interaction between, more than the mere technical and economic spheres".* (Sartorius 2006 p.274)

Therefore, to understand the dynamics of transition in the context of a technological change, particularly in a complex system such as in Nigeria, a co-evolutionary approach which acknowledges the interaction between all components of the socio-technical system is essential (Gaziulusoy 2010).

In theory, the term evolutionary is often formulated in relation to innovation and transformation, referring to gradual change or to the evolutionary mechanism of variation, selection and retention (Nelson and Winter 1982; Foxon 2011; Nill and Kemp 2009). Thus, the co-evolutionary understanding is an attempt to overcome the dichotomy between two dominant approaches advocated to achieve long-term objectives (sustainability) that is, technology-oriented versus behaviour oriented approaches (Brand 2003). As Foxon (2011) noted, this thinking is highly relevant to analyzing issues in which there exists complex interactions within the social system towards the introduction of new technologies.

5.4.5 Path-dependency / lock-in

It has been generally understood that technological transition change tends to proceed 'incrementally' along fixed paths due to the risk reducing behaviour of organisation from an innovation development perspective. This phenomenon is known as path-dependency of transition (Arthur 1989). Path dependency creates technological lock-in, which acts as a barrier against radical innovation (Nelson and Winter 1982). In the context of energy, it explains the presence of the carbon "lock-in" of current energy systems (created over time through the co-evolution of technological, institutional and user practices) which appears to have created significant barriers for the development of the renewable energy sector (Unruh 2000).

5.4.6 Uncertainty

Inherent within transition process is the presence of uncertainty. One particularly important implication of the uncertain nature in transition is that firms and/or investors' expectations of future markets, technologies and policies are argued to impose a crucial influence on their decisions about which technologies to invest in and develop. Thus, uncertainty refers to situations that are not or cannot be known in advance, because they are outside existing conceptual models.

5.4.7 Knowledge and learning

Knowledge is often claimed to be the most fundamental resource in a transition, while learning is the most important process (Lundvall 2007; Wieczorek *et al.* 2013). As transition theory has developed, the understanding of different kinds and forms of knowledge, e.g. tacit as opposed to explicit knowledge and learning e.g. learning-by-doing and learning-by-using (Rosenberg 1982), learning-by-interacting (Lundvall 1988) have expanded social insights into the development and diffusion of technologies. A key element of knowledge and learning acquisition is its catalytic action towards the innovation decision process.

Rogers (2003) has described the innovation-decision process as:

> *"an information-seeking and information-processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation"* (Rogers (2003 p 172).

Furthermore, he explained that the innovation-decision process involves five steps: (1) knowledge, (2) persuasion, (3) decision, (4) implementation and (5) confirmation in which they follow each other in a time-ordered manner (Sahin 2006). In terms of the knowledge step, Roger argued that an individual learns about the existence of an innovation and seeks information about the innovation, that is: 'What'; 'how'; and, 'why', put simply what the innovation is and how and why it works" (Rogers 2003 p. 21). Rogers asserted that the questions above form three types of knowledge:

1. Awareness-knowledge: Awareness-knowledge represents the knowledge of the innovation's existence. This type of knowledge can motivate the individual to learn more about the innovation and, eventually, to adopt it. In addition, it may further encourage an individual to learn about other two types of knowledge below, prior to adoption (Kruijsen 1999).
2. How-to-knowledge: The other type of knowledge, how-to-knowledge, contains information about how to use an innovation correctly. Rogers saw this knowledge as an essential variable in the innovation-decision process. To increase the adoption chance of an innovation, an individual should have a sufficient level of how-to-knowledge prior to the trial of this innovation. Thus, this knowledge becomes more critical for relatively complex niche innovations such as the OBRE technologies.
3. Principles-knowledge: The last knowledge type is principles-knowledge. This knowledge includes the functioning principles describing how and why an innovation works. An innovation can be adopted without this knowledge, but the misuse of the innovation may cause its discontinuance. For instance, Sprague, Kopfman and Dorsey (1999) argued that one of the biggest barriers to faculty use of technology in teaching was that faculty lack a vision of why or how to integrate technology in the classroom.

Hence, to create new knowledge, technology theory and practice should provide not only a how-to experience but also a know-why experience (Kruijsen 1999). In fact, it is argued that an individual may have all the necessary knowledge, but this does not mean that the individual will adopt the innovation because the individual's attitudes (characterised by institutions and culture as defined in section 5.4.3) also shapes the decision to adoption or reject the innovation (Sahin 2006).

In summary and aligning to the assumptions of Woolthius *et al.* (2005) assumptions, the basic conceptual underpinnings of transition theory and frameworks are first, that innovation does not take place in isolation. Interaction is central to the process of innovation. This involves interaction between actors such as government, firms, universities and intermediaries. Additionally, central to the concept of interaction are both co-operation and interactive learning (Lundvall 1992). A second assumption is that institutions are crucial to economic behaviour and performance (Smith 1997). Legal (e.g. regulation and law) and customarily institutions (e.g. culture and values) form the 'rules of the game' or 'the codes of conduct' that may reduce uncertainty – see Section 5.4.6 - in the system. These rules shape, and are shaped by, the interactions between actors that take place within these rules. Third, co-evolutionary processes play an important role. They generate variety, select across that variety, and produce feedback from the selection process to variation creation (Hauknes and Nordgren 1999). This process of novelty and variety creation is the result of constant interaction among heterogeneous actors in a societal system (Smith 1999) and is necessary to maintain the diversity that makes selection possible (Nelson 1995; McKelvey 1997). Thus the occurrence of a problem or barriers is argued to arise if or when the combination of the principles mentioned are not considered during a transition process, ultimately slowing down the transition phase as a whole (Woolthius et al. 2005).

In the next section, the study discusses the rationale and applicability of the transition theory to this study.

5.5 Rationale and applicability for adopting the transition theory

Contemporary concerns, particularly the sustainability characteristics of the incumbent energy system (fossil fuel), has become an important global debate. This has inevitably steered a redirection towards alternative energy sources, including renewable energy sources. However, a key argument is that renewable energy technologies often fit poorly within established socio-technical regimes (e.g. in terms of price, performance, consumer preferences) (Smith 2007), this may be due to existing socio-technical regime systems being characterised by stability and locked-in path dependency (Elzen et al. 2004).

Thus, it can be argued that the success of any innovation to be adopted and diffused is largely determined by how the broader socio-technical regime system functions and interact with each other as elements of a collective system of knowledge creation and use (Hoogma *et al*. 2002; Rotmans *et al*. 2001; Loorbach 2007). Therefore, in contextualising OBRE development as discussed in chapter 2 and 3 within a transition system, it appears that its transition will be underpinned by the consequences of the activities of diverse actors' interactions and collaboration, which are in turn influenced by broader socio-technical system functioning and perhaps, on the way in which they positively interact with each other within the system. Hence, transition theory served as a guiding lens on how such coordination and interaction could take place, providing the necessary platform for evaluating the potential prospects for a transition towards OBRE development in Nigeria. Furthermore, the use of transition theory provides the basis that OBRE technology can be regarded as a type of innovation whose development are underpinned by functional activities undertaken by network of actors. These actors are argued to operate under a particular socio-technical regime system and their actions and interactions may contribute to the development of OBRE for beneficial purpose (Carlson and Stankiewicz 1991; Bergek *et al*. 2008; Suurs 2009).

Drawing on the SNM framework, the research operationalises the OBRE niche innovation based on the institute(s) such as UNIPORT (Section 4.3) that they tend to develop technologies to interact with broad actors, thereby creating a process of social learning at each phase of development. This interaction is suggested to influence the way the technology becomes adapted and socially embedded (Osunmuyiwaa and Kalfagianni 2016). Put succinctly, niche experiments are necessary conditions for transition but are insufficient for a proper diffusion of technologies including OBRE, unless they are developed to conform or are 'shielded' to a point of maturity in order to become embedded with the existing socio-technical regimes system. In terms of socio-technical regimes, the research also operationalises the role of structural dependence among the RE actors and how this, has shaped the transition towards the adoption of RETs in Nigeria. Specifically, in energy transition, actors proposing change within the energy regime often use socio-technical regimes' mechanisms in triggering transitions. Such mechanisms include: (i) the enactment of renewable energy policies, (ii) the creation of renewable energy-based agencies, and, (iii) the promotion of renewable energy investments by members of the regimes. These mechanisms however, - in Nigeria terms - appear to be ineffective in relation to their relevancy in promoting and encouraging RE based on the discussions in Sections 2.6.2.1, 2.6.2.2 and 2.6.2.3. This may further increase dependence on fossil fuel use by the incumbent socio-technical regime. Thus, transition theory has provided theoretical insight of key principles to be considered in unlocking the ineffective nature of the RE landscape in Nigeria, which will be relevant in achieving this research aim.

Transition theory also served as a guide to the design of the interview questions used in gathering empirical data for the research study (See Appendix 4). In general, the significance of transition theory and SNM has enabled a critical investigation that will result in understanding:

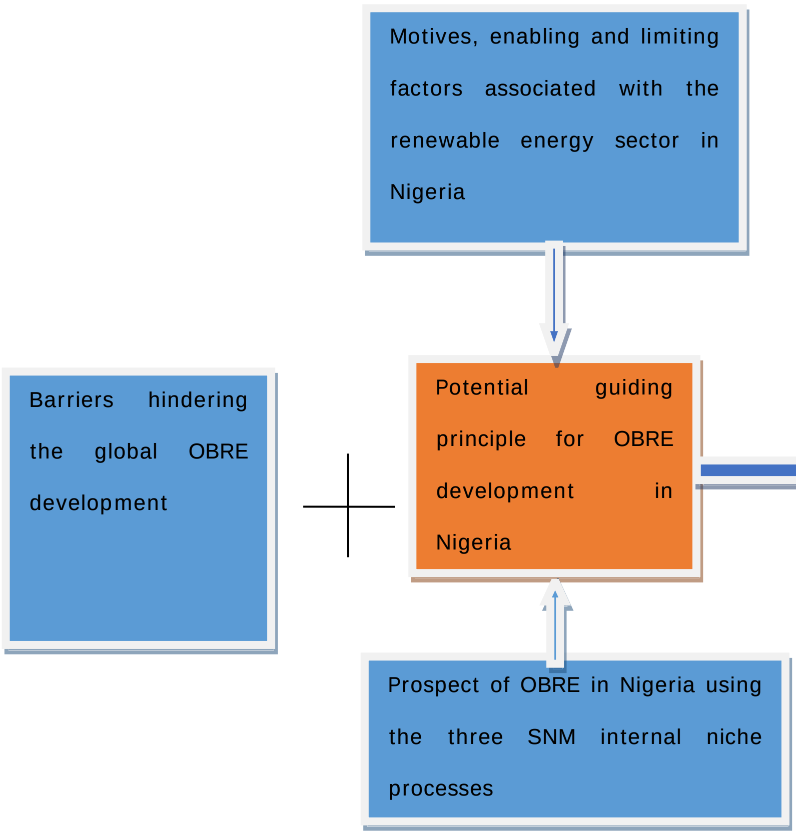
1. Why there has been no OBRE commercialization despite the several developmental practices underpinning the industry (See Chapter 6; section 6.3.2.2);
2. Potential guiding principles for the prospective transition towards OBRE development in Nigeria, underpinned by the following:
    a. The motives (local – Nigeria - and global landscape motivating RE transition), the enabling and limiting factors associated with the transition processes

b. the role of local political actors and coalitions in the transition processes

c. Insight into the activities linking OBRE niche development within the RE market through the three analytical lenses of SNM's internal niche processes.

Taken together item 1 and 2 above, the study's conceptual framework (that is theoretical underpinning in relation to the research study context) is informed, which is presented in Figure 5-6.

Figure 5-6: The research study's conceptual framework



Source: Author generated

Leshem and Trafford (2007) argued that a conceptual framework is simply a less developed form of a theory, and consists of statements that may link abstract concepts to empirical data. Accordingly, the conceptual framework for this study is to provide a clear and explicit connection between the theories, earlier literature findings, rationale of the present study, expected research design, likely interpretation of the research findings and the prospective conceptual conclusion(s). Fundamentally, the conceptual framework is developed to provide information and guidance on how the overall aim of the study would be achieved. These insights are combined to generate a methodological account for analysing and discussion purposes towards identifying the critical success factors required for the prospective transition towards OBRE development. Overall, the transition theory is considered suitable to be used as a theoretical framework to evaluate the prospects for a transition towards OBRE in Nigeria.

5.6 Concluding summary

This chapter discussed transition theory and framework as the theoretical lens underpinning this research study. The theory also provided two prominent perspectives for analysing transition practices: socio-technical transition and innovation system. The Chapter reviewed the various principles and approaches of the theory, and demonstrated its applicability to evaluate the prospects for a transition towards OBRE development in Nigeria. It also revealed that transition theory considers certain guiding principles by which technology innovation development can be embedded within existing socio-technical regime systems. Overall, understanding the philosophy of transition theory may enable a potential transition towards a successful adoption of a particular technology such as OBRE. However, it is fair to suggest that the observed limitations in both the global OBRE and RE development landscape, particularly in Nigeria, are yet to consider fully the thereotical underpinning principles. The next chapter discusses the methodological approach utilized to achieve the aim of the study.

CHAPTER SIX

Research Methodology and Methods

6.1 Introduction

This Chapter will review the research methodology as well as methods adopted by the study. It will introduce the research paradigm underpinning this research and discuss how this relates to the research method espoused. It will go on to discuss the research methods utilised including the case study strategy, as well as describe the tools for data collection and analysis. The chapter will also cover the issue of validity, reliability and credibility of data in relation to the method employed.

6.2 Research paradigm that underpins the study

A researcher' intentions, goals, and theoretical assumptions are intricately linked with the research that is undertaken. This is because how the researcher views reality and knowledge affects the methods of uncovering the interactions between phenomena as well as how the researcher values the studies of others' research in relation to the researcher's study (Grix 2004). Thus, understanding the underlying assumptions and philosophical reasoning that informs the choice of research questions and methodologies applied to answer the questions is an important first step of developing a clear and precise research design (Bryman 2012).

The word paradigm refers to the underlying assumptions and intellectual structure upon which research and development in a field of inquiry is based (Kuhn 1962). Dill and Romiszowski (1997 posit that the main functions of a research paradigm are to:

1. Define how the world works, how knowledge is extracted from this world, and how one is to think, write, and talk about this knowledge;
2. Define the types of questions to be asked and the methodologies to be used in answering them;
3. Decide what is published and what is not published;
4. Structure the world of the academic worker; and,
5. Provide its meaning.

Thus, the components of a research paradigm are argued to include the following (Creswell 1998; Guba and Lincoln 2005; Grix 2004) which are further explained in relation to this research study:

1. Ontology – how one views reality;
2. Epistemology - understanding of the nature of knowledge and;
3. Methodology - processes of inquiry.

6.2.1 Ontology

Here the research use Guba and Lincoln's (2005) definition of ontology as a perspective on the nature of what is being studied, firstly, whether it exists as some objective of facts of reality or secondly, does the nature of that being studied vary due to a range of possible factors, including social, economic, political, situational, or experiential/personal. The first is the objectivist view that social entities exist independent of social actors (Ryan et al. 2002). The implication for this research is that the research would have to take the view that there is an objective reality, which exists independent of the researchers' understanding and is called Realism ontology assumption (Ryan et al. 2002; Burrel and Morgan 1994). The second is the subjectivist (social ontological) view that social phenomena are created from the perceptions and consequent action of social actors and that this is a continual process as long as social interaction of the actors also continues (Saunders et al. 2009). Thus, reality may be created and shaped by social, political, cultural, economic, ethnic and gender-based structures and it is called Nominalism (Ryan *et al.* 2002; Burrel and Morgan 1994).

Accordingly, both the nature of research subject and the researcher's prior knowledge and experience, have contributed to the shaping of this PhD research as a Nominalism ontology assumption. The researcher therefore addresses the PhD research problem (research question) through the basic beliefs in the existence of multiple realities underpinned by social, economic, political, situational, or experiential/personal range of factors.

6.2.2 Epistemology

Another crucial element within the composition of a research paradigm framework is the philosophy of the researcher (Cohen and Crabtree 2006). Cohen and Crabtree (2006) argue that the paradigm, within which the research is situated, is heavily influenced by the philosophical assumptions made and adopted by the researcher. This refers to the various views that the researcher holds about human beings and this world, which informs the researcher's selection of a 'theory in practice' or 'philosophical stance'. This philosophical stance is based on the premise of epistemology or nature of knowledge. Epistemology by its nature highlights the perceptions of research findings as an objective product of neutral observer, or as an inter-subjective product constructed by the relationship between the researcher and the system in study (Guba and Lincoln 2005). It is what constitutes acceptable knowledge in a research (Collis and Hussey 2003; Hassard 1991). Burrell and Morgan (1979 p2) explained the epistemological assumptions on whether knowledge is,

> *"hard, real, and capable of being transmitted in tangible form", or whether it is, "softer, more subjective, non-physical or even inspirational kind, or based on experience and insight of a unique and essentially personal nature".* (Burrell and Morgan 1979 p2)

As a result, the epistemology assumption is mainly concerned with the relationship between the researcher and the problem under investigation giving rise to two prominent philosophical stances: positivist and anti-positivist (interpretivist).

The positivist and interpretivist schools of thought view the world from different dimensions with the former believing that only knowledge that is both observable and measurable can be regarded as indisputable knowledge. Hence, these schools of thought are concerned with objectivity and evidence in the course of an investigation (Ritchie and Lewis 2003). The emphasis within the positivists is placed on observation and reason as a means of understanding a phenomenon (Ritchie and Lewis 2003; Collis and Hussey 2003). It assumes the objectivity of the researcher and an objective reality, knowledge of which can only be added from data that can be directly experienced and verified between autonomous observers (Dash 2005). This puts such a philosophical stance at odds with this study, which aims to investigate how OBRE development can be developed within a social system, which by its very nature considers different perspectives of multiple stakeholders. On the other hand, the interpretivist argues that a researcher can only understand a particular phenomenon through involvement within the research (Burrell and Morgan 1979). Thus, the interpretive school of thought is of the view that the world, people and institutions are essentially different from actual science (Bryman and Bell 2004). The interpretive school of thought lies in contrast with a positivist philosophical stance and as a whole reject the constraints imposed by observation. Here, the research takes into consideration the impact of the researcher and their background within the context of their research, and will generally rely on the 'research participants' views of the situation being studied. That is, the intention of the research is to interpret

> *the world of human experience"* (Cohen & Manion 1994, p 36), suggesting that *"reality is socially constructed"* probing *"into the various unexplored dimensions of a phenomenon rather than establishing a specific relationship among the components,* as in the case of positivism (Mertens 2007 p.12).

In principle, the interpretivist school of thought

> *"generates or inductively develops a theory or pattern of meanings" about a concept"* (Creswell 2009, p.8-9).

It also involves the element of observation and interpretation of information obtained from research participants in the social world (Dash 2005; Saunders et al. 2007). This makes the interpretivist school of thought more applicable in relation to this study than positivism thereby making such a stance more applicable in the context of this study

6.2.3 Methodology

As presented in the previous section, with the study's adoption of a pragmatic philosophical stance, utilizing a qualitative approach to data collection was found most appropriate in achieving the aim of this study. This is because the qualitative approach to data collection focuses on understanding and explaining the beliefs, experience and behaviour of research participants in a particular context. The decision to use a qualitative methodology within the research is based not only on its alignment with the study's pragmatic philosophical stance or research but also its appropriateness given the social context of the study (Tashakkori and Teddlie 2003; Bryman 2006). While primarily a qualitative research study, it also utilises secondary quantitative data in the data collection method when addressing the mathematical/measurement indices utilised in understanding the principles of calculating the theoretical power potential being generated from an OBRE HEC device as illustrated in Sections 3.2.

The qualitative aspects of the research covers the background investigation, the nature and concept of OBRE, case study context, as well as the descriptive aspects of the data collection techniques employed within the study. The element of quantitative data, however, is in the form of literature (secondary research that includes online and desk-based research) in order to support the rationale for this research study in Nigeria. The study research approach is inductive in nature where emergent theories are systematically generated from the data collected from the qualitative method (Kumar 2005; Strauss and Corbin 1998). That is, the theory is emergent from the methodological collection and analysis of data as opposed to a theory-led study where a hypothesis is tested (Gibbs 2007; Strauss and Corbin 1998; Kumar 2005). The process of generating theory means that not only do the emergent themes come from the data but they are also produced within the context of the research subject (Gibbs 2007). In order to generate the theory, the research employs a case study strategy, examining a case as the basis of the enquiry that ensures the theory is

> *"contextualised and developed by recognising patterns of relationships among constructs within the case as well as their underlying logical arguments"* (Eisenhart and Graebner 2007, p.25).

A case study is seen as a choice of object to be studied (Stake 1995), or even as a research strategy (Yin 1994). When considering Stake's (1995) views, Nigeria's potential use of OBRE for electricity generation has been identified as a case 'object to be studied' as it satisfies the criteria of being specific, unique and a bounded system. Furthermore, Yin's (1994) and Merriam (1988) have also suggested that if the nature of a research enquiry about a phenomena, its context and the need to use pertinent sources of information is required, a case study design appears to be unavoidable, thereby lending itself as a methodological strategy. The use of this strategy is particularly suited to a pragmatic applied research scenario as is the case here, where there is a

> "*need to understand a particular problem within a unique situation in great depth"* (Patton 1990, p. 54).

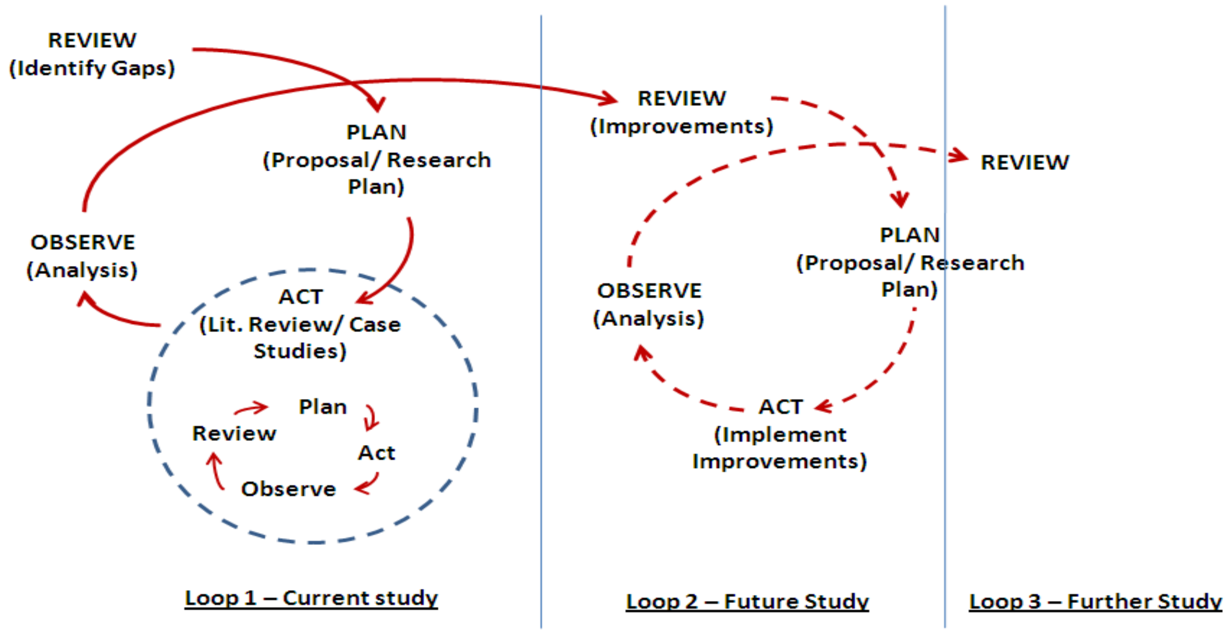
However, a frequent criticism of case study strategy is that its dependence on a single case, such as this study, may appear to render it incapable of providing a generalisable conclusion. Yin (1994), argued that the number of cases studies used, does not necessarily transform into a generic study but that the goal of the study should establish the parameters, which should then be translated into the case study design. Furthermore, Yin (2003) argued that the skills required to employ a single case study based research is mainly a good knowledge of the phenomenon as there are no routines in the research procedures. Consequently, even a single case study, such as this, could be considered acceptable, provided it meets the established objective that it allows for analytical generalisation which has been applied in some single case studies related to this research study (Mutokolo *et al.* 2014; Hansen and Nygaard 2014; Strachan *et al.* 2015). Nevertheless, the issues relating to generalising or the transferability of a single case study approach in this study was addressed by exercising rigour on the study's design and methods through validity, reliability, and credibility in accordance to Patton (2002).

Additionally, the use of case studies strategy is particularly suited to situations where the research seeks to explore the 'why' and the 'how's' as is the case here (Edmonson and McManus 2007). Therefore, this research examines the 'whys' in terms of why is the renewable energy market in

Nigeria, is still in its pre-development phase, and determining the how's from the point of view of how can the transition towards OBRE development be facilitated in light of the current predevelopment phase associated with the renewable energy market.

Yin (1994) also classified two types of case study categories: explanatory and exploratory. The explanatory portion of this research refers to the aspects of descriptive research, which in this context seeks to clarify again, the *"why"* from a transition towards OBRE development perspective, in Nigeria (Kumar 2005 p 10). The exploratory portion of the study comes to bear when addressing the final set of research objectives, where it seeks to evaluate the prospects for a transition towards OBRE and the design of an intervention framework that will systematically influence, guide and structure OBRE transition process. The underlying aspect however, in justifying the use of case studies either as a strategy or as means to generate theory is its fit with the philosophical underpinnings of the study as this tie into all other aspects of the study including the nature of the research question (Schell 1992). In considering the practical nature of the research, the study also explores the use of an action research strategy. Although the study is also not a primary piece of action research, its focus on improvement and concern with social practice (O'Brien 2001; Kember 2000) sees, it embody some of its key elements as a foundational strategy. Thus, it seeks the development of 'theory to practice' where the researcher is seen to be partially participating in the situation encountered and to have a stake in assisting, responding, improving and potentially implementing with regards to the research study's aim (Cohen and Crabtree 2006). This sees the research as a scientific (an increase in knowledge, new insights and the potential development of theory) as well as a practical goal (a social objective), conceptually underpinned by the action research as presented in Figure 6-1.

Figure 6-1: Contextualising action research within the research study



Source: Akinsete (2012).

Figure 6-1 depicts the nature of the research in the context of an action research spiral with this current research study forming the first loop (Loop 1) of the spiral, with an opportunity for further study (Loop 2), which is based on the findings and recommendation of the loop 1. This 'further study' is in relation to the proposed OBRE project for Bayelsa state as previously mentioned earlier in Chapter 1. Thus, the study explores improvement not only within the context of the subject of the research, but also within the meta process, that is the actual conduct of the research.

Furthermore, due to the nature of this study, the action research focus takes this perspective as a starting point for an interventionist approach towards mobilising a transition, in this context, for OBRE development in Nigeria. Additionally, engaging pertinent research practitioners' from the perspective of the action research process can ensure broad support and potential buy-in for constructive decisions on OBRE development. For that reason, it was in the interest of the researcher to explore and understand the complexities surrounding the contemporary nature of the renewable energy market in Nigeria against the backdrop of how, in practice OBRE can be successfully developed at both the design and implementation level. The summary of the research design for this study is summarized in Table 6-1 in relation to the components of the research paradigm, explained in Sections 6.2.1, 6.2.2 and 6.2.3.

Table 6-1: Position of study in relation to the research paradigm underpinning the study

Assumptions	**Position of study**
ONTOLOGY	Reality is constructed inter-subjectively. It is a reality created and shaped by social, economic, political, situational, or experiential/ personal -based forces.
EPISTEMOLOGY	Investigator cannot separate from what they know and this inevitably influences inquiry. What can be known is inextricably tied to the interaction between a particular investigator and a particular object or group being investigated - interpretivist
METHODOLOGY	Methods ensure an adequate discussion between the researchers and those with whom they interact in order to collaboratively construct a meaningful reality. Meanings are emergent from the research process and typically, qualitative methods are used with some elements of quantitative methods

Sources: Author generated

6.2.3.1 Researcher's position

It was important for the researcher to consider the 'positioning' of their role within a research context especially an applied one like this. Nettleton (2011) suggests that there are three possible stances an applied researcher could take within the context of their research, namely; as a 'master of nothingness', a 'native', and a 'connected critic'. Being the 'master of nothingness' refers to a situation where the researcher attempts to step outside the situation, while the 'native' position refers to the exact opposite where the researcher is very much embedded in and amongst not just the situation but the people being researched. Finally, the 'connected critic' refers to the tensions between the two previous positions; with the critic, who despite being intellectually and/or emotionally attached, seeks the success of the common enterprise over the welfare of the natives.

The position adatpted by the researcher in this study was a 'concerned' connected critic which enables the researcher to instigate societal changes whilst methodologically collecting, analysing and interpreting data (scientific insights). Thus, the researcher believes that reality is created and shaped by social, political, cultural, economic, ethnic and gender-based structures. Further, the researcher in this case, is also understood as having a stake in improving a problematic situation, therefore an active participant in that situation, thus rejecting the notion of neutrality.

6.3 Research methods

After considering the philosophical assumptions underpinning the research study above, this section discusses data collection techniques and the type of analysis employed in the study. Researchers employ and discuss various data collection methods: interview, focus groups, observation, participatory, questionnaire based surveys (primary data collection techniques), and literature review (secondary data collection techniques) for gathering information, evidence and facts (Creswell 1998; Collis and Hussey 2003; Saunders *et al.* 2007). Researchers will tend to select the method or methods that they consider as adequate means of collecting information in order to address the problems under investigation (Spencer et al. 2003; Devine 2002). The appropriate choice and application of the collection method is however considered to be one of the challenges in the course of a research (Sale and Brazil 2004; Read and Marsh 2002). In this regard and against the background and aim of this study, the interview method was selected as the most appropriate data collection technique thus, serving as the primary source of data.

The nature of this study, including the transition theory and frameworks influenced the choice of the aforementioned techniques since it sought respondents' perceptions, strategic action towards a potential real life application of OBRE. Furthermore, due to the research being a social policy study through its requirement to meet certain information needs and its potential for actionable outcomes, the use of the interview data collection enabled:

> "*a social action grounded on the experience – the world view – of those likely to be affected or thought to be part of the problem* (Walker 1995, p 19)

Sections 6.3.1 discusses the data collection technique employed for this research study.

6.3.1 Interview – semi-structured interview

An interview has been regarded as one of the most significant and efficient techniques for data collection (Silverman 2006; Gubrium and Holstein 2002). Parahoo (2006, p307) defined interview as a:

> *"verbal interaction between one or more researchers and one or more respondents for the purpose of collecting valid and reliable data to answer particular research questions"* (Parahoo 2006, p307)

Similarly, Collis and Hussey (2003, p167) described interviews as

> *"a method of collecting data in which selected participants are asked questions in order to find out what they do, think or feel about a phenomenon"*. (Collis and Hussey 2003, p167)

Interviews can be conducted face-to-face, voice-to-voice or screen-to-screen and through email-correspondence (Collis and Hussey 2003; Bell 1999). Additionally, the nature of questions and the discussion involved generally allows data to be audio-recorded or taken through note taking, though not in all cases (Saunders *et al.* 2007). The goal of the data collection via interview is to ensure that the same context of questioning is generally given to all interviewees so that responses from respondents can be reliably aggregated and analysed (Bryman and Bell 2004). Three interview approaches are utilised for research studies namely: structured, unstructured and semi-structured interview approaches with each processes undertaken based on the nature of problems being investigated (Sanders *et al.* 2006).

In a structured interview format, the interviewer has predetermined questions that have been designed to extract the required information (Parahoo 2006; Smith 2003; Collis and Hussey 2003). Patton (2002) also called this method a 'guided interview', where a systematic and comprehensive approach is adopted by the researcher in the course of interviewing across a number of people. Additionally, some cases may encourage the respondents receiving the questions to be investigated in advance.

An unstructured interview is the second interview approach in which the interviewer does not have any pre-planned questions prior to the interview (Sekaran 1992). Some scholars called this approach a standard open-ended interview as the researcher enquires from the study participants the same questions throughout the exercise with room for allowing the interviewees opportunity to explain different areas of the aspect under investigation. This enables the researchers to collect rich information and presents an opportunity to ask questions that were not originally on the interview sheet. Additionally, such instances allow the respondents to shed more light on issues under discussion (Collis and Hussey 2003; Saunders *et al.* 2007). However, with such an approach it is seen to be acceptable if a competent researcher who seeks access to the relevant information without deviating from the main issue conducts it (Maxwell 2005).

The semi-structured interview is a combination of the two approaches discussed above and is believed to be the preferred option for conducting interviews in different scenarios, as it possesses the advantages of both the structured and unstructured approaches (Collis and Hussey 2003). It is conducted within a specific context; such that some questions are omitted, in particular interviews and the order of questions may also vary depending on the nature of conservation between the researcher and interviewee (Collis and Hussey 2003). Therefore, considering the nature of this research, a semi-structured interview was utilised and designed with questions asked in line with the objectives of the study. The semi-structured interview aimed to collate empirical evidence upon which a view can be formed regarding the nature and context of the renewable energy sector in Nigeria with emphasis on the transition stewardship being undertaken to promote the sector's development. It also critically appraises the contemporary nature of the renewable energy sector in Nigeria, in terms of the potential transition stewardship that could support the transition towards OBRE. It was crucial to take the transition stewardship aspect being employed in Nigeria in order to gain a holistic understanding of the policy and project level design employed by the government that could limit or enable OBRE development in Nigeria. This view is expected to cumulate in evaluating the underlying factors that should be considered to ensure successful transition towards OBRE design and implementation. Additionally, it was envisaged that the data collected in this phase will provide a consistent means of validating or reviewing some of the findings or issues that emerged from the piloted interview-based focus group and related theoretical concepts associated with this study. Therefore, the semi-structured interview was very useful to gain an all-inclusive understanding of the pertinent information in relation to achieving the research study's aim.

Generally, interviews have been argued to have many advantages compared to other data collection methods, especially questionnaires that are also predominantly used in research studies (Sarantakos 1998; Turner 2010; Collis and Hussey 2003). Sarantakos (1998) describes its flexibility, high response rate and easy administration as some of the advantages of interviews. Turner (2010) also argued that most often, an interview is combined with other methods of data collection in order to give the research a well-formed set of information for analysis, including discussing and addressing specific enquiries in detail and clarifying some of the questions from previous data collection methods including secondary data and pilot studies. The objective of this is to improve the overall findings of this research. Accordingly, Turner's argument was evidentially utilised within the research where, for instance, pilot studies were first utilized, for instance in the phase two pilot study (Section 6.3.2.2), prior to using the interview technique. Smith (2003) however, raised some general concern about interviews. For instance, he argued that if the questions are poorly worded, it might lead to confusion or misunderstanding between the interviewer and the research participants. Secondly, problems such as inadequate recollection of events or experiences can make instant responses unreliable from the research participants.

6.3.2.1 Population and sample size

According to Sekaran (1992, p225), the population of a study refers to an "entire group of people, events, or things of interest that the researcher wishes to investigate". Similarly, it is defined as:

> "an aggregate or totality of all objects, subjects or members that conforms to a set of specifications" (Polit and Hungler 1999, p37).

Nevertheless, it is not easy or feasible to survey the entire population in a chosen area of interest when the numbers of the people involved in the research are considerable (Collis and Hussey 2003). Therefore, researchers always define a sample of the population in a bid to represent the entire population. This sample of the population is considered a person, group, organisation or system that can influence and be influenced by actions, objectives or policies (Gray, Owen and Adams 1996). However, it can be difficult to involve this sample of the population in a meaningful way due to differences in strategies, perceptions and the way they are structured. This belief is underpinned by some of the following factors: knowledge of the environment, priorities of interests and principles and the differences in challenges they face (Nichols 2002).

Applying the perspective above, it allowed the researcher to obtain an idea of the stakeholders under study and to define who to interact with or not for the purpose of the first two pilot phases and the actual interview method employed. Therefore, in keeping with the main aim of this research study, a purposive based selection process was undertaken to identify the organisations and potential research participants within the organisation. The purposeful sampling approach is a technique whereby a researcher selects a sample from the population based on the judgment that the chosen respondents meet certain criterion (Fogelman and Comber 2002). Thus, a purposive sampling technique was used to select the potential participants based on their functional responsibilities, knowledge, experience and skills particularly, within the renewable energy market of Nigeria. It also included those affiliated with the marine environment and OBRE development within Nigeria and globally, particularly in the UK. This criterion gave more emphasis to their level of expertise on a particular area of study or the issue under investigation.

It was also necessary to identify a suitable population from which appropriate data could be drawn. The research specifically categorised the population sample for the semi-structured interview into the following groups: regional and national (Federal and state) agencies; renewable energy developers; consultants – international, regional and local; research institutes (local); and finally NGOs. In this respect, each of the groups mentioned above has either policy, strategy, operational, monitoring or related decision-making roles in the management and development of renewable energy in Nigeria. Thus, the total population upon which this research relied upon included the staff of the following list of organisations for the semi-structured interview as detailed in Table 6-2.

Table 6-2: Identified research participants for the interview in Nigeria

Participation Code	**Organisation Name**	**Level of Respondents**	**Type of organisation**
OBRE 001	Federal Ministry of Power	Civil Servant	Ministerial Parastatal
OBRE 002	Federal Ministry of Environment	Civil Servant	Ministerial Parastatal

OBRE 003 and OBRE 004	National Electricity Regulatory Commission x 2 personnel	Advisory	Ministerial Parastatal
OBRE 005 and OBRE 006	Energy Commission of Nigeria – 2 personnel	Civil Servant	Ministerial Parastatal
OBRE 007	Transmission Commission of Nigeria	Managerial	Ministerial Parastatal
OBRE 008	Federal Ministry of State, Power	Civil Servant	Ministerial Parastatal
OBRE OO9	Ministry of Power, Bayelsa State	Civil Servant	Ministerial Parastatal
OBRE 010	Nigeria Institute of Oceanography and Marine Research	Managerial	Agency
OBRE 011	Henrich Bolls Foundation	Senior Executive	Climate Change firm
OBRE 012	Federal Minister of Water Resources	Civil Servant	Ministerial Parastatal
OBRE 013	Petroleum Training Institute	Researcher	Academic institution
OBRE 014	Centre for Energy Research and Development	Advisory	Research institute
OBRE O15	Nigeria Investment Promotion Commission	Senior Executive	Ministerial Parastatal
OBRE 016 and OBRE 017	Nigeria National Petroleum Corporation x 2 personnel	Managerial	Ministerial Parastatal
OBRE 018	Gen Sustainable Solutions	Senior Executive	RE consulting firm
OBRE 019	Trinomial Solution Ltd	Senior Executive	RE consulting firm
OBRE 020	ECOWAS CENTRE FOR RE AND EE	Managerial	Regional institution
OBRE 021	CREED Energy	Senior Executive	Consulting firm
OBRE 022	Nature Care Resource Centre	Senior Executive	Civil society (NGO)
OBRE 023	Rural Electrification Agency	Civil Servant	Ministerial Parastatal
OBRE 024	Gen Sustainable Solutions	Senior Executive	RE consulting firm
OBRE 025	National Centre Hydropower Research and Development	Senior Executive	Research Institution of Hydro Kinetic turbines
OBRE 026	Niger Delta Development Commission	Managerial	Ministerial Parastatal
OBRE 027	Bayelsa State Government	Advisory	Ministerial Parastatal

Source: Author generated

Thus, twenty-seven (27) research participants amongst the stakeholder groups that are associated with either the energy or renewable energy sector in Nigeria were selected for the interviews. Following the review of the literature (secondary research that includes online and offline desk) regarding the Nigerian Renewable Energy sector (GIZ 2014; ECREEE 2014), it can be argued that most of the research participants, specifically the ministries, are authentic participants who have experience and knowledge of the renewable energy sector. Additionally, the use of a snowball approach (Saunders *et al.* 2007; Creswell 2009; Bryman 2012) significantly aided the interview process with reference to having more actors interviewed who could contribute to the study. This was a useful strategy as it enabled the involvement of other important individuals omitted from the initial interview design stage. Furthermore, in order to maintain the confidentiality of research participants, codes were used to represent research participants' response, instead of their name for ethical consideration. Thus, acronyms starting with 'OBRE plus a three number digit was used to represent research participants name for the main interview session as presented earlier in table 6-2.

6.3.2.2 Exploratory pilot studies

Two phases of pilot studies were undertaken prior to the main interview process. The first two were exploratory in nature based on unstructured discussion sessions primarily for the purpose of scoping and understanding the context and informing the research instrument. It included discussions with various stakeholder – individually and small groups. They did not involve any audio recording as permission had not been granted to do so at this stage.

In view of that, the first phase related to an informal discussion in exploring the main barriers associated to global OBRE development. Additionally, the pilot test served to gain expert opinion from industrial practitioners on guiding principles to be consider when envisaging a transition towards OBRE development, specifically in Nigeria. The Researcher therefore believes that understanding the global barriers associated with OBRE development can aid chart a sustainable development programme for OBRE design and implementation. The second phase of the pilot study was undertaken in form of an explorative discussion with different focus group, where the use of this technique was necessarily helpful in relation to the proposed OBRE project as earlier mentioned in Chapter 1. This phase underlines the use of the action research context as earlier mentioned in section 6.2.3. The phase also provided useful information for the main data collection method employed – interview survey. These phases are further explained below:

Phase one

Empirical investigation on the barriers associated with global OBRE development.

In light of the literature assertions on the barriers associated with OBRE development, as presented in Section 3.3, it was necessary to undertake an exploratory pilot study to confirm the main barriers associated with global OBRE development. Knowing these contemporary landscape challenges would help Nigeria chart a more sustainable OBRE transition by proactively responding to those limiting factors. Since the focus was on the barriers associated with global OBRE development, only one theme as a unit for analysis was utilised. Hence, the informal explorative discussion focused on the question below:

1. *In your opinion what are the current challenges or barriers hindering global OBRE development?*

OBRE industry experts were identified based on their background and their various roles in promoting the development of OBRE in their respective countries. The general response received from the discussion indicated their direct involvement with sectors' developmental activities, particularly within their various countries; consequently, their knowledge of the current barriers associated to the OBRE sector was informed by their authentic experience in the sector. In this respect, each of the selected participants are suggested to be experts in the field of OBRE, with each having some institutional obligation for policy or strategic design, R&D projects, academia or related decision making roles in the management and development of OBRE.

Initial contacts were made through conferences attended in the UK and Canada, with further contacts obtained through literature reviewed from academic journal papers and organisational reports; in this case, interactions were through phone discussions and e-mail correspondence. Here, relationship was established prior to scheduling the interview with the respective research participants. However, a rigid timetable for the informal discussion process could not be designed due to participants' availability, time taken to respond to emails sent, and some impromptu discussion via skype/face-to-face meeting, which was usually scheduled by the participants, specifically in the UK. Sixteen industrial experts were contacted from different countries. However, thirteen responded to the question within the period provided to respond to the questions asked while the remaining three never responded. Of the thirteen, informal discussion was held with two respondents via face-to-face imeeting, while three were via phone discussion, the rest was through informal email discussion. The explorative pilot exercise was undertaken between January 2014 to November 2014.

Against the backdrop of the question being enquired, the result of the explorative pilot test is presented in Table 6-3 below, on the main barrier(s) associated to the global OBRE innovation.

Table 6-3: Informal responses to the main barrier(s) associated to global OBRE innovation

Interview participant	**Quotations**	**Respondent Locations**	**Findings**
OBRE PRT01	*"it is financial funding. Cost of implementation is high"*	Portugal	Cost of implementation
OBRE UK01	*"At a strategic level, as with any new technology, ocean power faces a high cost of energy at its entry point within a well-established electricity market made up of mature generation technologies".*	UK	Cost of ocean power energy
OBRE UK02	*"… my opinion is the unstable policy to aid in driving this sector. Cost is another concern but with the right policies and regulatory frameworks,*	UK	Unstable policy and cost

	cost might not become a problem"		
OBRE PRT02	*"... cost is a big barrier but with the right political environment, cost will not be an issue''.*	Portugal	Cost is a big barriers
OBRE UK03	"*Cost appears to be the main issue here. Costs will fall significantly through time and volume, however overcoming this initial market barrier requires understanding at a political and regulatory level of the cost of energy profiles for new technologies".*	UK	Cost appears to be the main issue
OBRE GH01	*"Funding are the major barriers"*	Ghana	Funding
OBRE MY01	*"supporting political mechanisms such as regulatory frameworks"*	Malaysia	Supporting political mechanisms
OBRE UK04	"*One major issue bordering on the overall renewable energy development in the UK is highly political induced so whether it is OBRE or any other form of renewable energy technologies, with the right political drive other barriers may be alleviate"*	UK	Political support
OBRE SA01	*"cost"*	South Africa	Cost
OBRE CN01	*"... at present financing is a big issue for us especially during the demonstration period"*	Canada	Finance is a big issue
OBRE UK05	"*In fairness the UK government has supported the OBRE industry, especially in Scotland, however developers are yet to demonstrate any level of confidence in bringing this innovation to fruition especially with large scale development models"*	UK	Lack of confidence from developers
OBRE SG01	*"... from my point of view, there is limited interaction in the ocean energy sector amongst the stakeholders to push the sector forwards"*	Singapore	Limited interaction amongst stakeholders
OBRE UK06	*"... honestly I think it has to do with the top government officials who are still interested in fossil fuel technologies such as fracking. That may be the problem"*	UK	Political support

Source: Author Generated.

In analysing the responses from the explorative informal discussion, it is clear that the most significant barriers associated with the global OBRE development as strongly perceived by the participants were of three-fold: lack of finance; inadequate political support; and, insufficient collaboration amongst stakeholders. This result is consistent with Lovdai and Neumann (2011) and IRENA (2014), where they both argued that the barriers associated with OBRE development are the need for a supportive capital and political schemes along with meaningful stakeholders' engagement. Breakdown of the pilot study is present:

From the lack of finance perspective, the following assertion was made:

"it is financial funding. Cost of implementation is high" (OBRE PRT01).

Similarly, another participant attested to this fact that cost was an issue but narrowed it to the point of demonstration.

> *"... at present financing is a big issue for us especially during the demonstration period"* (OBRE CN01)

From the political perspective, the following assertions were equally made:

> *"... supporting political mechanisms such as regulatory frameworks"* (OBRE MY01).

Similarly, there were research participants who also felt that inadequate political drive was a barrier but explained that this barrier was on the political priority for fossil fuel based energy.

> *"... honestly I think it has to do with the top government officials who are still interested in fossil fuel technologies such as fracking. That may be the problem"* (OBRE UK06).

However, some research participants had strong reason to believe that the barriers, especially finance, could be disabled through strong policy and regulatory frameworks:

> *"Cost appears to be the main issue here... however overcoming this initial market barrier requires understanding at a political and regulatory level of the cost of energy profiles for new technologies*". (OBRE UK03).

Another research participant strongly believed that renewable energy development such as OBRE could not develop unless it is politically induced, especially in the UK.

> *"One major issue bordering on the overall renewable energy development in the UK is highly political induced so whether it is OBRE or any other form of renewable energy technologies, with the right political drive other barriers may be alleviated"* (OBRE UK04)

It may now appear that the underlying barrier to the global OBRE up-take is due to the lack of political priority to induced investment in the sector, especially in the UK. Contrary to this opinion is the assertion made by one of the research participants who made it clear that that UK government has actually supported OBRE development.

> *"... in fairness the UK government has supported the OBRE industry, especially in Scotland, however developers are yet to demonstrate any level of confidence in bringing this innovation to fruition especially with large scale development models"* (OBRE UK05)

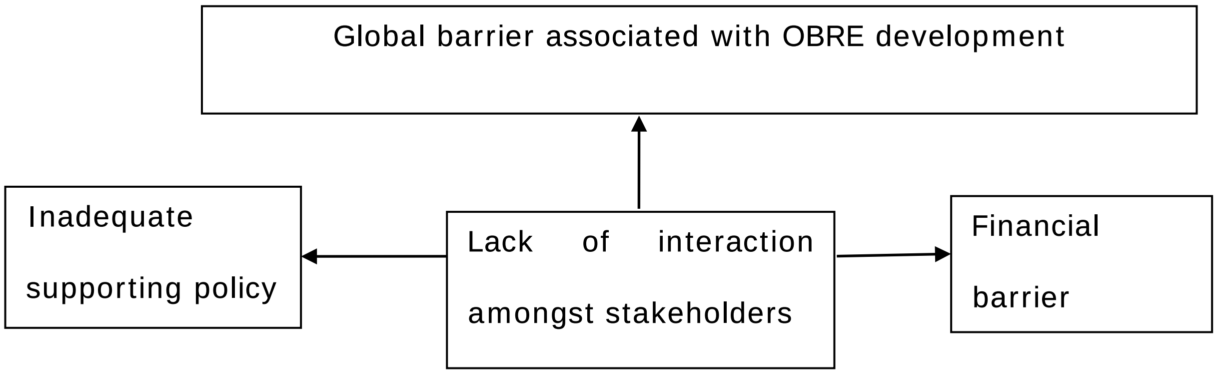
While appreciating the clear perceived opinions from the two research participants – OBRE UK04 and OBRE UK05, one research participant also felt that low stakeholder engagement is also a big factor hindering OBRE development.

> *"... from my point of view, there is limited interaction in the ocean energy sector amongst the stakeholders to push the sector forwards"* (OBRE SG01)

In conclusion, far less attention may have been paid to the issue of 'interaction' amongst various stakeholders involved in OBRE development in order to instigate the required political induced intervention. Hence, niche actors such as OBRE developers are expected to seek ways of influencing and interacting with wider policy setting if OBRE is expected to grow and diffuse (Strachan et al. 2015). This actually brings to bear IRENA (2014b) argument on the role of collaboration and interaction amongst diverse stakeholders and institutions to facilitate OBRE development. As a result of this, this empirical study provides a step forward towards achieving its aim in generating knowledge on factors that should be considered during the transition process for designing and implementing OBRE in Nigeria.

This research study therefore, infers that a potential relationship on the lack of interaction amongst stakeholders' may have led to the other two key problems associated with global OBRE development. Thus, it can be argued that the global barriers associated with OBRE development is due to inadequate supporting policy and financial constrained as a result of insufficient stakeholders' engagement (lack of interaction amongst stakeholders) as perceived by global industrial experts. This is conceptually illustrated in Figure 6-2.

Figure 6-2: Conceptualising the global OBRE barriers



Source: Author generated

Phase two

In this second pilot phase, the use of a focus group was utilized for the exploratory discussion on the proposed OBRE project to be developed in Nigeria as earlier mentioned in Sections 1.3 and 4.4.1. A fundamental element of the project is its integration with certain critical tasks, which includes the following requirements:

1. Undertaking credible consultation procedures to build trust and acceptance of OBRE amongst certain stakeholders groups especially the recipient state – Bayelsa state; and,
2. Understanding important implementation considerations towards charting the transition towards OBRE development.

Consequently, a piloted informal discussion based on a focus group strategy with certain key stakeholders associated within the energy/renewable energy market was undertaken towards achieving the two requirements above, in relation to the study's aim.

The theme 'focus' group used within the frame of this pilot study is theoretical explained below as per its nature and applicability with regards to this research. A focus group is argued to be a type of in-depth interview accomplished in a group, whose meetings present characteristics defined with respect to the proposal, size, composition, and interview procedures (Marshall and Rossman 1999; Silverman 2004). The focus or object of analysis is the interaction inside the group in which the participants influence each other through their answers to the ideas and contributions during the discussion. The general characteristics of the focus group are people's involvement, a series of meetings, the homogeneity of participants with respect to research interests, the generation of qualitative data, and discussion focused on a specific topic, which is determined by the purpose of the research (Friesta *et al.* 1998; Marshall and Rossman 1999; Silverman 2004). Focus groups are therefore used for generating information on collective views, and the meanings that lie behind those views (Morgan 1998; Bloor *et al.* 2001). They are also useful in generating a rich understanding of participants' experiences and beliefs (Friesta et al. 1998; Morgan 1998; Chestnutt and Robson 2000). Additionally, Friesta *et al*. (1998) posit that focus group research method can be applied for generating ideas for investigation or action in new fields; for generating propositions based on the perception of the participants and also generating additional information for a study on a wide scale. To this end, the nature of this pilot study lends itself to Friesta et al. (1998) position.

This exploratory pilot study is seen as an example of a co-production of knowledge between the researcher and key practitioners, including policy makers, in which a mutual understanding is developed towards solving a societal or scientific problem (Garniati 2014). It also provided the platform to explore and identify certain key ‘executive champions’ in some of the participating institutions or organisations. This was relevant as these individuals might have high levels of positional power in facilitating the allocation of resources and decision-making towards the actual practical development of OBRE in Bayelsa state (Brown *et al.* 2013). In general, this pilot study was chosen to capture stakeholders’ perceptions on the potential transition towards OBRE development in Nigeria. Subsequent intention to be derived from it, was to complement the main empirical study data collection technique – interview - within this research study. Nevertheless, the use of this strategy - focus group – for this pilot study may be constrained in some situations. This is in relation to the nature of utilising focus group data collection technique within a research study context as suggested by (Friesta *et al.* 1998; Chestnutt and Robson 2000; Silver 2004). Typical instances of contraints attributed to a focus group technique are illustrated in Table 6-4. However, all these limitations were taken into consideration when planning for this exploratory pilot study.

Table 6-4: Expected constraints of the pilot study in relation to a focus group method context

Constraint number	Limitation of focus group based method	Constrain situation
1	Interpersonal relation amongst participants within the group	If participants are uneasy with each other and will not discuss their feelings and opinion openly
2	Topic of discussion	If the topic of interest to the researcher but not a topic the participants can or wish to discuss

3	Confidentiality	When the researcher cannot guarantee confidentiality of the information.

Source: Author generated from (Friesta et al. 1998; Chestnutt and Robson 2000; Silver 2004).

In keeping with the main aim of this pilot study, a purposive based selection process was undertaken to identify the organisations and potential research participants within the organisation. A purposive sampling technique was also used to select the potential participants based on their functional responsibilities, knowledge, experience and skills, particularly, within the renewable energy sector of Nigeria, including those with affiliation with the marine environment and OBRE development in Nigeria such as NIOMR and PTI. This approach was able to address the constraint 2 (Table 6-4). In additional, the participants from each organisation that were selected together for this pilot study had similar concerns on the inadequate access to electricity in the country. It can be suggested that their relationship was amiable to an extent that meaningful and open interactions amongst each other was observed. This observation tended to also address constraint 1 (Table 6-4). Furthermore, in order to maintain the confidentiality of research participants, codes were used to represent research participants' responses, instead of their name for ethical consideration. Thus, acronyms were used to represent research participants' name; to address constraint 3 (Table 6-4). Through the purposive sampling strategy, the choice of Bayelsa state as part of the research participants was prompted due to the state's recent focus on OBRE as presented in Section 4.4.1. Hence, it was easy to engage the state. Prior to the actual explorative discussion session, communication via email and telephone calls with the various stakeholders' were established to develop the new relationship and further build the required trust. However, email use proved rather frustrating because emails often went unanswered when sent to the research participants. This somewhat built doubts about the dependability of the selected stakeholders' at the initial stage. This issue was resolved through voice-to-voice mode of communication (phone calls) prior to actual meeting. This approach came highly recommended by one of the research participants as asserted:

> "*Normally for most policy makers, it is very difficult to discuss anything by email, in generally they never answer. It is a cultural problem…*" (BSG research participant)

With respect to the size of the group within each of the selected organization above, according to Friestas *et al*. (1998), 6 to 10 people is suggested to be the moderate size for an 'actual' focus group discussion. Stewart and Shamdasani (1990) also suggested that the optimum size is 6 to 8 participants (excluding researchers), but can also work successfully with as few as 3 and as many as 14 participants. However, small groups risk limited discussion occurring, while large groups can be chaotic, hard to manage for the moderator and frustrating for participants who feel they don't get sufficient opportunities to speak (Krueger 1998). In addition, factors including where the sessions are to be conducted and the importance of the research participants are proposed to be critical in relation to the potential size of the group. Accordingly, the pilot study meetings were conducted with the following organisations along with the rationale for the explorative discussion and the number of participants involved as detailed in Table 6-5.

Table 6-5: Piloted research participants

Research participants / code name	Rationale for the discussion	Number of participants
Bayelsa State Government (OBRE BSG)	State focus for a potential OBRE development, specifically Tidal current. See Chapter 4, section 4.4.1	6
ECREEE in Cape Verde (OBRE ECREEE)	Regional institution support. See Chapter 2, section 2.5	8
Department For International Development (DFID) – (OBRE DFID.	International development organisations supporting Nigeria towards RE development. See Chapter 2, section 2.6.2.2	4
Petroleum Training Institute (OBRE PTI)	Conducted preliminary investigation on the broader form of ocean energy such as tidal range. See Chapter 4, section 4.2	5
Nigeria Institute of Oceanography and Marine Research (OBRE NIOMR)	Conducted possible preliminary investigation on the OTEC. See Chapter 4, section 4.2	3

Source: Author generated

The explorative discussion-based focus group pilot fieldwork was undertaken in three field visits, with on-site days amounting between 3 to 7 working days per visit, spread over a 9 months period as presented in Table 6-6. In terms of administering the pilot study, element of action research concept was utilized as a way of combining social science methods with the planning and implementation of practical activities in a real life setting (Dawson 2009). This is underpinned on the basis of achieving four basic themes: empowerment of participants; collaboration through participation; acquisition of knowledge; and, instigating a societal transition, in this case towards OBRE development (Loorbach 2007).

Table 6-6: Piloted study's field visits schedule

S/N	Date of Field Visit	Location(s) and Country	Planned activity to be undertaken during the field visitation
1	June 2013	Location(s): Bayelsa State Country: Nigeria	Preliminary discussion on OBRE potential in Nigeria and its relevance application in the state. First contact with BSG policymaking actors.
2	November 2013	Location(s): Lagos, Abuja and Bayelsa States Country: Nigeria	Mini-lecture/ presentation to pertinent stakeholders' in Bayelsa state on the nature of OBRE and its wider relevance in Nigeria. Subsequent engagement with NIOMR, PTI, and DFID.
3	July 2014	Location(s): Praia Country: Cape Verde	Lobby support from the regional institution - ECREEE, responsible for facilitating renewable energy and energy efficiency development in the West Africa sub-region.

Source: Author generated

The process that the researcher goes through to achieve these four themes is a spiral of action research cycles consisting of four major phases: planning, acting, observing and reflecting as earlier presented in Figure 6-1.

The use of the action research was informed by theoretical considerations focusing on the learning philosophy of undertaking an applied social policy research towards improving a situation in a particular setting (Dawson 2009; Huberman and Miles 2002). In conducting this pilot study, the researcher had built a considerable amount of experience working in the international development field, underpinned by the several relevant research studies, field visits and short-term research assistant contracts within the Robert Gordon University's Centre of Understanding Sustainable Practice (CUSP) at Aberdeen. Accordingly, over the course of the short-term research assistant contracts, the researcher was involved in the conduct of OBRE developmental activities within two real-time projects – Cape Verde and Indonesia, thus providing practical hands on experience in relation to this pilot study. Furthermore, prior upskilling during the researcher's MSc programme in Energy Management has equally brought about the interest to this applied research context. Accordingly, in line with the four action research phases, a summary of the process by which the piloted study was administered is presented below.

Planning stage

An initial contact was made with the Bayelsa State Government (BSG) concerning addressing the electricity challenges being faced by the state using OBRE. This initial contact was in June 2013 between the researcher and BSG stakeholders involved in energy planning in Yenagoa (capital city of Bayelsa State) through a private energy investor who happened to be an indigene of the state. The meeting ended with strong enthusiasm from BSG to progress the potential for OBRE development and they requested the researcher to come back for further deliberation. Thus, the researcher carried out appropriate planning for the follow-up visit by identifying suitable date, the main theme for discussion, preparation of communication tools such as power point slides and the required research participants for the pilot study session/meeting.

Acting stage

In the acting stage of the pilot group, that is actual implementation of the planned activities is illustrated in tables 6-5 and 6-6. The Researcher, along with four CUSP researchers travelled to Nigeria to attend the second meeting in Bayelsa as part of a three weeks fieldwork to the West Africa sub-region, in Nigeria, Ghana and Togo. While in Nigeria, for the second meeting with BSG, other organisations such as the Petroleum Training Institute (PTI), Nigeria Institute of Oceanography and Marine Research (NIOMR) and Department for International Development (DFID) were visited to form part of the pilot study. The purpose of these visits was to continue with stakeholders' engagement and to gain useful data on the potential approaches that may be applied towards OBRE development in Nigeria. For instance, the discussion with DFID was for market support programs/funding prospect. The data collection process involved discussion focused on the main aim of the pilot study mention earlier. This discussion occurred in the month of November 2013, while that of ECREEE in Cape Verde occurred in July 2014.

Observing (analysing and finding) phase

Notes were taken during the discussion and analysed to provide the key findings. Findings were then iteratively fed back as part of the theory development in Chapter 8 for discussion purposes, which is the reflecting phase of the action research concept. The pilot study analysis is presented below.

Analysis of the pilot study revealed two key findings related to stakeholders' perception on the prospective transition for OBRE development in Bayelsa State. Accordingly, the first finding revealed that the interview-based focus groups described the limited knowledge (lack of awareness) towards the nature and principles associated with OBRE's as a key challenge. Participants believed that the intrinsic worth that OBRE brings might not be exploited sufficiently if reasonable awareness programs are not demonstrated, especially to the broader stakeholders responsible for shaping and directing RE development in Nigeria. Research participants described this lack of awareness as one of the most explicit barriers hindering RE development in Nigeria. An explanation by two of the participants who characterize the concerns expressed by many:

> *"... in many ways the lack of understanding of these renewable energy technologies are the main challenges we have today in Nigeria ... (OBRE PTI)*
>
> *"How much do we know about this technology again... other renewable technology are still new to all of us here..." (ECREEE BSG)*

From a different comment but within the frame of the limited awareness theme, in one of the piloted interview-based focus group session, a participant insisted that a conference or seminar should be put in place to introduce the concept of OBRE:

> "*If it was possible to present this to a wider audience in their forth coming Lagos State Economic Conference, 2014... that could improve stakeholders' expectation of the technology"* (OBRE DFID).

Many in the piloted interview-based focus groups also felt that a potential field trip to some of the locations - described as being active in this innovative (OBRE) field by the researcher - such as the UK and/ or Canada is worth undertaking. They believe that onsite exposure to the technologies and its applications could provide a better understanding of OBRE and enhance the possibility of stimulating broader networks towards promoting OBRE development in Nigeria. This onsite visit idea was a common motivation across all the interview-based focus groups, and as the participant below explained, the rationale for this is to encourage potential market and technical support from key policymakers especially the Federal Government.

> *"I believe an international visitation is necessary to fully appreciate ocean energy activities so that it can be supported by government ..."* (OBRE NIOMR).

When describing the rationale for this argument, many participants in the BSG's piloted focus group session identified the challenges between theoretical innovation and the reality of practice. They explained that while technology innovation pronouncement especially from developed economies were pleasing to adopt, the discourse itself had limited connection to practical realities within developing economies, a point understood by one of the participant as a 'trust relationship' characteristics between the two economies by saying:

> "*can we trust this OBRE technology from Aberdeen ...*" (OBRE BSG)

This was a key theme 'trust' reflecting how actors in developing economy perceives technological innovation that are transferred from developed countries.

The second key findings from pilot revealed the lack of clarity of supporting policies and institutional frameworks fostering RE development in Nigeria. As succinctly put by two of the participants from different groups:

> *"Ineptitude of political priorities and the market framework to stimulate renewable energy in the West Africa sub-region" (OBRE ECREEE)*.

> "… have you *considered the lack of ability and skills to develop renewable energy sector in the various ministries responsible for policy design and implementation" (OBRE DFID)*

Participants in Bayelsa state were however, quick to acknowledge the effort made by the Federal Ministry of Power towards RE development in Nigeria, from a policy design context, but were also critical of the ministry's lack of capability in policy implementation. Accordingly, a number of the research participants acknowledged that certain 'politicking' existed in the RE sector hence the inadequacy in policy implementation. These sentiments were captured in the comments of one of the participants who explained:

> *"… have you considered the 'politicking' amongst some of the ministries in the renewable energy sector?"* (OBRE BSG)

In the context of Nigeria's language syntax, the word 'politicking' suggests 'awkwardness' in the relationship amongst the various energy/RE public authorities as presented in Tables 2-1 and 2-2 respectively. Another participant, an individual in an advisory role on energy matters described this implication as worrisome and requested the researcher to converse with the relevant public authorities responsible for administering renewable energy development in the country. The participant asserted by saying:

> *"… it will be good to discuss with the various ministeries such as Federal Ministry of Power, ECN and Federal Ministry of Environment on your OBRE thing so as to know your next step. If not it may not work at all"* (OBRE BSG)

Similarly, other research participants' groups also highlighted the need for the researcher to engage more with the relevant policy actors as they strongly believed that issues such as unsuitable organisation is a pertinent issue confronting the West African sub-region's RE development including Nigeria. This assertion was interwoven throughout the discussion session but captured succinctly by one of the research participants, specifically within ECREEE's focus group session:

> *"… clear direction and governance from governmental agencies in West Africa are missing, resulting in an ad-hoc development within the renewable energy sector".* (OBRE ECREEE)

In sum, this explorative pilot study provided some key perspective for a potential transition towards OBRE development in at least three ways: Firstly, the pilot study helped provide the experimental context in which a number of assumptions and ideas underlying the research objective 5 (Section 1.2) could be achieved, in practice. For instance, what is the role of policymakers within the transition process? Additionally, the researcher could evaluate the possible impact of bringing together these policy makers within a defined arena. Secondly, it provided a context in which the researchers could learn about the role of a facilitator in structuring transition process for OBRE development. This related directly to the researcher's role within the pilot study, which was based on an action oriented focus group approach. Thirdly and perhaps the most important one, the pilot test provided a situation, which allowed for rapid understanding of socio-technical transition theoretical ideas cultural practices, networking and multi-actors) and the formulation of a number of possible concepts which may be applicable towards the design of the intervention model in response to objective 5. Interestingly, the results of the pilot engagement appears to favour for an OBRE project to be undertaken, as highlighted in Appendix 1.

6.3.2.3 Administering the semi-structured interview

Prior to administering the semi-structure interview, the validity and reliability of the actual interview questions was undertaken in a bid to ensure the questions contained are not ambiguous or biased (Bell 1999) Jonker and Pennink 2010). Bell (1999) who posited that pilot studies reduce the tendency of time and resource wasting as it reveals deficiencies in the proposed approach design or procedure that could be addressed prior to the main administration of the survey. This is to test whether the instrument is capable of generating the targeted response from the audience through enhancing the quality of the questions vis-à-vis: wording, language and presentations of the context in an appropriate way, before actual data collection commences (Oppenheim 1992).

The pilot tests were carried out in the context of ensuring the adequacy of the research interview. The initial pilot test was conducted at the Robert Gordon University, Aberdeen between the period 9 April to 24 April 2015. Seven participants – three doctoral research students, two senior lecturers, one master degree students and one energy consultant, all knowledgeable in the field of renewable energy development, particularly within the African region participated in this initial pilot test. All their valuable comments and suggestions relating to the wordings, timeline to complete the interview, clarity of instructions and any questions that might make respondents feel uneasy were incorporated. Since, this was the main data collection source and its application was in Nigeria, the second pilot test was conducted between 20 April and April 24 2015 when the researcher travelled to Nigeria. This time five people participated – two key renewable energy experts in the Ministry of power and environment, Lagos state and three independent renewable energy consultants. Again, valuable comments and suggestions were received from this group, such as how two of the questions appeared similar in nature and should be compressed into one question. The interview questions were amended and the adjustment made in line with the second pilot test participants. These comments were helpful, as the main study participants (27 selected for the interview) did not raise any issues associated with the context and content of the interview.

The semi-structured interview schedules prepared allowed for a thorough exploration of the prospective transition towards facilitating OBRE innovation in Nigeria. Initially, individuals were contacted by email and telephone. However, most of the participants never replied when e-mail correspondence was used, specifically from the ministries. Since the researcher was still in the UK, the use of the telephone as a medium for communication became necessary to contact the participants. This yielded a good result and, all participants were happy to contribute to the study. An accompanying covering letter, a letter of consent from RGU was sent to all research participants with the aim of encouraging them to answer the questions, providing further the necessary credibility of the research study. (See Appendix 5).

In administering the interview, contacts were developed and a relationship was established prior to scheduling a meeting for the data collection with respective research participants. The researcher made pre-notification contact with the various research participants before the actual interview. These pre-notification contacts were made, first in the UK and during the field visit to Nigeria – at least a week prior to actual interview session. Accordingly, appointments with the relevant research participants were then scheduled for the interview sessions in Nigeria. The whole exercise of setting up meetings and interviews took a period of three weeks, one week in the UK and the remaining two weeks in Nigeria, specifically in Lagos and Abuja. Abuja was the main location for conducting the interviews because the majority (over 85%) of the research participants resided there. A timetable was prepared to facilitate the interview meetings for each of the identified participants as presented in Appendix 6 and an interview schedule was design to facilitate the interview process.

All interviews were recorded using a digital Dictaphone in order to capture all conversations, allow the researcher to focus on the interviewee and the questions including non-verbal responses (Bryman 2008). This increases the rapport between the researcher and the research participants. Every effort was made to transcribe the interviews as quickly as possible after the interviews to ensure that originality, expressions, were captured as best as possible. Further, there were differences in the length of interviews, ranging from 25 minutes to 2 hours. The average duration was approximately 1 hour. The researcher manually transcribed all the recorded data verbatim. This has been done because of the recommendation of many researchers on its importance and essentiality (Bryman 2006; Bryman 2012; Ritchie and Lewis 2003). For instance, the recorded data guards against bias and provides permanent record of what was and was not said (Huberman and Miles 2002). After the data transcription, the written interview was sent to the interviewees for confirmation and feedback on what they initially stated during the conduct of the interview[4]

6.4 Data analysis

The approaches available for qualitative data analysis vary, based on the type of anticipated outputs. The data collected for this research study was analysed using thematic coding method. This is consistent with the interpretive philosophical stance adopted for this research study. The goal of the thematic analysis was to identify important concepts and categories by method of constant comparison within a data text in order to provide a rich description of the social reality created by those themes as they are lived out in a particular setting (Patton 2002; Devine 2002). Vaimoradi *et al*. (2013) also defines thematic analysis as:

[4] Copy of interview transcripts are available upon request

> *"a systematic coding and categorising approach used for exploring large amounts of textual information unobtrusively to determine trends and patterns of words used, their frequency, their relationships, and the structures and discourses of communicating"* (Vaimoradi *et al*. 2013, p 401).

Bryman (2008) also explained that the use of a thematic analysis approach to reading a data text can support the development of new theories and models (inductively), as well as validating existing theories (deductively) thereby providing 'thick descriptions' of particular settings or phenomena. The emphasis on 'thick description' focuses on explaining what is going on within a given situation and by answering the question *"what is going on here?*" (Gibbs 2007, p4). Dawson (2009) explains that the most common way of using a thematic analysis is where coding is based on groups designed to capture the dominant themes present in a data text. He also indicated that this type of analysis is highly inductive, that is, the themes emerge from data and are not imposed upon it by the researcher (Dawson 2009).

Once the data had been transcribed, it was analysed using a thematic coding method. The codification process involved the categorisation of sections within the data (Taylor and Gibbs 2010), using a data led inductive theory approach in keeping with the research design. The research borrows from inductive theory method by starting with the generation of open codes identifying different relevant perceptions, before refining them into concepts (axial codes) where categories are developed and relationships explored (Strauss and Corbin 1998; Marshall and Rossman 1999). Finally, the selective codes were identified as core categories, which pulls the theory together (Miles and Huberman 1994). The findings from the analysis of the data are reviewed in the discussion chapter, contrasting some of the emergent perceptions with others within the literature before conclusions are drawn against the research question in the final chapter. This process of comparing findings to literature also serves as a measure of supplemental validity (Strauss and Corbin 1990). The next section presents an overview of the analytic process (method of coding) undertaken within the study.

6.4.1 Method of coding

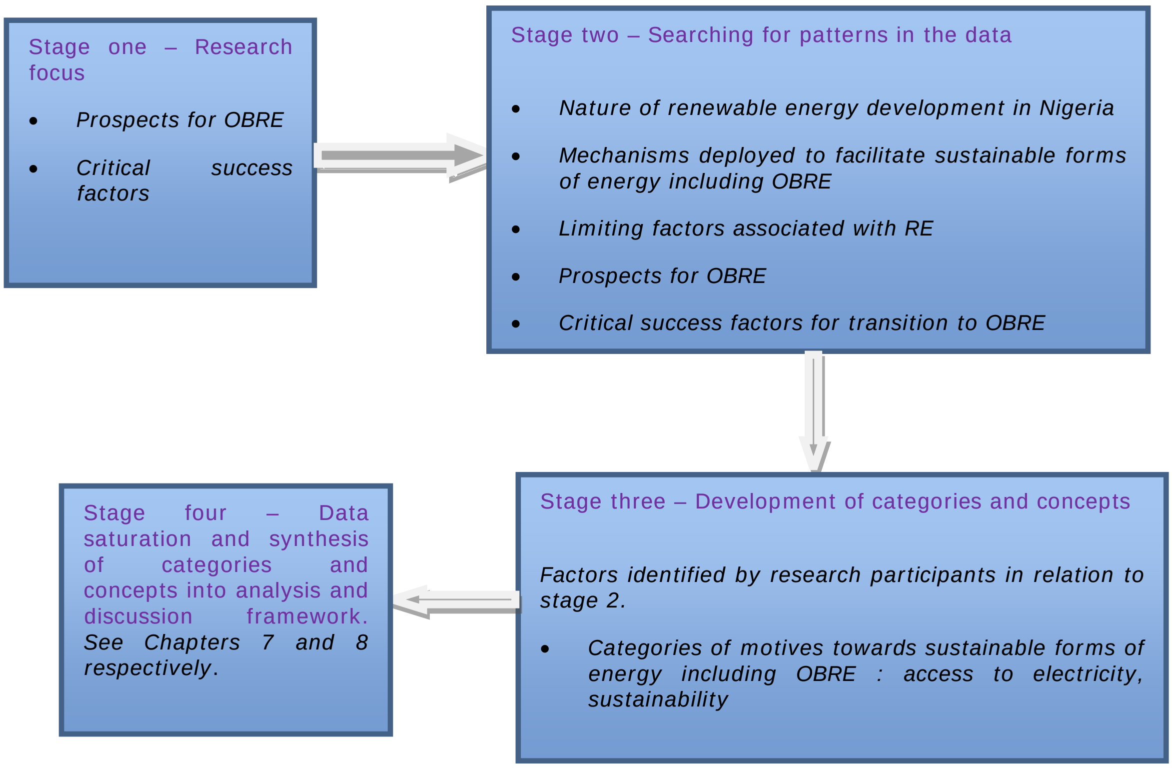
The first stage of coding was to specify the focus of the research study. Thus, the focus was specified as: i) evaluating the prospects - for a scope in Nigeria - towards a transition to OBRE, ii) identifying critical success factors that could aid in such transition, and iii) designing a model based on the critical factors to guide such transition. This focus allowed me to determine what data was relevant and should be coded and what data was irrelevant and could be discarded.

The second stage of analysis involved a search for patterns in the data. This meant an iterative reviewing of the data constantly asking the question 'what is happening here'? This iterative cycle of reading, reflecting, re-reading the transcripts enabled familiarity with the data and build up a stream of reflective notes on the data. This stage also ensured the researcher developed familiarity with the data sets being analysed. This consequently enabled the use of notes to write ideas, questions about the data, reflect upon the nature of the data and what the data is trying to communicate in relation to the research study's aim (Gibb 2002). This stage also provided the key unit of analysis for the purpose of analysis and discussion: i) the motive(s) towards RE development in Nigeria, ii) the limiting and enabling factors associated with its development, iii) the potential prospect for OBRE to be developed, iv) understanding of key actors relationship in OBRE development and; v) critical success factor(s) that will facilitate its transition, in practice.

The third stage in the analysis was the development of categories/themes and concepts. As the iterative cycle of reading and reflecting described in the second stage progressed, categories and concepts started to emerge. The constant comparison method of analysis was used in this stage to aid the development of categories and concepts. The constant comparison method of analysis was achieved through the open coding of individual transcripts. This allows the researcher to lift the coded piece out of the context of the whole interview/notes. Similar codes are then grouped together by method of constant comparison. This is achieved by comparing the codes that arose from one interview against codes from the same interview and those from other interviews. This resulted in a higher level of regrouped codes called concepts or axial codes (inductive theory) as illustrated in Appendix 7. By applying the constant comparison method to the concepts, some core categories (selective codes) emerged from the groups as presented in Appendix 8. Some of the concepts were retained as core categories.

The fourth stage of the analysis required that the data from the transcript be revisited several times and interviewees' perceptions compared with the categories that emerged until no more could be picked out from the data. This was in order to be certain that theoretical saturation is reached and coding and conceptualization can end. Thus, confirming the principle of saturation thereby allowing the development of a code sheet (presented in Appendix 9) covering all categories and sub-categories (themes) emerging from – and common to - the selected transcripts. The analytic process is illustrated in Figure 6.3.

Figure 6-3: Analytical method employed for data coding



Source: Author generated

6.5 Validity, reliability and credibility of the study's research

According to Denzin and Lincoln (1998), the issues of validity, reliability and credibility often constitute the source of a majority of the criticism surrounding research involving qualitative methods or methodologies (Akinsete 2012). Wolcott (1992) asserts that validity as a term tends to be over specified within the quantitative domain, creating confusion when relating it to the qualitative domain. Gibbs also defines validity in the context of qualitative research as the

> "extent to which an account accurately represents the social phenomena to which it refers" (Gibbs 2007, p.152).

This study not only utilized methods mentioned earlier (Section 6.3), such as the selection of well-informed participants from various levels, participant review, description and literature comparison to ensure validity of data collected. It also utilises triangulation between the different methods employed and respondents by engaging participants from different organisational levels as well as organisations external but related to the context of this study (Creswell and Miller 1997). Another form of validity utilised by the study was that summaries of interview transcripts are sent out to interviewees for validation prior to coding.

From a reliability viewpoint, the ability of the study to be repeated, "in different circumstances, and with different investigators" (Gibbs 2007, p91) was also ensured. In this study, where the focus was contextualised, the reliability rests profoundly with the construction of the research tools and techniques. Within this study, research tools have been subjected to internal peer review with the aid of presentations at research group meetings, discussions with supervisors, and most importantly with an international development agency - UNIDO, Vienna where an OBRE demonstration test is being planned for in Nigeria.

From a credibility point of view, the credibility of a study essentially hinges on the quality of its data: how it is collected, how it is treated, and who handles it. Patton (1999) in Akinsete (2012) suggests that the issue of credibility deals with three main concerns:

1. the rigour of the data collection and analysis
2. the credibility of the researcher
3. the philosophical underpinnings of the study

In the context of this study, the purposeful sampling of the case study organisations ensures the quality of the data set firstly. Thus, the selection of these organisations were informed by an extensive literature review, conferences attendance – for both OBRE and the renewable energy. These organisations were chosen for their distinctive functional responsibilities within the field of OBRE and Renewable energy development projects, as well as the combinations of the dimensions of influential prowess they characterise within their respective functions. While the experience of these participants lends a certain amount of credibility to the data obtained from them, collecting data not only from different hierarchical levels within one organisation, but also from other relevant organisations adds credibility by providing triangulation of data collected amongst the research participants.

Furthermore, the use of a combination of the pilot studies, interview data and archival data (including secondary quantitative data) within the study, provided further justification of the rigour in relation to data collection (Patton 1999). Transition frameworks were used as theoretical lens and was employed as part of the element towards developing the study's interview schedule. It also provided the main foundation for the conceptual intervention model. Moreover the frameworks have been utilised in transition research studies (Markard et al. 2012; Van Eijck and Romijn 2007; Loorbach 2007, Wieczorek *et al.* 2013; Hansen and Nygaard 2014; Strachan *et al.* 2015; Cowell *et al.* 2015; Osunmuyiwaa and Kalfagianni 2016). In terms of SNM, Van Eijck (2007) utilized its concept to investigate the prospect of a transition towards biofuels in Tanzania.

Patton (1999) acknowledges that while there is no definitive set of criteria to address the credibility of the researcher, the fact that the researcher serves as the primary instrument of investigation means that issues like training, experience and preparation ought to be given some importance. In this regard, the researcher possessed knowledge of research methods. Moreover, over the course of the study the researcher has been engaged in renewable energy transition programs, for instance the current OBRE project in Nigeria. Training and conference attendance have equally built up some level of experience to undertake the research study further contributing to the researcher's credibility. The researcher has also been engaged in lecturing, specifically in the field of energy and sustainability at the Robert Gordon University, while undertaking this research study.

The last component of credibility considers a study's philosophical underpinnings. As an inquiry, which is inductive in nature, the study lends itself to an interpretative philosophy (Creswell 2009) (see Section 6.2) to best address the research question. Again, coupled with the multifaceted nature of its applications (socio-technical), the 'social intent' of this study provides a participative style with some element of an action oriented method. As such, the case study strategy was adopted as it offers in-depth insights set within live contexts (Yin 2003).

6.6 Concluding summary

This study adopts an interpretivist philosophical stance and utilises a qualitative method in the examination of the research topic. It uses an inductive theory approach in order to generate emergent ideas and themes from the data. The research was undertaken using a case study strategy, exploring the prospective transition towards OBRE development in Nigeria. The study uses qualitative data from both primary (semi-structured interview) and secondary sources (desktop based), including some elements of quantitative secondary data (desktop based). In terms of the quantitative secondary data collection, an extensive review of literature on the mathematical modelling and optimization techniques for OBRE development was undertaken in order to offer resourceful data on the extent of energy availability within an OBRE hydrological settings. Data was analysed using a thematic content analysis which involved identifying the most frequent code from the data set and then analyzing the emerging thematic codes in order for theory development.

The next Chapter presents the results and findings of the data collection techniques employed in this study.

CHAPTER SEVEN

Interviews: Results and findings

7.1 Introduction

This Chapter analyses and presents the data collected through the interview employed. The interview were conducted to provide views and experiences of the research participants concerning the renewable energy market and the prospects for a transition towards OBRE electricity generation.

Thus, this chapter focuses on six key aspects that emerged from the analysis in relation to the study's aim. These include research participants' views regarding the contextual motive towards renewable energy development in Nigeria, research participants' opinions on the mechanisms designed to facilitate renewable energy development, research participants' reflection on the NREEEP's developmental and coordination process. Additionally, research participants' opinion on the barriers hindering renewable energy development in Nigeria, their overall assessment on the prospective transition towards OBRE and the potential enabling factors that should be considered in facilitating the transition towards OBRE development.

The data within this chapter has been presented in a way that ensures that the views and experiences of research participants are fully integrated in the overall analysis process. Furthermore, tabulated quotations are used to provide detailed accounts of research participants' views and experiences along with illustrating the varied and similar views of research participants on the subject matters. Overall, the interviews conducted served three purposes:

1. Understanding the prevailing conditions concerned with renewable energy development in Nigeria;
2. Understanding conditional prospects identified for triggering OBRE development in Nigeria; and,
3. Assessing the critical factors to be considered towards facilitating a transition to OBRE development in Nigeria.

The next sections from 7.2 to 7.7 present the findings from the interviews conducted.

7.2 Motives for facilitating the transition towards renewable energy development in Nigeria

This section explores the motives promoting the need for renewable energy development in Nigeria. From the participants' views, two main categories of drivers towards renewable energy development in Nigeria were identified: improving access to energy in Nigeria, specifically domestic electricity delivery and sustainability consideration.

7.2.1 Improve access to energy in Nigeria, specifically electricity delivery

This section presents how the first category above (7.2.1) was perceived by the research participants as one of the essential purposes for renewable energy development in Nigeria. It presents the different views as indicated by the research participants in relation to the theme. Table 7-1 includes the range of research participants' views resulting from analysis of interview data.

Table 7-1: Research participants view on motive towards transition to RETs

Research participants	**Findings based on Researcher's interpretation**	**Quotations**
OBRE020	To support the increase in energy demand	*"… increase in energy demand. Cost of doing business in Nigeria is high due to no power".*
OBRE015	Current energy supply is insufficient.	*"One cannot over emphasis a nation like Nigeria that demands so much of energy. We depend so much on energy but it's not sufficient for you".* *"… that's why we talk about renewable energy. So we believe that for us to increase energy in Nigeria, we cannot leave out the opportunity that is available in the renewable energy promotion".*
OBRE027	Meeting the current lack of electricity in Nigeria	*"One of the objectives is to meet the lack of access to electricity in Nigeria. If you look at the current status in Nigeria, you will discover that about 60% to 70% are lacking electricity accessibility".*
OBRE011	Self-generation for electricity consumption	*"… but I think it's this people's sentiment of 'I don tire', government leave me alone and if I can get my own power, I better own it and I don't deal with you again".*
OBRE001	Energy security	*"Well for us it's for the increase availability of energy security in term of*

		getting other energy mix.
OBRE018	Energy diversification for security purpose	*"… I think the main reason for renewable energy development in Nigeria is for energy diversification".*
OBRE022	Increase in population especially in the rural areas of the Nigeria	*"… there are number of reasons, but the most important for Nigeria is to get 'light' because of the large population especially where significant part live in the rural areas of the country".*
OBRE023	Rural electrification	*"In my opinion one driver that is pushing for renewable energy development in Nigeria is for rural electrification. That is where the national grid is not accessible to the communities in the rural areas"*
OBRE009	Electricity access target	*"Basically one of the plan is to use renewable energy in ensuring that the target fixed of 75% electricity access is achieved by 2020"*
OBRE006	To meet the inadequate supply of electricity	*"The main reason for renewable energy development in Nigeria – one, is the issue of inadequate supply of electricity particularly in the rural areas and even in the urban area".*
OBRE007	Resource exploration for electricity generation	*"… our nation is one of the largest nation in Africa and we know that the power we consume today is nothing to write home about and God has blessed this nation that our resources are high in terms of solar, winds and offshore renewable resources"*
OBRE025	Energy security and insufficient supply of electricity	*"The now obvious need for energy diversification in Nigeria; the need for national energy security; grossly insufficient supply of electric power…"*

Source: Author generated.

From the table above, research participants categorised the motive for renewable energy development as either: to meet current energy demand and increase electricity supply or to achieve energy security. In sum, it is evidenced that whatever the purpose for renewable energy development in Nigeria was, it will be used to address the inadequacy of the current domestic electricity supply. A further insight on this theme is succinctly discussed herein: Three of the research participants asserted:

> *"… we know of course there is a huge electricity deficit in the country so there is no reason why renewable energy should not play a major role". (OBRE017)*

> "*I think the key reason will be that we have the resources, varieties of viable options to use in Nigeria ranging from solar up north, even wind, hydro which we are already using and potentially offshore renewable in the coastal regions. Secondly, we have a deficit in our electricity generation and with the growing population; we need to find ways of improving/supplying enough power for basic, productive uses and also for household uses"* (OBRE013).

> *"I think the main reason for renewable energy development in Nigeria is for energy diversification and also to harness the resources that we have that are abundant".* (OBRE018)

However, one of the researcher participants took a slightly different perspective by asserting on the security issues associated with the existing energy system (fossil fuel) as a motivation towards a transition to renewable energy sources. He explained:

> *`"In 2013, between January and September, 761 pipeline vandalisation has been carried out in the country which prevents oil or fuel to be transferred to other states from the southern region where the energy deposit is. So if you look at this case of volatile situation of transporting crude oil to other part of the country, it becomes a security problem…."* (OBRE 026)

The policy community (some of the research participants) surrounding energy development in Nigeria also had strong reason to believe that the key motive towards renewable energy was the need to extend electricity access to rural communities. Rural communities, particularly the remote regions (such as coastal areas) are predominantly without any form of access and political focus - as contained in the NREEEP document - has set priorities towards ensuring some level of rural electrification via the REP. As one political advisor put it:

> "*... energy for the rural communities if you look from what you are currently studying"* (OBRE014)

In summary, interviewees in particular, policymakers were clear in their perception that the motive for developing renewable energy potentially appears to be to 'improve the electricity situation' in the country, whether as an electricity delivery source to meet demands or as an energy security towards diversification from fossil fuel usage to a more sustainable source. This was underpinned from the frequent assertions made by the research participants, especially when one considers the existing epileptic power supply in the country. This finding was significant as it shows that 'political priority' has been given towards transitioning to sustainable forms of energy sources further aligning to global debates on energy challenges. The political priority emphasizes commitment that is attributed to the governmental actors, which has long regarded energy development as central to the economic future of Nigeria (FMOP 2015).

7.2.2 Sustainability consideration

Relevant to the motive above, was research participants views that another essential motive towards renewable energy development is the sustainability theme – a global debate on climate change (global warming) and how renewable energy sources are considered as a mitigation factor. From a wider insight, some researcher participants believed that with renewable energy development, there is the ability or potential to integrate environmental protection and economic growth within the country, through its activities and projects. This was advocated by majority of the research participants, suggesting the potential for socio-economic development via renewable energy development. Table 7-2 includes the range of research participants' views resulting from analysis of interview data.

Table 7-2: Sustainability as a motive for RETs development in Nigeria

Research participants	**Findings based on Researcher's interpretation**	**Quotations**
OBRE008	Sustainability	*"... why not look at more long term sustainable option such as renewable energy".*
OBRE013	Sustainability	*"... so why we are going to renewable energy is because it is sustainable"*
OBRE002	Socio-economic development	*"... for Nigeria, as the renewable energy sector continue to develop, the primary driving forces are less likely to be environmental and more likely to be energy security, employment potential and job & wealth creation".*
OBRE001	Environmental friendly energy sources	*"... then hopefully achieving some environmental friendly development".*
OBRE004	Strategy towards clean development using renewable energy sources	*"... Nigeria is member of the Kyoto protocol party, so from the environmental side, part of our strategy towards clean development is to use renewable energy to develop as quickly as possible".*

Source: Author generated.

The research findings gives special attention to some of the comments made on this theme. Accordingly, research participants were of the opinion that small-scale renewable energy forms could be utilized by rural communities towards achieving sustainable development particularly, in terms of economic value. This is significant given the low socio-economic growth in these region where prevalent poverty exists. Thus, one can clearly see the interdependencies charaterised between access to energy and sustainable development (SDG 2015). It also emphasis some form of credibility about the Federal government commitment to the SDG and the Climate Change Green deal. This was succinctly put by one of the research participants:

> *"… again from the economic aspects, these technologies on small scale are cheaper and are easy to maintain. If you look at smaller communities, they can manage these technologies and pay less. So it has economical value".* (OBRE0024)

Nonetheless, some participants, coming more from the environmental viewpoint on sustainability principles, believed that environmentally friendly energy sources currently being advocated globally appear to be a key motive towards renewable energy development in Nigeria. A senior researcher in the field of sustainability presented this, by asserting:

> "*What we are discussing any day, anywhere, in countries is sustainability. Renewable energy is self-sustaining".* (OBRE013)

Similarly, one participant took a different view on the sustainable perception, claiming that the increasing worries towards climate change effects including desertification caused by the fossil fuel energy sources appears to be a strong motive to seek alternative energy sources in form of renewable energy sources. He cited the rural areas as a typical example where adaptation to climate changes effects were of key weakness. Actors who happens to be key political resources deployed by the Federal government to address the issue of climate change perceived this.

> *"... mostly in the rural area uses biomass fuel woods or for cooking and other things and these results into desertification and environmental degradation. So in other to combat desertification and environmental degradation, we must introduce renewable energy".* (OBRE005)

> "*Another driver is the climate change factor so this is another driver that is making renewable energy to become recognised in Nigeria and that is why it is captured in the National Energy Policy of 2003."* (OBRE006)

From an applied perspective, one of the research participants (key political actor in the federal ministry of environment) believed that renewable energy is environmentally friendly when implemented, by citing examples using power supply from water sources:

> `"*... when you talk about pollution, there is no pollution unlike thermal or gas. Water power is clean and environmental friendly".* (OBRE002)

While appreciating the assumed socio-economic and environmental value of renewable energy development towards the wider context of sustainability, commercial values in terms of profit making – from the economic perspective of achieving sustainability - may have also served as a motive towards renewable energy development in Nigeria, particularly from a private sector's perspective:

> "*We are private company that is operating as a social enterprise in the renewable energy space in Nigeria. What we do mostly is to improve access and awareness towards the adoption of renewable energy, household facilities, etc. towards reasonable profit making potential".* (OBRE021)

However, research participants (all) were cautious and suggested that although the elements of sustainability may be one of the motives towards renewable development in Nigeria, an essential and perhaps most significant motive from their point of view was ‘access to electricity for all’. From a broader perspective, by bringing all the responses together and going by the aforementioned reasons given by the consenting participants in their arguments, it is evident that these motives seem to have been the key push towards renewable energy development in Nigeria. This is consistent with the transition theory and concepts that underpins that transition occurs due to a persistent problem, which can be caused by exogenous or endogenous factors. Thus, these may serve as key components towards building a strong business case for facilitating a transition towards OBRE development in relation to electricity and achieving sustainability.

7.3 Mechanisms facilitating renewable energy development in Nigeria

This section explores the various mechanisms designed to facilitate renewable energy development, as perceived by the research participants. Three categories – institutional framework, stakeholders and network formation - were perceived by research participants as the main mechanisms facilitating renewable energy development in Nigeria; with the most significant being the institutional framework element.

7.3.1 Structural and institutional framework

7.3.1.1 Policy and regulatory schemes

A good number of the research participants (twenty) felt that structural and institutional interventions in form of policy design and regulatory schemes have been the enabling mechanism facilitating renewable energy development in Nigeria. Therefore, this was a key theme that participants perceived, as observed in the structural and institutional frameworks implemented by the Federal government. With reference to policies, research participants strongly believed that it has provided the background and rationale for the required enabling environment such as regulatory frameworks, private participation and perhaps some element of funding for renewable energy development programs in Nigeria. The institutional design referred to by the research participants in relation to the mechanisms for facilitating renewable energy development in Nigeria are outlined in Table 7-3:

Table 7-3: Institutional mechanisms facilitating RE development in Nigeria.

Research participants	**Findings based on Researcher's interpretation**	**Quotations**
OBRE001	Energy policies	*"... we have a number of this policies starting from the NEP 2001 reform which requires that access to go to 75% using all source of energy and then to the national energy policy 2003 which also encouraged the commercialisation of renewable energy and so on".*
OBRE016	Energy policies	*"Even though we have plethora of policies scattered everywhere, it has somewhat helped in increasing renewable energy development to a certain point in Nigeria where people are now implementing various renewable energy*

		technologies in homes and for businesses".
OBRE003	Regulatory schemes such as FIT	*"… Feed In Tariff – FIT – which has been approved by NERC so as to encourage renewable energy investments by the investors".*
OBRE019	Documented in a policy statement	*"The first driver is the fact that it is covered in our policy statement. I have read it. When I started my renewable energy works on Biogas, I looked at the policy and discovered that policy on Biogas development is there. Which means the government is interested and aware".*
OBRE007	Political will	*"Political will, otherwise whatever you want to do, nothing will make head".*
OBRE004	Regulatory incentives	*"We have put in place regulatory condition to promote renewable energy. Next, we have developed licenses procedures to simplify renewable energy. We have also put in place more friendly licensing fees. We have FIT for them that are quite generous that we hope will attract investors. These tariffs are concessional tariff that are paid and available for 20 years giving assurance for investors".*
OBRE017	Regulatory framework	*"First thing is to make the rules of the game clear, rules need to be in place so that the person will have comfort on what the framework that is how investment can be guaranteed or secured. I think there is a step towards that right direction by publishing the feed in tariff by NERC".*
OBRE005	Policy documents	*"I will say there have been efforts in developing sort of policies or master plan. Started with renewable energy master plan, developed into 2005, followed 2010, out of that came renewable energy policy draft document even with the rural electrification policies, with reference from the renewable energy".*
OBRE023	Policies	*"Policy is one of the biggest step for us to 'crawl' before I will say we should begin the implementation process because that is the biggest foundation towards renewable energy development in Nigeria …"*
OBRE008	Policy documents/ statements	*"Nationally, there are lot of policy been drafted and that's is based on the renewable energy master plan from 2013 to be transition into policies"*

Source: Author generated

Table 7-3 has demonstrated that policies (recurrently perceived by all research participants including policy makers such as FMOP) appear to be the main instrument facilitating renewable energy development in Nigeria. Indeed, government alignment towards renewable energy development has been facilitated by policy framing of renewable energy where successive governments have positioned renewable energy implementation as central to national economic and environmental future. Thus, interviewees asserted that policy has been put in place for renewable energy development in Nigeria.

> *"... policies, apparently there is a policy now".* (OBRE004)

> *"Policy is one of the biggest step for us to 'crawl' before I will say we should begin the implementation process..."* (OBRE018)

Nonetheless, many research participants (ten) felt that the non-approval of the supporting statements in policy documents by the legislatives might have clearly undermined the strength of the institutional frameworks to work. This sentiment was captured in the comment of some of the participants including key policy makers:

> *"... all these mechanisms (policy) that I have just mentioned are yet to be approved by our law makers. So I don't know how the mechanisms can help renewable energy development if people making the law have not seen the documents"* (OBRE005)

> "... *I really don't know if there are drivers designed, I mean we have loads of policy and I don't know if they have passed those things into reality. Or they are just piece of paper sitting on a desk shelf gathering dust".* (OBR E006).

> *"... in a way the policy is a barrier because of its duplications and not a driver though it will help in developing that space in terms of what*

is available, what do we do to add value towards the national goals and to bring in some sort of sanity – rules and regulations". (OBRE024)

Integral to this statement as put forward by OBRE024 was the perception that the policy itself may have perhaps, facilitated informal business activities for renewable energy development.

"... *but it doesn't stop business from establishing within the renewable energy space because everyone is just jumping into renewable energy development in Nigeria"* (OBRE024)

A different perspective on how the policy itself drives wider scale of energy objects such as small-scale RE development was however, put forwards by some research participants. These participants (two specifically) were more specific about the kind of policies being designed by the government, especially with a focus on rural development while others reflected more on the contextual nature of the policies being designed to promote RE development. Concerning the kind of policies, a ministerial civil servant said:

"*I will say there have been efforts in developing sort of policies or master plan. Started with RE master plan, developed into 2005, followed 2010, out of that came RE policy draft document even with the rural electrification policies"* (OBRE023).

While the extract below also presents the contextual nature of policies, being designed in relation to certain energy objects or pathways as succinctly put by an international development consultant:

"...apparently there is a policy now but I can't tell you how much this policy drives small scales renewable deployment" (OBRE011)*.*

Another frequent perception as perceived as key institutional mechanism is the regulatory schemes underpinning the market development such as the proposed FIT. Research participants were quick to suggest that the role of regulatory instruments have facilitated some form of key RE development through incentives and regulatory authority:

> *"... incentives to promote RE in Nigeria by tax holiday, capacity development, FIT, and have been approved by NERC so as to encourage investors"* (OBRE005)
>
> "... *regulatory institute of Nigeria Electricity Regulation Commission"* (OBRE014).

However, some participants took a slightly different approach on the regulatory strand by explicitly unpicking the various elements within the body of the regulatory structure. A key actor in the federal ministry of state, power posited this particular instance:

> *`...the second category is regulatory scheme. We have put in place regulatory condition to promote RE. Next, we have developed licenses procedures to simplify RE. We have also put in place more friendly licensing fees. We have FIT for them that are quite generous that we hope will attract investors. These tariffs are concessional tariff that are paid and available for 20years giving assurance for investors. This can be called regulatory incentives"* (OBRE008).

Building on the above, a form of actors network towards formalizing the regulatory element for RE development pathway was explained by one of the research participants who is a senior civil servant with the national electricity regulator commission (NERC). This assertion further advances governments intention to encourage RE development in the country as he advocated that:

> "*When you mean drivers, you can have a lot, Drivers you can have, ranging from policy instruments to market regulations. I think, again, NERC, the regulating body which is similar to OFGEM here in*

> *the UK, has processes in place, they have tried to finalise the FIT and are currently working with NBET at the moment where they are looking at having an open book system so that they can have a robust system that can take/consider RE of 1MW and above".* (OBRE003).

However, a deeper reflection from the role of sub-national governments (as most discourse above on the mechanisms are being issued by the national government) towards RE development proofed stimulating. Why? While discussing with a key actor in the federal ministry of power, Bayelsa on the mechanism towards promoting RE in the state, especially when OBRE is particularly being considered for riverine communities, the research participant put this forwards:

> "*we have no mechanism because we rely on the federal government to help the state in this matter because they don't bring us into it. Though when it comes to oil and gas we can handle it along with the federal government… you should know that the oil and gas brings money"* (OBRE009)

What this instance highlights is the lack of collaborative and integrated network relationship between the national and sub-nation government actors towards facilitating the wider relevance of RE development. This is further discussed in Section 8.2.2.

7.3.2 Stakeholders mandates and engagements

Supporting the renewable energy development programs, stakeholders' participation in decision-making, coordinating, funding and deployment is another key element that deserves attention when exploring the mechanism context towards facilitating renewable energy development in

Nigeria. This sub-section outlines the actors and organisations within the stakeholders' category observed as driving RE in the country.

7.3.2.1 Key stakeholders' mandate towards renewable energy development in Nigeria

In addition to the institutional led mechanisms in form of policies and regulatory settings, different actors and organizational arrangements or mandates, specifically from public sectors have also been put in place to facilitate renewable energy development. It is also noticeable that the public and perhaps, private sectors involved have both enabled such development as earlier mentioned in Section 7.3.1. Thus, some of the research participants' commented over their roles (governmental functions) within the renewable energy development space:

> *"The federal ministry of environment initiated the Renewable Energy Programme as a response to mitigate Climate Change issues. Through the activities of the Renewable Energy Programme the Federal Ministry of Environment plays the following roles: develop and implement strategies/policies that would regulate the renewable energy sector as obtainable in global best practices ..."* (OBRE002)

> "... *I work with the federal ministry of power in Nigeria for setting all energy policy in the country and my role within the organisation is for developing and providing oversight on policy implementation for energy including renewable energy".* (OBRE001)

> *"The mandate for ECN is strategic planning and coordination of the national energy policy in its entire ramification. The commission looks at all aspect of energy including renewable energy and here in the commission, we have a department which is dedicated to renewable energy development ..."* (OBRE005).

From the discourse above, it is very clear that Nigeria Government officers and ministries are in pole position to encourage national planning in order to facilitate the different approaches to RE development. On the other hand, the role of the three public sectors, appear to be similar with specific key mandates towards policy design and implementation. Hence, one can argue that there appears to be a lack of clarity on who is responsible for policy design and administration in the renewable energy market.

In contrast to the unclear mandates of the three institutions above, some public authorities associated with renewable energy development do seem to have specific mandates as detailed below:

> *"... our input here towards renewable energy development is water. Water for drinking, sanitation, then water for agriculture, we build dams to support all this services I have mentioned and also to support hydro-power development".* (OBRE012)
>
> *"NIPC is government agency with the responsibility of promoting investment in Nigeria. We handle all the sectors including energy and promote electricity generation potential for investors to come into Nigeria, including renewable energy business"* (OBRE015).
>
> *"... as a regulator deals with Feed-in-Tariff, and reviews policies for renewable energy and tariffs from a regulatory perspective to create the enabling conditions for private investors into renewable energy development"* (OBRE 004)
>
> *"The role of the ministry is to co-ordinate and implement electricity at the state government levels..."* (OBRE008).

The research study reflects on OBRE008 assertion and considers the relationship between the ministry and that of the sub-national ministry in RE development. Accordingly, when asked about this matter – following previous assertion by OB, he (a key political advisor on development pathways for energy objects) posited:

"... *we are working with the FMOP only who interacts with the state governments"* (OBRE008)

Aside from the public sector's role in facilitating renewable energy development in Nigeria, other stakeholders from regional and international organizations' involved in renewable energy activities appears to have significant contribution in supporting renewable energy development in Nigeria:

> *"... ECREEE's relation with the renewable energy system in Nigeria is the same as with the other countries in West Africa where we have a mandate to promote and support in facilitating the deployment of any renewable energy services and technologies across the nation".* (OBRE020)

> *"The HBS foundation is a politically green foundation looking at ways for societies and communities to develop 'do not spoil the planet' from the context of climate change mitigation measures – using renewable energy technologies - and adaptation. So in Nigeria, we work with civil societies and other actors such as federal ministry of power to figure out how Nigeria can develop sustainably"* (OBRE011*).*

The involvement of private and civil organisations including the business communities and NGOs, within the country has also stimulated some level of renewable energy development, as stated by some of the participants:

> *"... there have been a lot of individual's practices in Nigeria, business communities demonstrating that this can really work in Nigeria".* (OBRE021).

> "... *renewable energy is one of the mitigating approaches to climate change. Our role as NGO is promoting awareness on new innovative renewable energy technologies, educating on the opportunities in them and mostly trying to work with communities on how they too*

can benefits from adopting renewable energy technologies" (OBRE022).

Promoting renewable energy through these institutions, especially the public organization is often seen as having the required capability and capacity to address the contextual nature of RE development. Thus, capacity development becomes a vital facilitating mechanism. Only one of the research participants working in Energy Commission of Nigeria highlighted this opinion from research centres/institutions design perception. It was indeed a useful insight, acknowledging the different roles played by some of these institutions towards RE uptake. Specifically, the research participants commented:

"There are two main national research centers dedicated to carrying out research and development on renewable energy. They are resident in two universities – Usmanu Dan Fodiyo University in Sokoto (Sokoto Energy Research Centre (SERC)), and University of Nigeria, Nsukka (National Centre for Energy Research and Development (NCERD). Also, we have other centre such as University of Ilorin [National Centre for Hydropower Research and Development (NCHRD)]. They conduct research on Hydro, which is RE. Beyond that, we have another one in Benin [National Centre for Energy & Environment (NCEE) at the University of Benin conducting research in the field of Energy and Environment. So all these bodies are setup to encourage the promotion of RE" (OBRE006).

7.3.2.2 Key stakeholders' engagement forum towards RE development in Nigeria

Within the stakeholders' structure mechanism is the appreciation of a networking element that has also been suggested by some participants as one of the instruments for facilitating renewable energy development. This perception by one of the research participants (federal ministry of environment) argued that the most of networking element actually stems from an international collaboration context:

> "*In a bid to promote the renewable energy sector in Nigeria, the Ministry has taken strides to develop and foster National, Continental and International partnerships. These include the Nigeria-German Energy Partnership, Nigeria-Nordic (Sweden, Finland & Norway) Energy".* (OBRE002)

Hence, it was surprising that many of the research participants (twenty two) did not comment/appreciate the role played by the IMC in shaping the RE development landscape. This brings a useful insight on whether local actors' network within the frame of RE do exists and if yes, how adequately has it informed and shaped energy transition. Again, this perhaps, reflects back to the two assertions made by OBRE009 and OBRE008 in Section 7.3.2.1 and the limited correspondence on the IMC. However, one of the IMC members (from ECN) asserted on the role played by IMC in policy formation by asserting:

> *"The first thing we did was to develop the policy in which the Federal Executive Council –FEC- approved the policy of what we call energy policy of which RE is an integral part, a chapter in the policy. And then in the policy, it was stated that Nigeria will try to develop RE, to be able to diversify the energy mix because that's one of the policy plan, diversify the energy mix".* (OBRE005)

Integral to the assertion above, some of the research participants (four) felt strongly that no form of mechanism has actually facilitated the uptake of renewable energy in the country. This position depicts the fact that there was acknowledge that mechanisms are being put in place but the marginal role being played by RE demonstrates its ineffectiveness. Two key senior servants in their respective ministries succinctly put this forwards:

> *".... as I said we are yet to have a policy, an implementation policy in Nigeria. So I can say we don't have a seriously influencing driver designed for renewable energy development in the country. The uptake is not even there"* (OBRE027).

> *"If it is policy there are policies! We just discussed the NREEP just passed by the FEC two weeks ago, I think. That was driven by the ministry of power that is more geared to power but what has the other policies done from 2005, 2007, 2012…"* (OBRE016)

It is evident from the data gathered that indeed, Nigeria has put in place key mechanisms in form of structural and institutional settings to facilitate and encourage renewable energy development. Likewise, business communities have also contributed to its development from a wider insight due to governments' priority focus on introducing sustainable forms of energy sources. Specifically, even though policy appears to have supported the development of RETs in Nigeria, some of the research participants believed strongly that the same policy as a driver designed to facilitate renewable energy development in Nigeria appears to be a barrier hindering its development. Additionally, one can argue that it seems that international agencies; the private sectors (who are practically involved for profit making venture); and the NGOs (advocating for sustainability) maybe the main drivers fostering RE in Nigeria, in practice.

7.4 Reflection on the developmental process for a renewable energy programme

Exploring the extent of a renewable energy project appears to be quite crucial especially when examining how the various stakeholders, specifically the public sector, interact and collaborate towards facilitating renewable energy development in Nigeria. This section outlines the level of stakeholder engagement in one of the policy formation projects called the National Renewable Energy and Energy Efficiency Policy - NREEEP in Nigeria, which was approved by the Federal Executive Council in May 2015.

Therefore, the purpose of this interview was to gain a further understanding of some of the key activities/processes in practice, within the lens of a typical renewable energy development programme such as the NREEEP. As stated in Chapter 2, the NREEEP initiative for the 15 West African nations was facilitated by ECREEE to foster renewable energy development in the member states, which includes Nigeria. In Nigeria, this project potentially brought together different stakeholders' particularly the public sectors within the various MDAs, specifically the IMCs. Additionally, the NREEEP project appeared to have been coordinated by the Renewable Energy and Rural Access Department in the Federal Ministry of Power, in conjunction with the other IMCs. In light of this brief background, the opinions of some of the research participants, those involved in the project as detailed in table 2-2 and 2-3 were examined based on the following categories: roles and responsibility of the Federal Ministry of Power and;

interaction and collaboration amongst the IMC members, in relation to the NREEEP project.

7.4.1 Roles and responsibility of the Federal Ministry of Power

Research participants commented on how adequate the federal ministry of power coordinated the NREEP project in relation to role and responsibilities. Research participants perceived that the FMOP's role was unjustified and that they lacked the requisite mandate to facility policies that will promote RE transition including the wider context of sustainable forms of energy development. Interestingly, amongst the research participants who took part in the project, a high level of dissatisfaction emerged from pertinent policymaking officers including actors from ECN, NIPC and NERC as they asserted their views:

> *"… the Federal Ministry of Power (FMOP) provides power which is current multiplied by voltage, you see it as IV. Their role is to provide, to provide electricity for Nigeria in megawatts, in Mega Watts. It is not to conduct studies, policies, theirs is not policy but they are not doing it. What they are doing is not their work. The Planning and analysis is not their work, to lay down pipelines (strategies and roadmaps) is not their work. It's the, ECN by the mandate given to lay down pipelines, advising, planning and coordination on all issue of energy. But that is what FMOP is doing… so who will do the implementation, me. Of course not, it is them to implement and not to do policy".* (OBRE006).

> *"I believe that ECN has already designed an Energy policy I think in 2012, called REMP but FMOP hijacked it and were on the driver seat and is now projecting as theirs. Because when ECREEE came, where they stopped was at FMOP and FMOP now brought in ECN. It shouldn't be that way because the mandate of ECN to my knowledge is strategy planning and coordination of the National Energy Policy in*

all its ramification, by so doing advising the government and conducting research". (OBRE015).

"I know that the FMOP is anchoring the process. The issue here is that Federal Ministry of Power is for power thereby neglecting other potential uses of renewable energy for thermal, drying, water pumping etc. If ECN was to handle it then it could have helped cut across all side" (OBRE004)

These assertions, was generally supported by other research participants (five), who participated in the NREEP thus, suggesting that the committee members were not pleased with the role and responsibility accorded to the Federal Ministry of Power (principal coordinator) on the NREEEP project. It also showed that some of the participants such as NERC favoured ECN to be the coordinating agency, perhaps due to their mandate as highlighted earlier in Section 7.3.2. This appears to be a significant finding within the frame of energy transition in Nigeria where distinctive favourism is being played within the context of policy network in transition theory. Categorically, the discord surrounding FMOP and ECN presents a major limitation to the REM and potentially emerging RETs such as OBRE. It also seems that the current focus within the REM may have been on 'supremacy scuffles' thus, this requires the need for better understanding of the meta-governance implications and the role of each key policy actors associated with renewable energy development.

Nevertheless, further analysis provided insight into a wider possible complication that may arise within ECN's capability to coordinate renewable energy policy, especially for electricity generation. Underpinning this argument one of the research participants who favoured ECN concluded by saying:

> *"… it's a bit difficult for ECN to do anything now even for power because they are under Federal Ministry of Science and Technology (FMO S&T) but when it was alone, it allowed it to have a cross ministerial outreach with all energy development in Nigeria. There is no way the minister of FMO S&T will get to do electricity (power) issues rather it will be taken to the Federal Ministry of Power. So there is this disconnect"* (OBRE004).

While the arguments above may have depicted some issues regarding the role of FMOP and who infact should have been mandated to take charge of the NREEP project, some interviewees (though not as much as those who disfavoured FMOP) commented on the adequacy of the FMOP. Two significant comments from NERC and Federal Minister of Water Resources (FMWR) were:

> *"I give it to Federal Ministry of Power because they consulted widely. They drafted the makeup of the stakeholders. There was quite a lot of workshop. They worked with this GIZ, one of their consultants. They produced draft report, circulated the report to all the stakeholders involved that is the ministers, Director General, and the papers came down to the desk officers of each ministries, departments and agencies working on it. We were so lucky that we were told that it has been approved"* (OBRE003)

> *"I think they did well. Data was scattered all over, no coordination, no clear agency taking the lead to coordinate RE unlike in Energy Efficiency which is being led by FMOE. I think when FMOP took charge of the NREEEP, things started changing and the policy was signed by the federal executives".* (OBRE012).

The empirical study result now considers other stakeholders roles and responsibilities aside that of FMOP, which overall revealed a sense of limited cohesion amongst the stakeholders. Findings suggest that there appears to be an inadequate involvement of key IMC (Table 2.2), undermining the true value of the development process. This observation was evidenced by some of the research participants' assertions on their role within the NREEP project. Two of the research participants (though senior staff members of their ministries) asserted:

> *"...I got a letter from my superior to just represent the department without proper understanding of the project"* (OBRE017).
>
> *"... I only go there when my boss calls me to attend on his behalf* (OBRE008).

Thus, it is clear that during the NREEP project in Nigeria, there was no distinct structure to ensure pertinent stakeholders' involvement/interaction, which is a key element in an energy transition process and also crucial to the success of the NREEEP project. When the researcher probed further to gain more clarity on the issue, OBRE008 simply said:

> *"that's the case when there are no collaboration amongst the heads of ministries..."* (OBRE008)

This further aligns with the assertion made by one of the research participants on the lack of proper coordination within the RE sector as evidenced - in practice, where different institutional mandates have been designed to facilitate renewable energy development - in Section 7.3.2:

> *"... no coordination with no clear agency taking the lead to coordinate the renewable energy project".* (OBRE019).

Interestingly, this comment was presented during the explorative unstructured pilot test in Section 6.3.2.2 where a research participants' group strongly believed that issues such as unsuitable organisation is a pertinent issue confronting the West African sub-region's RE development including Nigeria. This assertion was succinctly by one of the research participants, specifically within ECREEE's focus group session:

> *"... clear direction and governance from governmental agencies in West Africa are missing, resulting in an ad-hoc development within the renewable energy sector".* (OBRE ECREEE)

This again, depicts a significant finding in relation to this research study's aim, providing wider implication of energy transition process in Nigeria. What this experience shows is that normative assumption of a process – in this case, the IMC - is quite rhetorical from actual observation of the process, particularly when actor oriented objects seems to be the driving vehicle. Perhaps, this conclusion may be short sighted if one considers the environment – developing economies against developed economies – where such observation is been undertaken. Indeed, it is a dire situation for OBRE development. Therefore, it will appear that most of the renewable energy decisions as documented in the NREEEP may have been undertaken in absence of key IMC members' inputs. The next section provides an in-depth reflection/understanding of how FMOP engaged with the other policy actors during the NREEEP project.

7.4.2 Stakeholders' engagement in the NREEEP development process

The platform for developing key RE programs in Nigeria is through the 'Inter-Ministerial Committee' (IMC) where all stakeholders associated with renewable energy development come together to make policy-innovation decisions. The IMC has been repeatedly mentioned in earlier discussions and may be taken as the platform/arena for energy transition processes despite a claim from one of the research participants of its non-existence at the time of the interview:

> *"it was a forum to discuss the way forward for power in Nigeria which has some of these members – FMOP, NERC, ECN [the host], NNPC, and NIPC. It's called the IMC collaboration on power. It borders on each mandates and how their input will foster the power sector. It was a good forum but unfortunately, the FMOP do not like issues disturbing them especially emanating from other parties rather agency should deal with their own things. Hence the IMC died off, due to inadequate governance as a result of no cooperation…".* (OBRE015).

However, this may be a significant finding to be further explored by evidence do suggests that there is indeed a form of committee where decisions for energy transition is being deliberated as put forward by many of the key actors within the frame of REM. Thus, underpinning this theme is to assess the level of engagement undertaken during the NREEEP project.

There were evidences suggesting actors were duly engaged during the project as defined by some of the research participants. One of the research participants, who apparently was the coordinator of the NREEEP project, put this succinctly:

> *"… we worked through the Inter-Ministerial Committee (IMC) on the renewable energy sector which is a multi-sectorial committee that brings all MDAs within Nigeria that has anything to do with renewable energy or Energy Efficiency or even rural energy access … As we recognise that renewable energy development is not a single sector programme. It is a multi-sector thing; environment is key, water resources is important, ECN, industry expert and so on. We have been having regular IMC meeting where we first brought all the policies that each MDAs have tried to develop on their own in line with renewable energy development. We read them, discussed them, got involved partners, and came up with the current policy NREEEP in 2015. So it was more of consultation, engaging, some data collection and analysis process*". (OBRE001).

Firming up the assertion above, other research participants, (this time a private consultant within the REM) claimed that she was invited for a public consultation as part of the wider element of the project but asserted that she is yet to get further insight of the final documents:

> *"I attended the public consultations on NREEEP project, afterwards I also reviewed the documents to access what is to be included, added modified, etc. I was invited to the public consultation through a NGO. However, we haven't heard back from them yet on the final documents".* (OBRE021)

This is significant as it shows that the NREEEP project did consider broader actor network but limited in dissemination of consultation output. However, exploring the extent of interaction and collaboration from other IMCs stakeholders proofed central as significant evidence showed that limited stakeholder engagement was undertaken. Research participants on their reservation towards the efforts that the coordinating agency – FMOP - made to engage all stakeholders showed this. One of the research participants commented on this from a wider implication perspective:

> *"Wide consultation is a barrier to renewable energy development because deployments are undertaken without proper consultation… On this basis I will say I am aware of the NREEEP through whispers and not by involvement"* (OBRE018).

Another of the research participants (a key policy maker in ECN) took a slightly different perspective, this time reacting to the limited engagement towards key actors like himself:

> *"No am not aware. They might be doing it but am not aware. … This is what I am talking about, people doing things due to favouritism but not by competency and functions"* (OBRE005)

Efforts to probe further to what actually happened were declined by participant OBRE005 during the course of the interview. The researcher however, approached one of the research participants who oversaw the NREEEP programme within the West Africa sub-region and enquired about his perception(s) on Nigeria's NREEEP design with regards to the engagement process by FMOP:

> *"... off course I am aware, ECREEE is facilitating the NREEEP project for all West African countries. However the internal project framework and engagement is not our prerogative as long as the national consultant employed delivers his mandate to the regional office in Cape Verde"* (OBRE017).

One research participant in response to FMOP's extent of engagement during the NREEEP process, explained that the engagement was rather poor, particularly emphasing on the fact that international consultants (GIZ) were the ones actually doing the engagement exercises.

> *"... actually I saw one consultant from the UK and also GIZ asking us to come over for meetings*" (OBRE 002)

From a different perspective, one of the participant felt that the role given to FMOP to lead the NREEEP project was rather undeserved by asserting:

> *"... who will do the implementation, me. Offcourse not, it is them to implement and not to do policy"* (OBRE006)

This finding reflects further on the inadequate capability to facilitate energy transition with significant dependency of international consultants from developed economies. This perhaps reflects on the inadequacy of policies, which are documented from foreign perspective with limited attention to local environment dynamic.

In summary, it may appear that the engagement process for the NREEEP project was not properly managed as alleged by research participants' responses leading to the perception that the NREEEP may be another form of aspiration with absence or limited actor network in its design and implementation.

7.5 Opinions on the limiting factors hindering renewable energy development in Nigeria

This section explores the views of research participants in relation to the barriers hindering renewable energy development in Nigeria. This may however, be a very broad area of research. The focus of this section remains on exploring the views of research participants concerning the barriers that are relevant to renewable energy policy implementation that influences, or interests, the researcher and potentially key stakeholders towards the prospect of introducing OBRE in Nigeria. Accordingly, the barriers referred to by the research participants in relation to renewable energy development are outlined in Table 7-4:

Table 7-4: Barriers hindering RE development in Nigeria

Research participants	**Findings based on Researcher's interpretation**	**Quotations**
OBRE015	Institutional and Governance barrier - no policy implementation framework	*"... policy, legal and regulatory framework, none existing structure for power purchase agreement and awareness of renewable energy benefit"*
OBRE027	Institutional and Governance barrier - lack of commitment from government	*"... in my perspective, it's the commitment of government, no serious commitment.*
OBRE026	Institutional and Governance barrier - non ratification of policy into law	*"The major barrier of renewable energy development in Nigeria is lack of policy. We have policy in place but government or national assembly are yet to sign it into law".*
OBRE025	Institutional and Governance barrier - system leakages	*"... corruption is another barrier but it's actually everywhere globally but more prevalent in our continent"*

OBRE008	Capacity barrier – lack of stakeholders to facilitate implementation	*"……well it's one thing to have things down on paper and say this is what we aspire to and there is another thing to have a concrete step in place to actually get there. To have the actors in place and institutions in place to actually do those things the resource to support that and the capacity as well so there is a big gap between aspiration and what is actually happening"*
OBRE024	Institutional and Governance barrier	*"Investments is a barrier because of poor motivation primarily due to poor policy framework, inconsistencies and lack of continuity in government policies, interest and priorities of successive governments are making the renewable energy industry in Nigeria unattractive to investors".*
OBRE011	Networking collaboration	*"I think cross sectoral interaction is another obstacle, a real challenge and inside government has a lot of non-interwoven thinking and working"*
OBREO19	Capacity, Institutional and Governance barrier	*"The major barrier is policy implementation, the will power to implement Nigeria policy. Another major barrier is capacity building because its human being that will build, install and run it.*
OBRE005	Institutional and Governance barrier - inadequate stakeholders' engagement	*"Another problem is awareness. Most people are not aware of these technologies as a replacement for another technology. For example, policy makers and law makers are not aware of the advantages of renewable energy".*
OBRE007	Institutional and Governance barrier	*"… for me the oil and gas is the major challenge hindering renewable energy development. They are one of the major stakeholders. I am not saying it will not succeed, it will but it may take a while to development".*
OBRE001	Capacity, Institutional and Governance barrier	*"I think, as far as challenge has been, there are no policies that are dedicated to the development of renewable energy until recently. I think policy is one big issue, regulatory framework is another one. Of course, lately, financing has to be structured and capacity needs to be built and so on.*
OBRE021	Institutional and Governance barrier	*"… funding is a barrier. The government is broke".*
OBRE005	Infrastructure barrier	*"… but one of the core barriers as well is infrastructure because since the 1960s, government have not invested in grid expansion and maintenance".*
OBRE009	Institutional and Governance	*"… so every agencies is into renewable energy but*

	barrier – coordination	*nobody is there coordinate all activities, that is nobody has the sole mandate to strategically and tactically coordinate renewable energy development in Nigeria. There is no entry or exist requirement so there is no coordination".*

Source: Author Generated

Table 7-4 demonstrates that the barriers hindering the renewable energy sector in Nigeria as perceived by the research participants constitutes significant institutional and governance barriers. Additional barriers include capacity/ capacity and infrastructure barriers. Most research participants felt that this observation had been quite consistent for a while now, which has invariably stagnated the renewable energy sector of the country. An examination regarding the nature of the barriers is further explored in Section 7.5.1:

7.5.1 Institutional and governance barriers

7.5.1.1 Weak political will and legal structure

Some of the research participants strongly believed that renewable energy development had been limited by the lack of political will to implement policy statements. Consistent with the concerns expressed by the research participants on the lack of political will, one participant expressed his view with respect to the differences between policymaking and political will:

> "… *major factor that is limiting renewable energy development in Nigeria is the political will. The political will is very very weak, very very weak, very weak. The political will is very very weak. It is different from policy as the political will is implementation of policy. You need to implement the policy and for you to do that, you need to have the political will. So all the while you will be reading a lot of*

> *documents (policies), it will be there after some time it will be over taken by development so that is another constraint".* (OBRE006)

However, majority of the research participants (15) perceived that the inconsistency in policy design is the main barrier associated with renewable energy development. They believed that an unstable policy statement deters concrete policy implementation This is captured below:

> *"The major barrier of RE is lack of a stable policy...so how can implementation be undertaken* (OBRE021)

> "*The policy have been reviewed in 2003, in 2008 and reviewed again in 2013. So it means it has been reviewed about 3 to 4 times, yet neither was signed into law. These mean that either the government is not serious or these RE sources are not working..."* (OBRE0015)

Within their research participants' narratives on unstable nature of policies design, they also noted the inadequacy in the legislative/regulatory structure which they perceived to be repeatedly missing – thus has failed to pass any of the RE policies into law:

> "... *is the legislative framework. Very very weak! The legal tools, like the policy even though it has been signed by the federal executive council, it may take up to 10 years again for it to be passed into law by the National assembly and where it is not passed into law, it is not yet a legal entity".* (OBRE006)

> *"For me this is the main thing for me, an investors wants to invest, he wants to know what is the regulations [regulation in place is not realistic], the FIT, you know.* (OBRE020)

> "*Legal policy and regulatory framework, none existing structure for power purchase agreement..."* (OBRE026)

An observation made by one of the research participant on this strand of barrier (legislating RE policies) was on the lack of awareness of RE by the officers charged with statutory law making in the country. This again leads to a wider question about the level of engagement between IMC and the National Assembly on energy transition involving RETs. One research participant claimed that engaging with the lawmakers is one of the most difficult task within the energy transition framework. He asserted that:

> *"Though both policy and law makers are not aware of the advantages of RE. You have to seat them down or call them to conferences and workshops and when they are invited, some of them will not attend because they have political party meeting to attend".* (OBRE005)

This finding is quite significant but perhaps one should not be surprised at this, given that majority of the efforts towards RE development in Nigeria has so far been marginal with repeatedly inconsistency in federal executive effort to facilitate a meaningful RE program. However, in Nigeria, not that legal approval matters towards facilitating niche innovations such as RETs development.

7.5.1.2 Lack of funding

Another commonly identified barrier was the limited/lack of funding for facilitating renewable energy development in Nigeria. Most finance for renewable energy projects were being funded by international organisations such as UNIDO, UNDP and UNEP with government expected to provide the supporting environment in form of national coordinators, infrastructure, in-country transport and accommodation for international consultants. However, the following quotes demonstrate the frustration of the research participants regarding the lack of funding:

"Investment is a barrier because of poor motivation primarily due to poor policy framework, inconsistencies and lack of continuity in government policies, interest and priorities of successive governments are making the renewable energy industry in Nigeria unattractive to investors". (OBRE025)

"... funding is a major problem because most of the financial institutions in Nigeria are not accustomed to renewable energy, what I can call green project, you know that renewable energy is green project". (OBRE005)

"There may be myriads of problems: one is finance, funding; funding is a major problem because most of the financial institutions in Nigeria are not accustomed to renewable energy, what I can call green project, you know that RE is green project". (OBRE011)

7.5.1.3 Lack of co-ordination / meaningful engagement

While realizing the potential value of renewable energy and at the same time trying to facilitate its uptake in the country, research participants have acknowledged that the potential success for the sector will be to address the insufficient co-ordination amongst the stakeholders' promoting renewable energy development in Nigeria. For instance, one research participant claimed that four public stakeholders' are currently and simultaneously involved in coordinating renewable energy development in Nigeria, which in itself is a siginificant barrier:

"... *ECN has mandate for all energy in its ramification such as planning, advising government. Both in renewable energy and non-renewable energy sources. However, when Rio – climate change protocol came up, Federal Ministry of Environment decided on developing renewable energy. In addition, Ministry of power wanted to do rural electrification they use renewable energy too. So every agencies is into renewable energy but nobody is there to co-ordinate* *all activities, that is, nobody has the sole mandate to coordinate renewable energy development in Nigeria. Even NNPC has a desk or department on renewable energy too".* (OBRE005)

Due to this very concern, an IMC was constituted as earlier mentioned (OBRE015)*.* Taking a different perceptive, there was mention that within same ministry, there also seems to exist different departments mandated to develop renewable energy:

> *"... within the Federal Ministry Of Environment, there is a department for Climate Change and they should be doing renewable energy because it's their mandate and then you have programs on renewable energy being managed by another department within the same ministry..."* (OBRE011)
>
> *"...and one doesn't know much of what the other one is doing".* (OBRE011)

An interesting finding on the barrier associated with RE development in Nigeria within the corridor of stakeholder engagement is the existence of an organisation that may appear to be hindering renewable energy development. This finding was particularly significant even though only two-research participant mentioned it. Considerating the frequency of other barriers being mentioned, one may be tempted to discard this perception. However, two of the research participants presented an understanding of this, where one is in the oil and gas industry and the other a key director in PTI:

> "... u*nfortunately, we are a country that invest majority of our resources on the oil and gas. The oil and gas is the sector that has killed so many new initiatives, new opportunities because the sector is thriving, but now I am happy in the drop in dollars. I believe this will make us go to back to the drawing board and I believe this is the*

reason why most of people are now clamoring for such renewable energy initiatives”.(OBRE018*)*

“… in that paper I was arguing that oil was under developing our other industries including renewable energy because we have the oil we are not thinking of other ways to develop Nigeria economy”.(OBRE013)

This finding further provides strong evidence to suggest that the barriers associated with the renewable energy market may be due to social actors’ factors in form of engagement/interaction approaches with wider actor network.

7.5.2 Capability/capacity barrier

Having considered the institutional and governance elements of the barriers to renewable energy development in Nigeria, another barrier perceived as important is the capability and capacity to develop and adopt renewable energy innovations for beneficial purposes. The data presented in Table 7-4 demonstrates that capacity has its own impact towards hindering renewable energy development in Nigeria as asserted by two of the research participants:

“… t*o have the actors in place and institutions in place to actually do those things, the resource to support that and the capacity as well so there is a big gap between aspiration and what is actually happening”.* (OBRE024)

“Capacity building is one of the major barriers because its human being that will build, install and run it. And renewable energy is a skilled area, especially if you are looking at OBRE; it’s not something that you do by trial and error”. (OBRE014)

One research participant took a marginal narrative by painting a picture that there exists some form of capacity building platform from research institutes perspective. Specifically, OBRE019's argued that capacity development might not be a problem towards renewable energy development in Nigeria. This he perceived in relation to the tidal range theoretical assessment he conducted and believes that the country do have some level of capacity and capability to foster RE development:

> *"... but I must say, in Nigeria, we have the human capacity. We only need to put them together and it will flow. More like training, yes practical experience. Like Knowledge Transfer Practices"* (OBRE019).

While the asserting above may suggest some level of fact, most research participants (13) emphasised that this lack of capacity is amongst pertinent stakeholders within the REM and as a result has limited the potential to promote the benefits and values associated with renewable energy:

> "*It is one of the major, capacity building because its human being that will build, install and run it. And RE is a skilled area, especially if you are looking at ORBE, it's not something that you do by trial and error. You do it by people who know what they are doing. The human capacity is major problem".* (OBRE025)

This assertion (capabilities and capacities limitation) interwoven in participants' discourse on the barriers limiting the REM was perceived to be as a result of the lack of awareness of the contextual nature of RE. This again provides a true reflection of earlier assertion of National Assembly's limited interest on RE. Two research participants captured the barrier on lack of awareness succinctly but differently put forward:

"Lack of Awareness is a key problem associated with renewable energy development in Nigeria. Take for example, the operation light-up Rural Nigeria project launched by the former President Dr. Goodluck Jonathan was a disaster waiting to happen because the renewable energy technologies that were being installed in the villages were being removed and sold by the communities for income generation". (OBRE024)

"... because the government is still trying to understand what is renewable energy, my experience is this, when we went to one of the state in Nigeria for a presentation towards renewable energy development, it was rather strange to them. We had to do presentation, upon presentation upon presentation, bring down our technical partner from UK to continue doing presentation before they could understand it and this are major stakeholders that will drive this renewable energy process".(OBRE018)

However, one research participant believed that this awareness is intentional and it provides the platform to indulge in corruption within the RE frame:

"... Bureaucracy*, level of corruption in the energy sector has hindered its uptake so it is not the lack of awareness but lack of patriotism, statesmanship".* (OBRE014).

Furthermore, interwoven in participants discourse about awareness and corruption is the debate on how policy makers perceived RE. While it can be argued that policy makers are quick to appreciate the value of RE in light of the different policy statements, the extent that the policy is focused on actual socio-economic impact is perceived to be unclear, in the words of one of the participants:

"So how much of the politically foundation is geared towards people orientation to sustainable growth, I don't no. so if you hear renewable energy policy in Nigeria, you should say, wait a minute and what does this really mean, does it really benefit the ordinary people". (OBRE011).

This is another fundamental finding especially when one considers the researcher's methodological stance as presented in Section 6.6.

7.5.3 Infrastructure barrier

Infrastructure is one of the barriers identified by research participants even though it was not mentioned as often as other barriers discussed. The issue of infrastructure as mentioned by research participants is on the current nature of the transmission grid in light of the proposed Feed-In-Tariff (FIT) market support instrument that is being anticipated by the government in the future. Accordingly, one participant was of the opinion that a major barrier that could undermine RE in Nigeria is the proposed FIT scheme as he asserted:

> *"… when you talk about electricity, renewable energy is not grid inter-tied. That is to generate enough electricity from renewable energy and feed it to the grid, maybe the excess. This brings into play grid connectivity and upgrade to be able to take renewable energy. We must be ready to configure our grid to be able to take renewable electricity. But our grid infrastructure is out-of-date".* (OBRE026)

Another element of the infrastructure discourse is the nature of the infrastructure – energy object (hard energy development for the REM) being suggested as a limiting factor within the frame of renewable energy development. According to one of the research participant, a persistent focus towards RET development is the 'lock-in' paradigm for the continued expansion of large scale electricity generation technologies which tend to confer power on centralized bureaucracies while marginalizing the role of citizens.

> *"...because as I said in the beginning, Nigeria politicians like gigantic solution which may not be what is required ..." (OBRE 011)*

Generally, one key participant appears to have acknowledged the repeated challenges within the RE market explaining that the Federal Government is looking into all this concerns:

> *"I think, as far as challenge has been, there are no policies that are dedicated to the development of renewable energy policy until recently. I think policy is one big issue, regulatory framework is another one. Of course, lately, financing has to be structured and capacity needs to be built and so on. So as we move ahead, these challenges will be sorted out".* (OBRE001)

7.6 Prospect of OBRE development in Nigeria

This section covers all aspects involved in evaluating the conditions under which OBRE could be developed in Nigeria. It adopted the SNM approach as the analytic lens, which conceptualises the prospect towards transitioning to OBRE development. It draws on the three internal niche-level processes as discussed in sub-section 5.3.1.1.

7.6.1 Expectation on OBRE development

Research participants had different views in terms of the expectation towards OBRE development in Nigeria. The expectations of actors appear to be positive concerning OBRE's potential benefit. The positive expectations among the research participants are based mainly on awareness of the OBRE concept, along with political interest towards its development in Nigeria and forecasts of a future market for electricity generation. Theoretical resource assessment as presented in Section 4.3.1 provides further positive expectation for its development in Nigeria. Accordingly, research participants' response to OBRE prospect is underlined in table 7-5.

Table 7-5: Research participants' response to OBRE development in Nigeria

Research Participants	Quotation
OBRE004	*"... definitely with our potential in the country we have our offshore renewable energy from Lagos to Calabar".*
OBRE001	"*The policy talks about all the RE sources that we have including the offshore winds, wave and tidal. So they are included in the NREEEP document as potentials".*
OBRE024	"*Yes because I know more of the developed nations, somewhere like in Nigeria, the potential is there..."*
OBRE019	**"...***definitely, what we can get in Nigeria is some sort of small scale energy generation from OBRE which will serve some communities within the areas".*
OBRE006	"Yes, it is there in the NREEEP document".

Source: Author generated

7.6.1.1 Awareness of OBRE nature and its potential development

Some of the research participants had certain knowledge of OBRE and commented on its inclusion in the current NREEEP. For example, one research participant commented:

> "Yes *I am aware of OBRE. The policy talks about all the renewable energy sources that we have including the offshore winds, wave and tidal. So they are included in the NREEEP document as potentials ..." (OBRE005)*

However, it is noteworthy that those respondents that appeared to be positive about this innovation were the ones that had certain level of involvement with OBRE development. For instance, NIOMR and PTI, as discussed in section 4.2. Some of the other participants claimed no knowledge of OBRE and its inclusion in the NREEEP document. Those that specifically claimed no knowledge of it were participants that were not involved in the NREEEP process. For instance, two of the research participants commented:

> *"... hmm what is that?"* (OBRE027)

> *"Am afraid I really do not know what OBRE is"* (OBRE026)

However, it was surprising that a key policy maker who was engaged during the NREEEP project also claimed of lacking the knowledge on whether OBRE was included in the existing RE policy, even though he was sent the NREEEP document for his review and amendments (the researcher was shown a mail sent by the FMOP to all IMC members acknowledging their input and also solicited further input towards the final RE policy draft prior to presenting to the President for approval). The research participant succinctly phrased is lack of awareness by saying:

> `*"Not aware of any OBRE in the policy"* (OBRE016)

Another slightly dimension to the issue of how research participants perceive OBRE was how they conceive the structure of an OBRE technology. For instance, while one research participant was not decisive enough as he tried to figure out what OBRE was, he enquired if the researcher was actually talking about wave and offshore wind. On this basis, the research participant asserted:

> *"Not really but I want to believe you are talking about wave, offshore wind"* (OBRE022)

This actually highlights the lack of awareness (significant findings) of the broader settings of renewable energy to key stakeholders as earlier mentioned in Section 7.5.3.

7.6.1.2 Future market for OBRE, in particular electricity generation

Further to the knowledge and inclusion of OBRE in Nigeria's current policy, some of the research participants positively suggested OBRE's potential applicability for electricity generation in Nigeria, as well as seeking developmental support from the oil and gas industry. The following quotes illustrate this point:

> *"... what I was expecting was that oil companies (since they have experience on offshore activities) be given mandates to research on offshore renewable energy for their own use... They have money to invest in it. They can invest in it and use it for power and community developments". (OBRE004)*

> *"... we can get in Nigeria is some sort of small scale energy generation from OBRE which will serve some communities within the areas". (OBRE013)*

Some research participants, particularly renewable energy practitioners in the country, were skeptical about this innovation being applicable in Nigeria. The criticism from these research participants on its application appears to be related to the persistent problems hindering the current renewable energy development in Nigeria and perhaps the global OBRE development spectrum.

> *"... I am also aware of its global development but in Nigeria I am not aware because we may have issue on its application in Nigeria due to barriers". (OBRE 024)*

On the other hand, one of the research participants further elaborated on the current developmental nature of OBRE, specifically in Europe, which may not be appropriate in the Nigeria's market:

> "… *I know more of the developed nations, they are still looking at OBRE and the focus is more on large scale technology towards large scale generation and distribution for urban generation so while the technology is there it is not yet commercialised because of the scale that it is been developed. This may not be applicable in Nigeria".* (OBRE 025)

7.6.2 Formation of social actors' network

The expectations towards the prospect for OBRE development in Nigeria and its inclusion in the policy context of the Nigeria's renewable energy have been identified. It is therefore important to explore the formation of the social actors' network from the perspective of the current actors involved in OBRE development in Nigeria and the relationship of these innovative actors to the broader energy settings. This is because their interaction and relationship is expected to enhance OBRE's societal fitness.

7.6.2.1 Interaction amongst niche actors

The results of the interviews suggest that actors' network formation was clearly absent within the frame of niche innovation for OBRE. This is not surprising going by what transpired in the NREEEP project as discussed in Section 7.4. In particular, NIOMR asserted:

> *"I am not aware of any other persons or organisation involved with OBRE development in Nigeria" (OBRE010)*

Also when PTI was asked if the institution has taken the tidal range discovery to the broader settings of the socio-technical regimes, the response was:

> *"... for now, my answer is I have not discussed with any other agency or ministries". (OBRE013)*

This lack of interaction amongst the niche actors' has also prompted limited collaboration with the broader actors, especially those at the political setting level associated with renewable energy development in Nigeria. It further highlights the persistence in the lack of collaboration and interaction amongst actors within the RE space.

7.6.2.2 Collaboration between niche and regime actors

Likewise, there was no interaction between the niche actors with the wider energy settings of the incumbent socio-technical regimes' actors as asserted by two key socio-technical regime actors:

> *"... since then I don't know whether any development had been done when no information is there". (OBRE005)*

> *"As I have told you that there is no activity, it may just be studies and it's not documented".* (OBRE006).

Other than the specific statements above from these two set of key stakeholders (ECN officers), the general perception from other research participants was:

> *"No we are not aware".* (OBRE002; OBRE003; OBRE007; OBRE023; OBRE026 amongst others)

However, one of the research participants informed the research that there was this one occasion in which a stakeholder (ocean energy developer) visited him towards financing a feasibility study for an ocean energy project. He commented this:

> "*... but just last week some people came over to my organisation to request for financial aid from my department to undertake OTEC feasibility studies". (OBRE0016)*

Furthermore, he expressed a sense of frustration (shaking his head) by emphasising that the main actors such as ECN were not even engaged at all, by asserting:

> "*Agencies such as ECN were not in the know-how of this development which is what we having been talking about, the lack of collaboration and interaction". (OBRE0016)*

This assertion above was said because when he *(OBRE0016)* made further enquiry from the visitor if they had contacted institutions such as ECN; they responded no. Thus, it is fair to accept what OBRE005 and OBRE006 of ECN stated on their lack of awareness to any ocean energy development, let alone that of OBRE.

7.6.3 Learning process

Learning processes involve knowledge about the technological aspects of various niche-level experiments, including technical design, theoretical and empirical resource assessment, pilot tests and knowledge development/diffusion. However, broader learning processes pertaining to the social embeddedness of these efforts also plays an equally important role. This is because it requires that various actors within the socio-system should co-evolve with many aspects of the technology, including what relevant regulatory conditions, institutional and environment aspects could or should be designed and implemented.

The evidence suggests that the learning processes in the creation of a niche environment for OBRE development have been concentrated on technical forms of learning including theoretical resource assessment, as indicated by the niche actors from PTI and the National Centre Hydropower Research and Development respectively:

> "*We conducted a research on that. What I did, is to understand the principle of tidal energy and the way of converting the potential energy in water heights which contains potential energy which can be translated into mechanical energy and from mechanical energy to electrical energy".* (OBRE013).

> *"… as you have rightly observed, the two papers were based on hydrokinetic energy conversion technology potential for Nigeria".* (OBRE025)

However, one research participant claimed to have initiated some form of social learning in a bid to create more awareness on OBRE applicability in Nigeria. The research participant felt the increased need to engage key political circle towards OBRE potentials, however cited the stress involved in actually getting the co-operation from this political actors including BSG circles:

> *"… we have been dialoging and creating the much needed awareness on OBRE development. But it has not been easy".* (OBRE018)

This also confirms initial assertion put forwards by one of the directors of ECN on the difficulty in seeking the audience of top politicians including governors, ministers, senators and commissioners on matters such as energy transition.

Overall, it appears that in Nigeria, there was no effort made to bring together stakeholders to inform their decision-making on the prospect of OBRE development in Nigeria even though it appears that it has prospects to be integrated as part of Nigeria's future energy mix. The lack of actors' network formation and learning process to further increase its expectation - alignment and shaping of OBRE's vision - towards social acceptance may potentially limit the transition towards OBRE development, which is seen as a significant finding in this research study.

7.7 Potential critical success factors considered for OBRE development

This section explores the views of research participants in relation to the critical success factors that may enable the transition towards OBRE development in Nigeria. This comes in the heels of the significant findings noted in Sections 7.2 through to 7.6. The focus of this section is therefore, to explore the views of research participants regarding the enabling factors relevant to the transition context of OBRE development. Accordingly, two elements are examined in this section:

7.7.1 Principles to be considered for OBRE transition

This section examines research participants' views concerning the best way to undertake the transition towards OBRE development in Nigeria. Their views as depicted in table 7-6 is presented below:

Table 7-6: Research participants' view on principles to consider for OBRE development in Nigeria

Research participants	**Findings**	**Quotations**
OBRE006	Research and development	*"… I think current research you are doing can help identify the best technology to use, the cost implication of it, and maybe a way for implementing it".*
OBRE015	Stakeholders engagement	*"Creating awareness and allowing the population to know more about offshore renewable energy technology"*
OBRE001	Political advocacy and research and development	*"… on the guiding principle, well, I think number one, there should be a political decision to explore OBRE because it's quite an expensive endeavour. Secondly, studies should be conducted around the coastal region and offshore. I think these two key things will lead to funding making finances available if there is a political will and also a potential from a resource view. I think those are the things that need to be done".*
OBRE027	Political advocacy and stakeholders engagement	*"Political will and strong collaboration amongst all stakeholders"*
OBRE025	Stakeholders' engagement to create awareness, research, development, and policy advocacy.	*"… because it is still a very new area of renewable energy, there is need for intense publicity and awareness especially amongst relevant stakeholders and the general public (might need to work with relevant NGOs). I believe there is need for development, deployment and demonstration of a model technology especially for prospective investors. I also think enabling policy and this is even more important for a very new industry as OBRE. Policy advocacy is therefore very important and might need to work with renewable energy associations and key industry actors. There is therefore need for a winning strategy".*
OBRE008	Stakeholders engagement and governance; and demonstration	*"… starting from scratch is by identifying the key people you need to have on ground which goes back again to different stakeholders we identified earlier before making sure that dialogue amongst the group of people and having a proper management in place to actually oversee that process and facilitate this dialogue that we are talking about and again making sure that it's not about talking and not just about developing a strategy but also tied to concrete action to some sort of demonstrable outcome because action speaks louder than words. So I think demonstration in itself is the best form of advertisement".*
OBRE023	Stakeholders' engagement, awareness and demonstration	*"… OBRE project team be formed to organise and manage a demonstration pilot and to create the necessary awareness"*
OBRE022	Stakeholders engagement	*"… strong consultation with all necessary stakeholders and possibly do a pilot test".*

OBRE018	Stakeholder engagement,	*"… engage stakeholders such as ECN, NNPC, people that can make things happen."*
OBRE013	Stakeholders engagement	*"I would say that one needs to go to the state level and then to the national level… "*
OBRE011	Demonstration	*That is a big question, in this, case I will really say a pilot because Nigeria is 'seeing is believing' and we really need to see it. And like we are doing, show the economic viability and show that to the entire stakeholders who need to know".*
OBRE015	Stakeholders' engagement and meaningful advocacy	*"I think you need to have stakeholder's engagement, talk to the policy makers or makers specifically the ECN. They are the drivers and if the case for it to be made, they will facilitate and bring in again the stakeholders. For instance, the oil and gas will be invited. Because when you talk about Offshore, hmmm my mind goes not only on generating powered from offshore.You could do some advocacy. Advocacy is at two levels – if you do public advocacy that is fine. I think you should do a targeted advocacy where you can go to potential customers or end users…"*
OBRE007	Awareness creation and stakeholders' engagement	*"… one of the reason that OBRE will suffer if we do not do a proper awareness, stakeholders meeting, bringing the people together, the communities, newspapers, banks, whistle blowers, SMEs investors universities, media, investors, government, international oil companies,…if this is not done, it cannot be sustainable!*
OBRE017	Stakeholders engagement and demonstration	*"… most critical thing for us to do is to constantly engage with the processes, regulations, the laws, stakeholders, to see where the gaps are for a demonstrable project".*
OBRE002	Stakeholders engagement and demonstration	*"Put in a place a team to facilitate its development, intense stakeholders' engagement and demonstration pilot, maybe small kWs"*

Source: Author generated

7.7.1.1 Broad stakeholders' engagement

All research participants considered stakeholder engagement to be one of the key principles to be considered if a successful transition towards OBRE development is to be achieved in Nigeria. Thus, this presents key findings and perhaps may not be surprising in light of the research findings in the preceding Sections. Accordingly, the views on stakeholders engagements as a major principle to consider is further explored:

“Actually, OBRE is already in the renewable energy master plan. So we envisage we have to develop offshore renewable energy in Nigeria. One, we need to sensitise all stakeholders especially investors about this since we are now into market economy and I believe most of the investors should come from the oil companies because they are the people mining oil in the riverine area in the Niger delta areas” .(OBRE005).

“... I think you need to have stakeholder’s engagement, talk to the policy makers specifically the ECN. They are the drivers and if the case for it to be made, they will facilitate and bring in again the stakeholders”. (OBRE016)

“For me, it’s just collaboration amongst all stakeholders – National, State, Local and international”. (OBRE009)

In relationship to stakeholder engagement, one research participant slightly deviated by further giving his thought on the most important stakeholder to be engaged due to the market applicability of OBRE.

“First, OBRE is basically has to do with the coastal region. Unfortunately, these stakeholders in this coastal area are not highly enlightened and this will be one of the major challenges when you want to develop OBRE. OBRE will suffer if we do not do a proper awareness, stakeholders meeting, bringing the people together”. (OBRE018)

7.7.1.2 Demonstration activities

As indicated by research participants, there is also a need for an OBRE pilot to be undertaken so that its benefits in achieving the expected socio-economic development objective can be critically evaluated by stakeholders. The assumption here is to display to stakeholders’, in particular policy makers and the wider social system such as the users, a form of awareness creation – both implicit and explicit - of OBRE’s potentials in a bid to instigate political support for up scaling or replication across the relevant region. This was a major perception by research participants:

> "*Do a small demonstration to produce light and there will be massive support from all stakeholders" (OBRE024)*

> *"... I think current research you are doing can help identify the best technology to use, the cost implication of it, and the engineering part of it". (OBRE006)*

> *"... a resource assessment should be conducted first, just like for wind and solar renewable energy". (OBRE010)*

One could conclude that 'seeing is believing' in this case. Perhaps, research participants also felt that the debate on RE in Nigeria has been blown out of proportion with so many instances of its potential without any concrete evidence of such potential. This becomes a useful insight for the Research to consider after his doctoral degree thereby lending to the methodological approach, discussed in Section 6.2.3.

7.7.1.3 Political advocacy

There were research participants who also believed that political support from key public stakeholders is very important for the creation of an enabling environment that would be favorable for OBRE's transition process and possibly, for developing relationships with other stakeholders' such as the private actors.

> *"... you need to get the political buy-in. So it's a bit of lobbying. I also feel there should be a synergy amongst the ministries – FMOE, FMOP, NIPC, ECN, NNPC to support in advancing this cause" (OBRE 016)*

"... also Lagos state is serious about climate change and has been having some sorts of conferences and programs, they could use a sort of government advocacy to look at the potential of OBRE" (OBRE022)

Nevertheless, within this context, one of the research participants strongly believed the need for collaboration between public actors and the private actors in a bid to limit public's participation during the transition process.

"*... from my own side, it should be done under Private Public Participation (PPP), with the state government where the areas are suitable for OBRE development. It must be under PPP otherwise it is not realisable in Nigeria, that it will not be sustainable because the federal government may not have the strength to take on the project".* (OBRE018)

7.7.1.4 Learning and knowledge development

Some research participants acknowledged that learning and knowledge development from countries' with higher developmental capacities such as the UK could aid in facilitating the transition to OBRE development in Nigeria. They argued that this strategy should be the responsibility of the government as quoted by one of the research participants:

"... I think the Nigerian government can also learn from countries that have succeeded in offshore renewable energy, such as the United Kingdom, etc. and use the lessons learnt to develop a robust OBRE policy and strategic roadmap". (OBRE014).

In sum, it appears that the integration of OBRE in the future energy mix of Nigeria may be underpinned by significant stakeholder engagement with diverse interest and influences. This engagement is assumed to aid in fostering the other principles as presented through 7.7.1.2 to 7.7.1.4 thereby facilitating the following amongst others: political support, funding arrangements for research and demonstration; and the need for broader knowledge to understand what potential business opportunities can be expected from and during the transition process.

7.7.2 Key stakeholders' to be considered for OBRE transition

Based on the analysis of research participants' views in sub-section 7.7.1.1 regarding the relevance of stakeholder involvement for OBRE development in Nigeria, this section further explores the pertinent stakeholders to be considered towards assisting in the transition process. However, while findings do not define any specific roles to be played by the perceived stakeholders' they justify their selection by the research participants. Thus, this is illustrated through the assertions made by several research participants in Table 7-7.

Table 7-7: Relevant stakeholders to consider towards transition to OBRE introduction in Nigeria

Research participants	**Findings**	**Quotations**
OBRE004	Nigeria Power Training Institute, NDDC states and a project investigator	*"...... NAPTIM, to develop a curriculum to include OBRE as a case study. Potential (users) states within the coastal region because they will be the major users/beneficial. For example NDDC states and Lagos state. We also need a champion too, to lead this OBRE project".*
OBRE001	Federal ministry of Power, ECN and Rural Electrification Agency	*"Well, I will start by saying FMOP if you are looking at using OBRE to generate electricity, then ECN and also Rural Electrification Agency"*
OBRE018	Oil and Gas companies	*"I think the most powerful players in the renewable energy sector in Nigeria is the oil and gas sector (meaning they need to be part of the stakeholders because there is still this notion that and it's not just in Nigeria.... that renewable energy is trying to replace fossil fuel and any attention diverted to renewable energy is an attention diverted away from fossil fuel".*
OBRE007	Federal Ministry of	*"I think the FMOP, the coastal states government and maybe REA.*

	Power, coastal state government and the rural electricity agency, financial institutions.	*I also feel the involvement of international institutions and financial institutions, like the banks will be good too"*
OBRE005	Niger Delta Development Commission, state and federal government and financial institution	*"Get in touch with NDDC, It may not materialise immediately, but one of them may be interested. So NDDC, state and federal government and investors can be used to intervene. Also the financial institutions – You need them because if you use your money, it will be called money laundering".*
OBRE021	Government, international oil companies, private investors.	*"I think they are just three: First the government; second the IOCs and third player is us – the private investors. If we can all come together I believe in the next five years, the impact will be much compared to what we are doing now".*
OBRE013	Energy commission Nigeria, Nigeria National Petroleum Corporation	*"I think OBRE needs people who can push it so I suggest ECN and NNPC, with other international oil companies".*
OBRE027	Researchers, government – executives and legislators	*"Let me say, for now, one are the researchers, usually found in higher institute and then the government for now. The government is the executives (the head of state and the ministers) and then the legislatives. These are the government. Because the executive will take, the bill to the legislative and they will approve it and send it back to the executive to implement. So that is it. But the researchers will first of all come out with an idea and then sell it to the executives who will make it a bill through the legislative for implementation"*
OBRE023	Energy commission Nigeria, Federal Ministry of Power, Federal Ministry of Environment.	*"I can't really say but I think the people you have spoken to so far can help push it such as FMOP, ECN and FMOE".*
OBRE017	IMCs	*"The inter-ministerial committee – IMC".*
OBRE010	Federal Ministry of Power, oil and gas companies	"For me FMOP, the state's governments and I also feel the oil and gas companies who are into offshore can support from a financial point"
OBRE012	Ministry of water resources, ministry of power and the government	"*Ministry of water resources, ministry of power, the government itself should promote it"*
OBRE026	Coastal state governments, NIOMR and International universities such as RGU.	*"I think you should with the states government within those areas, I mean the coastal areas. I will also want to see us (NIOMR) get involved to with some international institutes like RGU".*

Source: Author Generated

The quotes above indicate that the Federal government, represented by the Federal Ministry of Power and Energy Commission Nigeria, appears as the key stakeholders to facilitate the development of OBRE innovation in Nigeria. Additionally, from the sub-national perspective, the coastal state government are perceived to be fundamental stakeholders, in particular to the region where OBRE is to be implemented. This returns us back to the explorative pilot study (Phase Two) where it was equally suggested by one of the research focus participants (policy maker in the power sector) advocating that key stakeholders need to be included for OBRE to be introduced in Nigeria. The participant asserted by saying:

> *"... it will be good to discuss with the various ministeries such as Federal Ministry of Power, ECN and Federal Ministry of Environment on your OBRE thing so as to know your next step. If not it may not work at all"* (OBRE BSG).

Aside from the key stakeholders identified above, some research participants advocated for the inclusion of the oil and gas companies and the financial institutions. Both actors were perceived as key actors. In relation to the financial institution, one particular participant captured research participants' sentiments by asserting:

> *"I once attended a conference, sorry, summit, on the way forward for the power sector in Nigeria. Virtually in that meeting I was able to understand that stakeholders are able to meet on a regular basis to deliberate on action and strategy but one thing that was missing is the financial institution because these are the people that will finance the projects. Without them how can you develop renewable energy?"(OBRE021)*

From a wider, perspective and referring back to the explorative pilot study (Phase One), finance was a key barrier for OBRE development as suggested by two research participants:

"it is financial funding. Cost of implementation is high" (OBRE PRT01).

Similarly, another participant attested to this fact that cost was an issue but narrowed it to the point of demonstration.

> *"... at present financing is a big issue for us especially during the demonstration period"* (OBRE CN01)

One of the research participants however, strongly believed that without legislative support and meaningful participation of the national assembly; through the provision of certain level of enforcement towards renewable energy development in Nigeria, it might be difficult to facilitate OBRE. In summary, he advocated their involvement by commenting:

> "*They are the national assembly. They are really the key players. Have a senate or house of assembly committee on renewable energy development. They will be able to set up budget for it. Currently the renewable energy budget is less than 5% of the Energy budget. For instance, less than 5% was set for RE development in 2013. If the national assembly can have that committee, OBRE will be developed quickly". (OBRE021)*

Another participant suggested the inclusion of what is termed 'private sectors influencers', who are argued to be close to the policy makers within the two arms of the federal government - executives and legislators.

> *"I think, we call them private sectors influencers, like the Lagos Business School (LBS) will be very good, universities, like Ahmadu Bello University (ABU), though they are not into OBRE, maybe*

because they are up north, but they have interest in renewable energy, they have interest and potential for innovative and they have a micro finance bank that can support you". (OBRE010)

Many of the research participants also agreed on the need to involve 'high powerful politicians' who make decisions of whether to undertake specific projects or not, including RE projects. In particular, one of the participants claimed that approval of projects are usually undertaken after office hours by asserting:

"... fundamentally, what we always leave out in our analysis is that developmental decisions are often taken after office hours. Is the politician with the big business, seats down in the evening and say this is what we need to do. So you need to really engage the big shots. At least for coastal, it could be from the chiefs, politicians, business people, talk to the Elumelums, talk to Tinubu even the former governor of Cross River state. Those who really pull the strings, whether in power or behind the power, even though they might be investing into oil heavily but they might be intrigued about this ideas and invest in it too". (OBRE 011)

From a research and development perspective, one of the participants suggested the inclusion of an academic or research institute. Given the current research centres that are dedicated to renewable energy development, it appears that none of them are particularly involved with ocean based renewable energy development. However, one of the research participant suggested that two universities might be approached:

"... University of Lagos will likely handle if it comes into Nigeria or University of Port Harcourt. When you talk about university, you talk about the personnel's there, people who have interest in it". (OBRE004)

Two research participants also drew attention to the Institute of Oceanography as a key participant because of their mandates in Nigeria's marine system. Of the two research participants, one advocated the involvement of international institutes' including Robert Gordon University. They suggested respectively:

> *"... we need to talk about agencies such NIOMR... "(OBRE015)*
>
> *"... I will also want to see NIOMR get involved too, with some international institutes like RGU". (OBRE016)*

Finally, one participant strongly believed that concerted effort amongst all the relevant stakeholders' is required to facilitate any renewable energy development in Nigeria, including the likes of OBRE. The research participant's views come into play when assessing the various roles and functions associated to each stakeholder within the renewable energy market as he commented:

> *"Basically when it comes to renewable energy development, no leader is in charge. All the MDAs basically, they've got their mandates, but when it comes to renewable energy in terms of electricity, the Ministry of Power takes charge, when it comes to maybe environmental like EIA, climate change, pollution; ministry of environment takes the lead role. Now, ECN, ECN takes the lead role of providing information when it comes to gathering information on renewable energy such as OBRE. Hence, there is no clear-cut of which stakeholders should involve; I feel all have something to give... " (OBRE019).*

Significant finding herein indicates broad stakeholders engagement is required towards facilitating OBRE development in Nigeria. Within the frame of this engagement, informal interaction may persist especially with key political actors. Broader level of awareness programme is also observed as a significant element that needs to be incorporated into the stakeholder engagement activities.

7.8 Concluding summary

This chapter has presented and analysed the findings of interviews conducted with twenty-seven of the research participants. The participants were asked ten questions that have been identified as requiring clarifications from findings in the previous Chapters. From the ten interview questions, six key themes were recognized as pertinent from the analysis, in relation to the study's aim.

In the first theme relating to the motive towards the transition to RE uptake, the study discovered that the focus towards renewable energy development in Nigeria is essentially required to provide supplementary access to electricity, especially to rural/remote communities. Another key motive as perceived by the research participants was the need to align the country's national programme towards achieving sustainability: from the context of leveraging the use of RE to support such programmes including responding to climate change concerns. Even though other motives including energy security, socio-economic development and the persistent increase in population were indicated by research participants, they were however, categorized under access to electricity or sustainability.

In relation to the second theme (mechanisms designed to drive RE development), the majority of the research participants asserted that supporting statement in policy documents was responsible in driving the renewable energy market. Participants also mentioned the institutional arrangement frameworks and market support mechanisms such as the Feed-In-Tariff as other key drivers. However, the study discovered that private sector participation, along with international agencies and NGOs support appears to be the main driver facilitating the current development status. On the other hand, it may also appear that the supporting statement in policy documents may have provided the enabling environment to encourage such development. The third theme reflected on one of the developmental programs – the NREEEP project – which was based on the advocacy from ECREEE; for each member state to develop supporting statements that will enhance their current RE development status. In relation to that, the study assessed the organizational structure and engagement towards the NREEEP development. Research participants indicated mixed sentiments on the overall success of the NREEP project; in particular, many of them felt the inadequacy of FMOP as the overall coordinator of the project. Specifically, three of the participants queried the role of FMOP in policy making as against policy implementation, perceived as FMOP's main mandate. This resulted, clearly, to the issue where pertinent stakeholders were absent; and were being represented by colleagues who felt their presence and contribution was very negligible to the NREEEP project process. Furthermore, participants point out that the international consultants (employed to support FMOP) specifically undertook the stakeholders' engagement which was meant to be conducted by FMOP. This raised question on the capability of FMOP to undertake policy design mandates in relation to RE development in the country.

In relation to the fourth theme, which focused on the limiting factors hindering RE development in Nigeria, research participants were quick to acknowledge that the same supporting statement in policy documents was the main barrier hindering RE development from the context of implementation of the policy statements. The research participants' views clearly underline the need for more appropriate political willingness towards RE implementation, including having the right regulatory and institutional framework, economic instruments, which could facilitate implementation programme. Other topical barriers as perceived by the research participants included: inadequate awareness of RE concept by key policy makers including the federal executives and national assembly; limited and ineffective stakeholders engagement; lack of capabilities and capacity to facilitate RE development; and, limited access to funds – which is surprising, given the surfeit wealth of the nation from its crude oil sector. Research participants believed that these prevailing barriers could limit the prospective transition towards OBRE development, even though majority of the research participant lacked the knowledge of what OBRE concept really is.

The fifth theme takes into account the prospect of OBRE development using the SNM's three internal niche process as the theoretical lens. Findings indicated the lack of niche-to-niche interaction and niche-to-regime relationship towards OBRE development was predominantly absent. From the niche-to-niche perspective, niche actors such as UNIPORT failed to interact with other OBRE niche actors including National Centre Hydropower Research and Development (NCHRD) and NIOMR. Likewise, there was no niche-to-sociotechnical regime relationship as evidenced by some key incumbent socio-technical regime actors. Consequently, the element involving ‘learning processes within the SNM’s internal niche framework was not accomplished.

Finally, the sixth theme, provided participant’s view on the enabling factors that should be considered (in light of the prevailing conditions associated with RE development) towards facilitating the transition to OBRE. In response, research participants agreed that strong stakeholder engagement with adequate organizational structure including some form of demonstration pilot were key towards facilitating OBRE development. Additionally, research participants believed that the following stakeholders should be strongly considered as part of the key actors facilitating the transition process: the Federal ministry of Power; the coastal state/ local government, Energy Commission of Nigeria, financial institutions and oil and gas companies who particularly operate in the coastal region.

The next Chapter picks up the summary above by critically discussing the key findings, which are interwoven with findings from the two set of pilot studies in section 6.3.3.2, along with pertinent literature from Chapters 1,2,3,4 and 5.

CHAPTER EIGHT

Discussion and synthesis of findings

8.1 Introduction

This chapter aims to discuss the findings produced from results generated in the previous Chapter, interwoven with findings from the pilot studies, specifically phase 1 and 2 into a critical discussion that incorporates literature, which had been set out in Chapters 2, 3, 4 and 5. Finally, based on the findings from the discussion, an intervention model is proposed in relation to the research study's aim.

8.2 Discussion of the major findings

The discussion is presented under the following four key themes in relation to this research. The first theme identifies the nature of renewable energy policy focus and the institutional settings in Nigeria required to facilitate OBRE development, while the second discusses the level of stakeholder engagement within the renewable energy market. This discourse intends to highlight the importance of agencies that could aid in facilitating the transition towards OBRE development in Nigeria. The third and fourth themes discuss, in turn, the prospects towards OBRE development in Nigeria from the context of SNM approach and the perceived critical factors considered to enhance OBRE development in Nigeria.

8.2.1 Nature of renewable energy policy focus and the institutional settings required to facilitate OBRE development in Nigeria

Analysis conducted in Chapter 7 suggest that institutional frameworks designed to facilitate renewable energy development in Nigeria, such as supporting statements in policy documents, regulatory frameworks and institutional roles or mandates will have a significant influence on how OBRE is designed and implemented in Nigeria. Major studies on the geographical adoption of renewable energy innovation practices have indicated that supportive policy design and institutional settings are required to guide and facilitate particular actions and outcomes towards renewable energy development. In particular, as put forward by DECC (2011) in Strachan *et al.* (2015),

> *"projects are generally more likely to succeed if they have broad public policy support…"* (DECC (2011) in Strachan et al. 2015 p. 99).

Transition theory and approaches have also proffered that technology innovations including OBRE innovation must be encouraged by appropriate policies linked to supporting new ideas and the creation of effective market mechanisms for their integration with the local environment (Geels 2005; Loorbach and Rotmans 2010). Furthermore, promotion of more sustainable forms of energy requires strategic institutional mandates amongst other requirements, including regulatory and market instruments to facilitate and shape the development of required sustainable innovations (Elzen, Geels and Green 2004; Cowell *et al.* 2016). These sustainable forms of energy including RE forms – in this case, OBRE - are potentially seen to address certain persistent societal problems including inadequate access to electricity and climate change concerns (Eames et al. 2006).

The findings from this study suggest that although broadly similar in terms of the intentions identified above, Nigeria's policy statement, institutional arrangement and market design are seen as hindrance to renewable energy development in the country. In practice, designing and planning processes are highly politicized and the potential prospect for any RE including OBRE to develop remains predominantly politically influenced. Therefore, it has not always been clear that the institutional landscape has the necessary experience to drive RE development in Nigeria. Since 2005 onwards, there has been increased political interest in renewable energy development in Nigeria, evidenced by the plethora of supportive statements in policy documents (GIZ 2014). Many studies have concluded that these statements in policy documents often tend to be unclear in particular with the implementation programme elements and the regulatory side of the policy statement (ECN 2005; ECREEE 2014). Coincidentally, this unclear element of policy has also been replicated in the area of OBRE development where the position of the Nigerian Government remains uncertain on how to approach OBRE development as detailed in both the NREEEP and the BIPA document (Section 4.4.1). The study also noted that the REMP document, which was designed by ECN in 2005, contained a development programme for OBRE design and implementation in the form of a short, mid and long-term strategic plan as illustrated in Table 4-1. However, that programme agenda appears to have been discarded and was never built upon in the current RE policy - NREEEP, even though it subtly made reference to OBRE potential for electricity generation. This suggests the inconsistency in policy documents required to drive RE in the country. Therefore, it is extremely difficult to assess the quality and value of such political ideas and scenarios (Eames et al. 2006) because policy designs, especially in developing economies such as Nigeria tend to be more focused on aspiration with little or no attention to actual implementation (Cargill in Verolme 2014, p10).

Indeed, a key factor, perhaps, perpetuating the marginal existence of RE development is the issue of how much of the policy context is focus towards people orientation and sustainable growth - social innovation (Doci et al. 2015). Findings suggested that policy documents facilitating renewable energy development are mainly focused on complex, large-scale infrastructures, which tend to confers power on centralised bureaucracies and corporate oligopolies whilst marginalizing the role of ordinary people, also seen within the developed economies such as in the UK (Strachan *et al*. 2015). Against this backdrop, political decisions tend to be undertaken informally, (which tends to invite corruption). Findings suggests that such decisions towards which energy development path are seemingly made at 'odds hours' as suggested by one of the participants:

> *"Fundamentally, what we always leave out in our policy analysis is that developmental decisions are often taken after office hours. The politician with the big business seats down in the evening and say this is what we need to do"* (OBRE 011).

This deduction is further reinforced when interpreting why renewable energy development in Nigeria is very slow. This clearly indicates that a significant understanding is required on how political decisions are formulated towards RE development, especially within the policy network corridors. Similarly, global OBRE development is suggested to also suffer a similar fate in relation to policy focus concerning its development path, which tends to be heavily focused towards complex, large-scale HECs devices (Leete *et al*. 2013).

There was enough evidence from this study to also suggest the lack of legal and regulatory framework to support the implementation of RETs in Nigeria. Regulatory frameworks serve as the legal foundation that institutes transparency and responsible management towards innovation development by providing institutional mandates, incentives, monitoring and auditing (International Energy Agency 2011). In Nigeria's terms, this framework is envisaged to encourage private investment, especially in electricity generation, thereby creating a level playing field for all investors within the sector. Thus, for private investors' participation, the rules of the game must be clear towards ensuring that their investment can be guaranteed or secured. From literature, supportive statements in policy documents issued by the government in Nigeria on renewable energy development are yet to be transferred into legislation, including the NREEEP (GIZ 2014). This is also consistent with findings from the interview conducted on the plethora of policies, which are yet to be signed into law for implementation. Hence, while the policy intention to buttress renewable energy development may appear to be clear, a firm regulatory regime to govern them appears to be predominantly absent. The absence of this clearly puts RE at odds with the petroleum market where significant work has been undertaken towards regulating the industry's business operations. As suggested by one of the research participants:

> *"… the main thing for me, an investors wants to invest, he wants to know what is the regulations (regulation in place is not realistic)…*(OBRE020).

The ESPRA (as discussed in Chapter 2) set in the provision of the legal basis for the electricity sector with necessary enabling provisions for promoting, enforcing, regulating the various forms of energy generation sources. However, the legislative system for electricity sector in relation to RE development has continued to fail. This repeatedly leaves policy and regulation actions to international organisations including GIZ, UNIDO and UNDP who on the other hand, are knowledge and politically limited in relation to the local politics being played and insufficient attention to wider level of national and sub-national agencies. Additionally, little wonder that the RE market is yet to have a clear market support instrument, although FIT has been 'informally' selected to create the required investment mechanism.

Renewable energy development is suggested to intersect a range of different interests, often part of different ministries, departments and agencies. Analysis in Chapter 7 suggests that the support for renewable energy development in Nigeria is governed by a set of institutions that constitute what is called the Inter-Ministerial Committee (IMC) - comprising of pertinent MDAs (Section 2.6.2.2). However, findings from this study suggest that although there are different MDAs with diverse interests, the sector has been ineffective due to the repeatedly unclear institutional mandates/structure. One of the key findings relating to this concern is the significant variation in governance by which these MDAs interact, or even attempt to interact in some cases, in order to support the implementation of policy statements and market support instruments. Therefore, rather than having a symbiotic relationship between themselves, there seems to be duplication in effort with significant solo work towards renewable energy development by each of these public institutes, especially ECN, FMOP and FMOE. This inadequate governance approach appears to be consistent with literature on the 'poor fit' of institutional arrangements towards renewable energy development (Cowell *et al*. 2015). The issue above is further consistent with the assertion drawn from the i explorative discussion-based focus group discussion held with ECREEE in Cape Verde who indicated that:

> *"clear direction and governance from governmental agencies (public institutions) in West Africa are repeatedly missing, resulting in an ad-hoc development within the renewable energy sector".* (OBRE ECREEE)

Accordingly, this makes it difficult to point out a clear champion or champions to drive policy agenda, deploy political resources, or to encourage policy communities around renewable expansion in the country. Furthermore, the inter-personal relations between the various MDAs' actors are suggested to be conflictual and how conflicts are managed may have a fundamental influence upon the transition path towards OBRE development in Nigeria (Cowell *et al.* 2016).

While the research acknowledges the role and nature of Nigeria's policy and institutional landscape in facilitating renewable energy development, it has equally challenged its ‘appropriateness’ with reference to the overall institutional governance strand facilitating such development. The emphasis on appropriateness brings to bear the criteria for institutional/governance formulation and design, which is suggested to consider certain principles that include certainty for the RE market; effective collaboration; interaction; and feedback, amongst public authorities actors and with the broader social system (meaningful policy network) (Geels 2011; Markard *et al*. 2012). In general, the inadequacy and unclear policy network arrangements within the renewable energy development context may very well have a significant bearing on emerging renewable energy technologies, including OBRE. Thus, making them become less anticipated even though they may appear to be a good fit for meeting societal needs.

8.2.2 Level of stakeholders’ engagement within the renewable energy market in Nigeria

Within the sustainable transition theory perspective, a trend towards engaging with diverse stakeholders is evident in addressing issues such as system complexity, power, agency and politics, especially in local communities (Midin *et al.* 2016). According to Midin *et al.* (2016), an important element towards achieving the sustainability agenda within the public sector is in the role of strong stakeholders’ engagement. Twomey and Gaziulusoy (2014) also asserted that within contemporary transition theory, technology innovations including OBRE could be considered as a joint activity or responsibility involving a large number of actors with different interests, perceptions, capabilities and roles. In particular, they explained that the transition approach pays much attention to the understanding and balancing of all interests, set within the context of sustainability programs. Therefore, the discussion in this section focuses on the effective participation of stakeholders' in renewable energy development decision-making in Nigeria, within the institutional setting context. This focus is discussed in relation to the extent of non-public stakeholder involvement and the effective engagement amongst the incumbent socio-technical regime actors towards facilitating renewable energy development in Nigeria.

It is evident from the study that Nigeria has instituted the IMC to provide the necessary oversight towards renewable energy development; the constituents of the actors appear to be an important factor in achieving the aim of the IMC. The IMC supports the development of renewable energy on behalf of the Federal government through retaining control of key constitutional and financial resources with the main centre of governance capability situated with the FMOP. The IMC also ensures that the renewable energy sector develops sustainably – taking into account the balance between economic growth, environmental issues and social concerns. Thus, it can be argued that security of supply; markets and competitiveness remain centrally controlled by the Federal government with little or no involvement from the non-public stakeholders. In particular, a key element of the IMC is the harmonisation of diverse interests from the different MDAs towards understanding the practical constraints and opportunities associated with the renewable energy market. However, analysis from the study argues that the IMC has been less prominent as earlier mentioned in Section 8.2.1.

The findings from this study also revealed the lack of other pertinent actors duly absent within the IMC, including state government representatives, major energy businesses such as the oil and gas companies; as well as trade association for renewable energy. Drawing from Chapter two, section 2.6.2.2, the members within the IMC are assumed to belong to the 'statutory' categories of stakeholders where policies and regulatory decisions are repeatedly taken to progress renewable energy development in Nigeria (BWEA 2007; GIZ 2014). Broader categories from the non-public authorities' stakeholders – in form of strategic, communities and perhaps symbiotic stakeholder's representatives are unfavourably missing from the committee structure. Though called IMC, the immersion of these key stakeholder representatives could potentially influence the strategic outcomes and perhaps shift it away from what the research study perceives as a 'steering committee' towards a more systemic, all-inclusive transition structure for developing the renewable energy sector.

The justification for this is evidenced, that the adoption and use of a new technology such as OBRE, entails learning, adaptation and capability development among all potential stakeholders' of the technology (Hoogman *et al.* 2002; Van Ejick 2007). This also enhances the chances of successful uptake and subsequent diffusion of the technology, especially for users such as the communities and individual consumers within the development process (Tigabu *et al.* 2013). Furthermore, the potential success of inclusive stakeholders' engagement is expected to form a network alignment amongst stakeholders' and potentially respond to some of the institutional concerns as discussed earlier in section 8.2.1 (Loorbach 2007).

From the perception of network alignment, this has been regarded either as a tendency towards network development or as an organised or purposeful way of development towards achieving certain objectives (Elzen *et al.* 1996; Park 2013). In either case, network alignment plays a key role in shaping transition, often dominating the direction of transition (Schots and Geels 2010). The network formation is also suggested to be influenced by a number of environmental factors, but the actors in the network are most influential where there is a process of interactive learning between the actors in the network, consisting of learning by interaction in the various activities including effective and meaningful public engagement amongst other learning experiences (Kemp *et al.* 1998; Hoogma *et al.* 2002; Park 2013). However, the impact of the inadequacy within the network formation of the stakeholders' engagement has resulted in the RE sector to still be in its pre-development stage of transition, as presented in Figure 8-1.

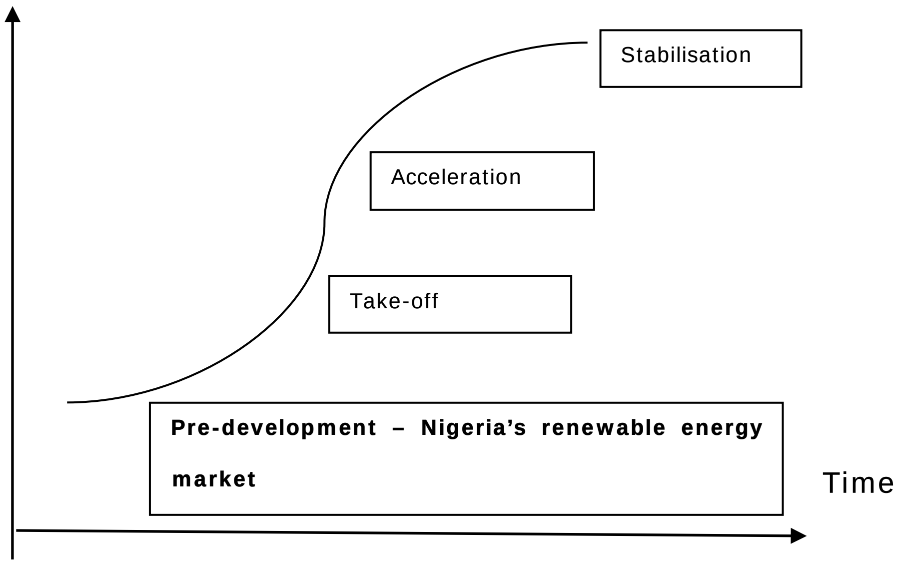
This transition phase was earlier discussed in Chapter 5, section 5.2 – multi-phase level of transition.

As indicated by Woolthius *et al.* (2005), weak network settings are likely to hinder the take-off and prospect of a technology innovation within a particular environment. Taking some pertinent examples from the findings of the phase one pilot study Section 6.3.2.2 (global barriers associated with

OBRE development), the issue of inadequacy in broader stakeholders' engagement was suggested to be a fundamental barrier within the OBRE industry.

Figure 8-1: Conceptual transition phase of Nigeria's renewable energy market

Renewable energy adoption Level



Source: Adapted and modified from Mutoko et al. (2014)

Additionally, according to Cowell *et al.* (2016), a beneficial element towards involving broader stakeholders' is the convergence of interest, capability and opportunity in relation to the:

> *"financial resources of potential business actors and the hierarchical and political resources possessed by policy maker"* (Cowell *et al*. 2016, p 9).

In Nigerian terms, two important non-public stakeholders' were repeatedly mentioned in the empirical study and seen as been pivotal in enhancing the renewable energy market in Nigeria: the financial and the oil and gas actors. That is, in order to broaden the network of the existing IMC, both actors are suggested to be significant as part of the key stakeholders' in order to achieve the research study's aim. For instance, one of the research participants stated:

> *"Fortunately the oil and gas are beginning to see the importance of renewable energy ... it will increase the speed because as far as am concerned, this are the major stakeholder in the energy sector. If this people are not part of it, I am not saying renewable energy will not succeed, it will but it may take a while to development". (OBRE018)*

Surprisingly, the perceived view of oil and gas sectors as being a hindrance to the growth of the RE market appears to be an interesting theme within the context of the RE market. Additionally, from OBRE development perspective, this could indeed be a reasonable assumption since a similar environment confronts both the oil and gas sector with that of OBRE's (offshore development).

From the financial sector perception, a key step has been taken within the financial institutions sector of Nigeria where the creation of a level playing field for banks to commence the adoption of international best practices on sustainability exists. In 2012, the Nigerian Sustainable Banking Principles (NSBP) was developed and adopted by the Bankers committee; comprising of thirty-four Nigerian financial institutions and the Central Bank of Nigeria; all tasked with achieving international best practices on sustainability banking (CBN 2012). The novelty of sustainable banking concepts is suggested to have created an avenue for potential funding streams because funding has been named as one of the barriers associated with renewable energy development in Nigeria and for most sustainability projects. The absence of diverse stakeholders is argued to have a negative influence towards the prospect of building partnerships/ collaboration, which may limit the alignment transition towards OBRE development in Nigeria. Thus, renewable energy development appears to display qualities of an 'issues network' in Nigeria (Cowell *et al*. 2016).

Aside from the broader perspective of involving other stakeholders towards developing, the RE market in Nigeria, the interaction amongst the incumbent public authorities engaged in renewable energy development is another key aspect when discussing stakeholder engagement, within the RE frame. This is due to the limited cohesion between certain public–authorities engaged in renewable energy development governmental actors in which the public authorities have constitutional mandates to govern and provide resources towards facilitating RE development in Nigeria. An understanding of the dynamism of key MDA actors' within this research study has clearly indicated this limited cohesion; as it also appears that the same public–authorities seem to have the same opinion regarding stakeholders' engagement (see Section 7.4.2). Little wonder it was suggested by one research participant from the explorative discussion-based focus group as a vital activity (for the researcher to discuss with the pertinent actors' governing RE development in the country) to be undertaken in relation to the transition towards OBRE development. Specifically, one of the research participants from the explorative discussion-based focus group phase two pilot study, suggesting, highlighted this:

> *"… have you considered the 'politicking' amongst some of the institutions in the renewable energy sector?"* (OBRE BSG)

The implication of this lack of coalition, in transition terms confirms the views of Twomey and Gaziulusoy (2014) concerning the importance of paying attention to understanding the structure and networks of actors and institutions within a transition process. In addition, perhaps, this may help in explaining further, why renewable energy is in its underdeveloped transition phase.

Analysis from Chapter 7, Section 7.5.1.3 suggests that an insufficient relationship exists amongst these public authorities stakeholders. This unsatisfactory relation appear to stem from the conflicting mandates which results to the unclear structural framework associated with some of the IMC members mandates and the bureaucracies within their engagement/interaction processes. This has perhaps weakened the aim of the IMC, which actually was a good ground for governing RE development in Nigeria. A clear example of the unfriendly relationship within the IMC was in the case of NREEEP project where findings from the literature and empirical data suggest that FMOP was accountable towards the design and development of the NREEEP. Also by extension institutions such as ECN, FMOE, NERC and TCN are understood to have pivotal roles to play in that design (GIZ 2014). Hence, a symbiotic relationship should exist in relation to the NREEEP development process. However, this was not the case as perceived from the findings, in particularly from ECN and NERC perspective. They both argued their dissatisfaction with FMOP being the coordinating agency for the NREEEP project. In addition to the above, the uncharacterised attitude of key IMC members from the perspective of appearing to some of the meetings brings to bear a persistent theme in the analysis of policy governance in Nigeria. The specificity of this utterance refers to some of the responses made by research participants on their involvement during the process, which fundamentally is seen as lacking some form of adequate coordination in the NREEEP development process. For instance, one of the participants asserted:

> "... *I got a letter from my superior to just represent the ministry..." (OBRE 017).*

Likewise, findings from the empirical study showed that the personnel above lacked the requisite skills and competence to influence any form of policy decision-making while representing his boss in the NREEEP meetings. While this has been suggested to be the norms in facilitating RE development in Nigeria, as put across by one of the research participants, it leaves policy actions, predominantly to other international development agencies such as German agency for international cooperation (GIZ), United Nations Development Programme (UNDP) and United Nations Industrial Development Organisation (UNIDO) as mentioned earlier. They too, tend to suffer from one of the following challenges within the prevailing institutional setting - failure to adequately address issues of power, agency and politics (Jochnick 2012).

Therefore, it is fair to say that effective stakeholders engagement is of great importance for successful renewable energy development and there was little or no evidence of an effective stakeholder engagement approach within both the IMC and the broader actor's network. It could also be argued that the non-involvement of non-public authorities and the lack of partnership amongst the IMC (public authorities) have had a profound negative impact on RETs development in Nigeria, not only from the policy design level but also in policy implementation. Accordingly, the absence of diverse stakeholders along with limited stakeholder engagement and coordination will negatively affect the prospect of transition to OBRE development in Nigeria.

8.2.3 Prospect towards enhancing OBRE development in Nigeria from the context of a SNM approach

This section discusses the result and findings from the SNM internal niche processes employed to analyse the niche development of OBRE in Nigeria, as detailed in section 7.6. As explained in Chapter 5, section 5.3.1.1, a technology is still in a niche-stage when its rules are not yet clear, its market share is low, and it still needs a protected environment (Raven and Geels 2010) as characterized within the OBRE market. Additionally, the availability of the HEC are very limited and the demand for them is not high, especially in developing economies. This has further defined the current state of the OBRE market to still be (at best) in a niche-stage, seeking for a protective and supportive (clear constitutional policy and financial resources) enabling environment to enhance its development as clearly explained by one of the research participants in the phase one pilot study (Section 6.3.2.2):

> *"... in fairness the UK government has supported the OBRE industry, especially in Scotland..."* (OBRE UK05)

In terms of Nigeria, findings from this study suggest that Nigeria has adequate resources to exploit its OBRE source, as discussed in Chapter 4. While a roadmap for a wider OBRE development is to be considered by the Federal Government of Nigeria (OES 2013), OBRE development in Nigeria still consists of loose experiments as investigations conducted in Nigeria have concentrated mainly on theoretical resource assessment. This is of no surprise as one of the first stages towards OBRE development is to undertake a resource assessment as presented in Section 3.2. Thus, similar to the global market of OBRE, Nigeria's OBRE developmental activities may be seen as being in its niche-stage requiring further protection and support (technical assistance) to progress its transition development.

Nevertheless, contrary to developed economies, where it is suggested that some level of persistent broader network interaction exists amongst OBRE niche innovators, policy makers and investors exist (Jeffrey *et al.* 2013b). This is exemplified by the presence of research grant for OBRE demonstration in those developed economies such as in the UK. However, findings from interviews conducted in terms of creating the required enabling environment from broader network interaction, is missing in Nigeria. For instance, individual efforts towards OBRE potential in Nigeria by organizations/actors such as Asiegbu (2014) are yet to be made public which may have resulted in the limited awareness of OBRE within the wider policy network arena.

Perhaps the reason for Nigeria's limited niche to socio-technical regime interaction may be that organizations involved in OBRE are not concrete niche developers, specifically private firms, who can influence and spearhead the wider lobbying settings for its development. This is because of the potential for profit making. According to Park (2013):

> *expectation on any new technology largely reflects on industrial views ... for its prospective development (Park 2013).*

This view is also consistent with literature studies on transition that suggests that niche innovators may trigger changes to the extent that they challenge the socio-technical regime (Strachan *et al*. 2015). This challenge could arise from resource oriented R&D activities or lobbying as showcased in the UK (Jeffrey *et al.* 2013b). Drawing upon the R&D element, learning process is generally recognised for a successful transition (Kemp et al. 1998) arising both individually as developers will increase their knowledge and collectively with the social system. It can therefore be argued that the 'collective' strand of learning process - through effective networking - aligns the niche innovators and other actors within the socio-policy system, towards shaping and directing the transition process (Schots and Geels 2010).

Analysis presented in Chapter 7, Section 7.6.1 suggests that the expectations for OBRE development in Nigeria were positive. The expectations were focused on the assumption that OBRE could be one of the potential renewable energy systems to provide access to domestic electricity to the coastal communities in Nigeria. Key findings from the analysis, specifically from phase 2 pilot studies revealed the willingness to collaborate and assist in the transition initiative. The success of the initiative is anticipated to lead to a larger share of OBRE energy system through replication (a growth in the number of OBRE energy system initiative). Nevertheless, beyond the envisaged expectation is the issue of the likely direction OBRE development path will take, which is still unclear as stated earlier in Sections 1.1 and 4.4.1. Trends affecting global OBRE development could influence the direction of Nigeria's development, as any development strategy will require a technology transfer medium from the developed economies. This may not favour Nigeria owing to the fact that current development practices, particularly from the European and North American regions are large-scale development prototypes as indicated by (Leete et al. 2013, p 871). The same is true for the mode of delivery: will the delivery of OBRE be decentralised or centralized in light of the developed economies favouring centralized energy path. Thus, expectation may be high but the development path remains unclear; even though it appears that, the proposed OBRE project in Bayelsa is to be developed using a decentralized mode of delivery.

In summary, expectations may appear to be significant for OBRE development in Nigeria, but it remains limited when such expectation is geared towards a few actors, specifically niche developers. Nevertheless, this is of no surprise as one of the barriers associated with the renewable energy sector in Nigeria is the inadequate engagement amongst various stakeholders. Park (2013) has put forward the role of other multiple stakeholders' who must share the level of expectation; which includes support of government bodies, public sector organisations, industries, and scientific communities, to aid in solidifying the level of expectation (Truffer *et al.* 2008). Accordingly, the higher the social learning process through broad engagement setting, the higher the influence on how positive or negative the expectation appears for emerging niche technology like OBRE. This is consistently missing in the renewable energy sector of Nigeria hence initiating the transition towards OBRE development would require certain facilitating factors that would harmonise all OBRE developmental activities with the social system in order to have a successful transition process.

8.2.4 Principles considered to enhance OBRE development in Nigeria

Against the backdrop of the preceding sections, contemporary debates on achieving sustainability – balancing economic growth, environmental issues and social concerns for societal development - have witnessed a move towards a transition to sustainable forms of energy systems, with global emphasis on renewable energy innovation (Strachan *et al*. 2015; Ruppert-Winkel *et al*. 2016). In effect then, renewable energy is a sector that has captured attention globally for different reasons as discussed in Chapters 2 and 3. In developed economies such as the UK, the driver for renewable energy largely comes from the need to reduce green house emissions and the need to ensure energy security (Strachan *et al*. 2015; UNDP 2015; Kern and Rogge 2016). In developing economies, although energy security is an important driver there are additional social drivers such as job creation and local economic development (UNEP 2016; Karakosta and Askounis 2010). Thus, in order to optimize renewable energy benefits, many nations are initiating national policy development processes on the project level, to drive the transition towards RE development, such as

OBRE. Nonetheless, a persistent theme in this transition to renewable energy is the significantly low uptake that presently besets its development; the West Africa sub-region is a useful case in this respect (ECREEE 2012).

A key question then, is what are the underlying principles to be considered towards facilitating RE development in relation to the concept of achieving a successful OBRE transition process. It is pertinent to ask this question if one considers the prevailing local condition (REM) within which existing RE technologies have fared in Nigeria. Additionally, these underlying principles have been considered in Section 5.4 when designing a transition programme, with significant attention to the central role of incumbent socio-technical regimes during the design process.

Analysis from the phase one exploratory pilot study (Section 6.3.2.2) and Section 7.7, suggests that strong stakeholder engagement, collaboration, and proficient governance of OBRE's various developmental activities, are central factors for OBRE's transition prospects. This is consistent with transition studies on the role of engaging stakeholders in sustainable energy system development, from policy design to actual project level implementation (Geels 2005; Kemp *et al.* 2007; Loorbach and Rotmans 2010; Mutoko *et al*. 2014). Findings from this study also showed that there is potential to enhance the governance capability of the many stakeholders from improved interaction, integration and co-evolution of all foreseeable activities associated with OBRE development in Nigeria. The findings from this research study make obvious that effective stakeholder engagement is critical to ensuring that the implementation of OBRE supports sustainable development. That is, the potential success of the stakeholder engagement is expected to form network alignment amongst the various key actors in order to respond to the diverse persistent problems identified in this study: as barriers limiting the wider renewable energy platform in Nigeria. This response includes provision of an enabling policy that will sensitise potential OBRE actors; identifying a supportive institutional environment, embedding social learning thereby inducing institutional capabilities and capacities to drive future OBRE development. It further recognizes the potential for a practical, small-scale demonstration to boost stakeholders' confidence and an increase in investment prospects for future OBRE growth.

Another aspect of stakeholder engagement relates to the categories of these stakeholders. Literature on transition reveals the importance of involving a diverse range of stakeholders in a potential sustainable project. Furthermore, these diverse ranges of stakeholders are expected to be relevant, especially for achieving sustainability as the key objective of the transition. Thus, facilitating OBRE transition from a stakeholder engagement perspective will require diverse actors input, ranging from influencers or enabling environment providers to technical and social partners from international, regional, national and local perspective (IRENA 2014b). Findings from this study further indicated that the main stakeholders' for OBRE development in Nigeria are the Federal government institutes such as FMOP and the coastal state and local governments. This view is consistent with the Sartorius' (2006 p274) co-evolution viewpoint as presented in Chapter five section 5.4.4. It is also believed that this socio-technical co-production, especially with the coastal state and local government as part of the main stakeholders' reduces the element of uncertainty as they are seen as the:

> *"people who will live and consume electricity's that could come from these installations … are the most important people for me" (OBRE011)*

However, a concern here is the heavily reliance of states government on Federal government to facilitate RE development in their territory. For instance, the case for market support – which is controlled by the Federal government agencies such as the Federal Ministry of Power – for OBRE may significantly delay OBRE development if resource priority is not in favour for OBRE development. Even though autonomous power has been given to states government to shape their individual market support towards sustainable form of energy development within their territories, this power however, has not been important in achieving such objectives by the state government.

Findings also suggest the need for other key stakeholders' to complement FMOP and the coastal state and local government in facilitating OBRE development in Nigeria. Accordingly, analysis from Chapter two, Section 2.6.2.2 provides some of the key stakeholders associated with renewable energy development in Nigeria (GIZ 2014). Notably these include the FMOE and ECN. In the same vein, these stakeholders were mentioned during the empirical study. Thus, these stakeholders are perceived to be relevant in a potential transition to OBRE development in Nigeria even though it appears that all three, FMOP, ECN and FMOE are perceived to be undertaking similar renewable energy development mandates as depicted in Section 7.

Findings from this study further revealed the importance of these two sets of stakeholders - financial institutions and the oil and gas sector. For instance, these two actors may address barriers related to lack of finance as identified in both literature and the empirical study. We now take a closer look on the role of the oil and gas sector as a key actor in relation to OBRE development, as perceived by the research participants.

The oil and gas companies are operating along and within the coastal regions where OBRE is being developed hence, they can be involved through Corporate Social Responsibility (CSR) projects. In Nigeria, given the unfriendly nature of the relationship between the oil firms and the local communities in the Niger Delta as discussed in section 4.4, support for the OBRE could mend the fractious relationship with the local community (Ebegbulem *et al*. 2013; Nwankwo 2015). This could be in the form of an inter-agency collaboration - a public-private partnership with the state government to development OBRE in order to provide some level of sustainable development in those riverine communities.

In summary, it is fair to argue that the transition towards OBRE development may only be possible when the diverse actors within the renewable energy sector in Nigeria reinforce each other and directs their activities towards a collective objective (Mutoko *et al*. 2014). However, a key question here is; how can these central success factors - stakeholder engagement amongst the diverse interest parties and proficient governance of OBRE transition activities, within the local dynamic environment - be harmonised and facilitated, in practice, bearing in mind the following:

1. unclear institutional frameworks settings in the renewable sector of Nigeria (discussed in 8.2.1);
2. the inadequacy in the nature of stakeholders' engagements during the design and implementation of RE projects (discussed in 8.2.2);
3. The unclear nature on how OBRE will be developed in Nigeria, even though expectations towards its potential benefits may be high amongst research participants and the lack of niche-to-socio-technical regimes relationship (discussed in 8.2.3); and,
4. Perceived guiding principles to facilitate its development in Nigeria (discussed in 8.2.4).

The next section highlights the intervention model that could facilitate the transition towards OBRE development in Nigeria.

8.3 Synthesizing the discussion of findings

Grounded in transition theory is the argument that through understanding the prevailing conditions that are concerned with societal change processes, it must be possible to formulate intervention principles and a model that will facilitate such societal changes (Rotmans *et al.* 2001; Loorbach 2007; Van Eijck and Romijn (2007); Loorbach and Rotmans 2010). This research has adapted this theory in critically evaluating the prospects of a transition towards OBRE development in Nigeria. Having noted the prevailing conditions concerned with the renewable development sector in Nigeria including:

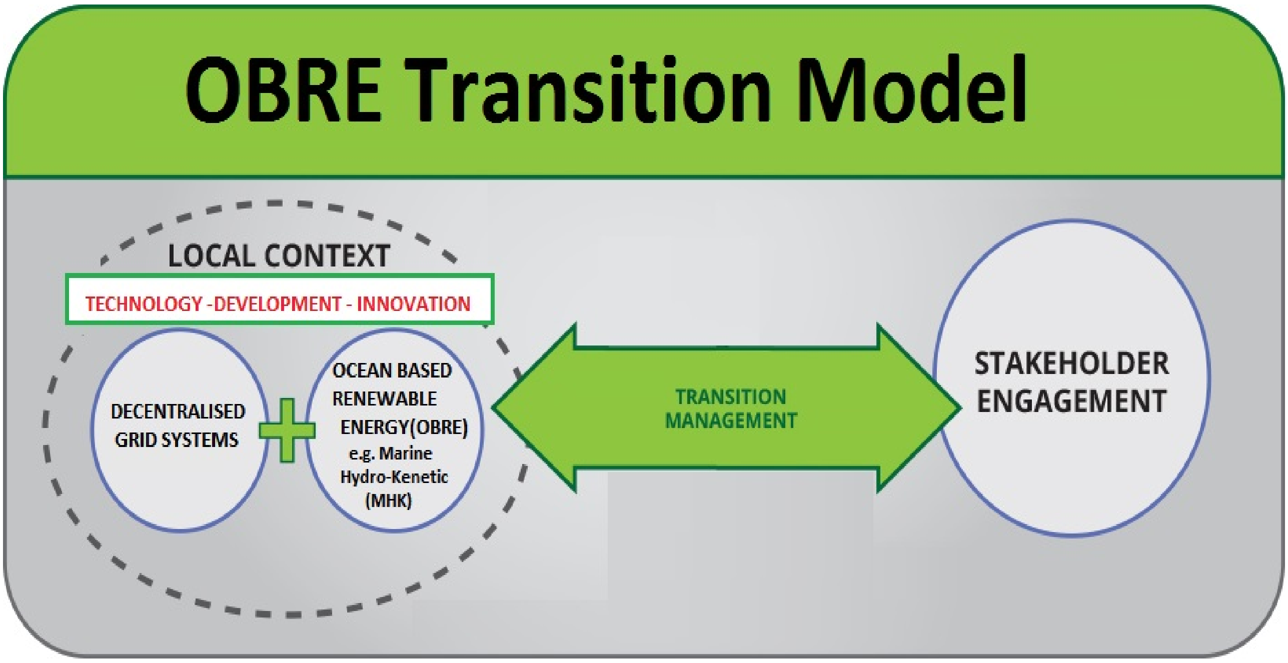
1. the motives towards renewable energy development;
2. the mechanisms designed to facilitate its development;
3. the contemporary barriers hindering the development which have been consistent over time and;
4. finally the prospect of introducing OBRE in relation to its global barriers, the nature of the renewable energy market in Nigeria and the proposed OBRE project in Bayelsa state;

It is clear that intervention principles or a conceptual model fit for purpose in the context of Nigeria is required, to respond to the prevailing conditions identified above while further enhancing some of the facilitating mechanisms as perceived by the research participants towards OBRE transition in Nigeria. The model is designed to create a market mainly at the coastal region where significant resource potential for OBRE based-electricity exists (Asiegbu 2014; Ladokun, Ajao and Sule 2013; Bryden 2010). Therefore, the model aims to provide a conceptual scaffold to guide the development of OBRE transition practice; based on three critical success factors drawn from the learning emergent outlined in the preceding sections of this chapter: Local Context, *Stakeholder* Engagement and Transition Management (governance processes and philosophies)

These critical factors constitute the building blocks of a model, that when carefully considered, has the potential to facilitate the transition towards OBRE development in Nigeria. All three are consolidated to form the Ocean

Based Renewable Energy Transition Model (OBRE Transition Model) as conceptually presented in Figure 8-2. Generally, the heart of the conceptual OBRE Transition model is the core principle of promoting sustainable development. Sustainability in this context is seen as encompassing not just the environmental factors that accompany development but also issues of social empowerment and economic opportunity using OBRE innovation as the vehicle to achieve this core principle.

Figure 8-2: Ocean Based Renewable Energy Transition Model



Source: Author generated

Accordingly, the conceptual model elements are discussed in the next section.

8.3.1 Local context

The local context forms the basis of the model, on which all other factors are stacked. In this regard, the Local Context determines the actual development and what the OBRE is to be used for. Local context here could depict a nation such as Nigeria, a state, like Bayelsa or a community within Bayelsa state. The local context is crucial for successful OBRE transition to occur. The principal intention of the local context is to facilitate community involvement, participation and ownership at a local-led development level. The emphasis is on taking a holistic view of the priorities of the local context as well as identifying appropriate solutions to address those priorities. This been termed as 'appropriate technology'. Appropriate technology studies in this context refers to not only a system providing the best performance at least cost, but also sustainability in terms of meeting local needs in the form of the following perspective:

> *"socio-cultural acceptability, technological and institutional feasibility, economical affordability, and environmental acceptability"* (Garniati 2014).

Within the context of the OBRE model, the local context ensures community participation not just at the OBRE project development stage, but also at the service delivery level. As part of this process, local capacity development and awareness, generation plays a major role, thereby addressing two barriers: awareness and knowledge capability to facilitate OBRE development. Moving forward, embedded within the local context frame is the Technology Development Innovation – TDI that lends itself to the TIS approach as discussed in Chapter 5, section 5.3.1.4. The TDI is considered to influence the immersion of OBRE by fulfilling key innovation processes as outlined in Table 8-1.

Table 8-1: Technology development innovation processes for OBRE development

System functions	**Activities description relating to the functions**	**Typical events to aid OBRE development**
Entrepreneurial activities	The existence of risk taking entrepreneurs (private sectors) is essential as they translate knowledge into business opportunities by performing commercial experiments.	demonstrations, Commercial projects and portfolio expansions – replications and up-scaling
Knowledge development through the creation of an adaptive capability/ capacity	Human, organisational and institutional capability development.	Training, development of OBRE educational materials, establishment of OBRE institutions. Sufficient efforts towards pilot demonstration to encourage upscaling or replications.
Knowledge diffusion	Using networks and other interactions to facilitate the exchange of knowledge between all the stakeholders involved in the OBRE development.	Conferences, workshops, alliances between stakeholders.
Demand articulation	Activities within the TDI that shape the needs, requirements and expectations of stakeholders with respect to their support of OBRE. This invokes the appropriate technology element.	Expectations, policy targets, standards, research outcomes.
Market Formation	Activities that contribute to the creation of a demand for the OBRE. A noted demand is the access to electricity.	Regulations and incentives supporting niche OBRE market development
Resource mobilisation	Facilitating access to financial, material and human capital.	Subsidies, investments, infrastructure developments.
Support from advocacy coalitions (policy network)	Forming advocacy coalitions to counteract institutional inertia through a **transition management process**	Lobbies to facilitate OBRE research guidance, formation of transition arena and identification of change agents and executive stakeholders, opinion and advice promotions

Source: Adapted and modified from Bergek et al. (2008); Van Alphen et al. (2006) and Suurs (2009)

Thus, the main purpose of this approach was to consider all the activities that contribute to the development, diffusion and use of OBRE within the local context. Enclosed further within the TDI are: (i) the energy path delivery infrastructure and (ii) the OBRE HEC device (Marine Hydro-kinetic – depicted in Figure 3.5). From the energy path delivery infrastructure: due to the potential market application, the use of either centralised or decentralised energy delivery can be utilised to transmit the electricity being generated from the marine environment to intended users. However, with the nature of the coastal region landscape in Nigeria, as discussed in section 4.4, the use of a decentralised energy system delivery was strongly considered here. Decentralised energy systems are said to lend themselves well to electricity provision in rural off-grid areas such as in the Niger Delta region of Nigeria, and have been argued to offer a number advantages including (Greenpeace 2005):

1. Mitigation of costs associated with grid connection in financially unviable locations such as the coastal region of South South geo-political region of Nigeria
2. Enhanced energy security as a complement to grid-connected, if applicable
3. Reduction of influence due to vested interests of big business organisations such as big energy utilities or public sector
4. Drives socio-technological innovation
5. Facilitates incubation of technologies which are safe and appropriate for the given context such as OBRE
6. Increasing opportunities for local leadership in the electricity sector

Considering these advantages, there appears to be a rise in the utilisation of decentralised energy systems and in many cases has been adapted in various guises for access to electricity (Wiemann et al. 2011; FMOP 2015b, IRENA 2014a). The decentralised energy system serves as the cornerstone around which the HEC device is constructed. In sum, the TDI in this study's context, places emphasis on first introducing, diffusing and using a technology developed in technologically advanced countries and then aiming to build local innovative capacity in the process (Kebede and Mitsufuji 2016).

8.3.2 Stakeholder engagement

Scoping of the local context is heavily contingent on the effectiveness of the stakeholder engagement process. Identifying the relevant stakeholders to be engaged will be beneficial to the overall success of the OBRE transition process. Stakeholders' that will be engaged in the TDI innovation process as presented in table 8-1 will need to be identified and engaged according to their interest and influence in OBRE development in Nigeria. The BWEA extensive stakeholder categories as discussed in Chapter 2, section 2.6.2.2 can be adapted in formulating the key stakeholders' within the conceptual model. Accordingly, potential stakeholders are summarized below, in relation to OBRE:

1. Statutory categories: Such stakeholders in Nigeria context include: the Senate Committee, ECN, FMOP and FMOE
2. Strategic categories: This may include the following within Nigeria's context: ECN, research centres and universities, NIOMR, UNIDO, the

project developers, private sectors investors, financial institutions, NGOs, amongst others

3. Community categories: They include the following from Nigeria's context: resident associations, community councils, regional or local fishermen's associations, amongst others living within the recipient community
4. Symbiotic categories: They may include the offshore oil industry in Nigeria and the distribution grid owners called the DISCOs.

Each of those stakeholders within the categories will usually form some perceptions on OBRE, seeking a balance between economic development, environmental issues and social concerns. Thus, they must be meaningfully engaged in a way to mitigate any negative perceptions that often surrounds renewable energy development processes in Nigeria.

The findings from this study indicate that this factor appears to be the most significant element within the model, and must be strongly considered for any meaningful transition to occur. There is a considered justification for this argument. Firstly, it reduces opposition lobbying and political risk to the prospective transition towards OBRE development in Nigeria, additionally obtaining and retaining consents, permits and rights granted by public authorities and local communities should ultimately reduce planning and operational delays from a tactical and operational perspective. To achieve this however, clear communication and guidance on OBRE transition strategy should be provided via stakeholder engagement activities. Involving stakeholders during all the phases of the transition process, from policy level to project implementation – feasibility, planning, implementation, monitoring and evaluation can improve the quality, relevance and uptake of OBRE technologies.

8.3.3 Transition management

The stakeholder engagement process as discussed in section 8.3.2 is underpinned by a key philosophy in the form of a 'Transition Management' approach discussed earlier in section 5.3.1.3. The rationale for this innovative case of exploring the use of transition management approach includes the inherent complexity and multi-faceted nature of the various diverse stakeholders' categories as presented in 8.3.2. It is envisaged that their interactions either may positively or negatively influence the broad diffusion of OBRE development process in Nigeria (Mutoko et al. 2014). Thus, its focus in this model is to facilitate dialogue between the wide range of relevant stakeholders' who are or may be brought together under a structured framework for OBRE's development in Nigeria. Furthermore, this creates the space for adequate policy networks to occur.

The basic philosophy is that of goal-oriented modulation, making use of 'bottom-up' developments and long-term goals both at the national, state and local level of government (Nill and Kemp 2009). Thus, there is great attention to governance; embracing a multi-level model of governance for shaping processes of co-evolution towards embedding OBRE within the society system (Kemp *et al.* 2007). Thus, a transition management process in this model is therefore geared towards pulling together policy makers, industry financiers, technical experts, researchers, government officials, development workers, non-governmental agencies and local community members. It creates a forum for policy discussion and addressing issues associated with OBRE development programs, while at the same time taking concise action on project specific issues on the micro level, such as choice of OBRE HEC, marine environment, community aspirations, and local development. This broad and deep interaction across multiple levels of stakeholders as applied within the OBRE transition model will be instrumental in rooting policies in 'on the ground' realities. Additionally it should tackle the existing lack of awareness of key issues that is pervasive within the renewable energy sector as perceived in both the discussion forum of the focus group and interviews – not only on the part of the public but also amongst various groups of policy makers and industry practitioners (IRENA 2014b). Thus, the starting point for transition management within this OBRE model is not from a technological innovation point of view but from a societal challenge towards enabling a prospective OBRE transition for electricity generation. Therefore, using a hypothetical OBRE transition management process, its prescriptive application for OBRE development is operationalized conceptually into five main stages as shown in the Table 8.2.

Table 8-2: A conceptual overview of the OBRE transition using the transition management approach

Stage	Key Activities	Output	Actors
Preparation & Exploration	Transition Team formation Process design System analysis Actor analysis Evaluate the existing ocean energy development agenda, 2005 – see section 4.2	Transition Team Process design Insight into major issues and tensions of the system Shortlist of relevant actors	OBRE Transition Model team
Problem structuring & Envisioning	Transition Arena formation Participatory problem structuring Selection of key priorities Participatory vision building	Frontrunner network Shared problem perceptions and change-topics Joint vision Guiding principles	OBRE Transition Model team Frontrunners
Back casting, Pathways & Agenda Building	Participatory back casting Definition of transition paths Prioritisation of transition paths Formulation of agenda / tactical actions	Transition paths Transition experiments Action plan/ transition agenda Change agents network	OBRE Transition Model team Frontrunners
Experimenting & Implementing	Broadening the network Working group formation Development of transition experiments & implementation within current policy and projects Dissemination of vision, pathways and agenda	Transition narrative Activities for broader public awareness and involvement. Transition experiment portfolio Launch Event	OBRE Transition Model team Frontrunners General Public

		Learning & implementation	
Monitoring & Evaluation	Participatory evaluation of method and content (process) Reflection on vision & agenda Monitoring interviews	Lessons for local governance Lessons for National governance Energy Transition monitoring framework	OBRE Transition Model team Frontrunners

Source: Adapted and modified from (Roorda *et. al.* 2014)

From the table, the experimenting and implementing stage of the transition management model shapes the TDI element of the local context. This is where the necessary conditions for transition towards both the formative and potentially market expansion stage of the OBRE is created (Jacobsson and Berket 2004). That is, the TDI element within the local context factor influences the absorption of the OBRE by firms and other actors by fulfilling the key innovation activities, presented in Table 8-1.

This comes as a fulfilment of the critiques of transition management of having neither clear conceptualisation of the individuals engaging in the transition experiments, nor a basis for monitoring or assessing changes occurring at the level of the participating individuals of the transition experiments (Scholz 2011 p159). Furthermore, the monitoring element in Table 8-2 will aid to address the perception given by the FMOE on the lack of monitoring within the renewable energy space:

> *"a key concern is the lack of feedback and monitoring during the RETs project's life cycle once funds are released for RET design and implementation in Nigeria"* (OBRE 002).

Embedding the sustainability element into the model, the TDI components (decentralised energy systems and OBRE) primarily address environmental sustainability via CO_2 and other greenhouse gas reductions. However, it also addresses socio-economic sustainability in terms of health benefits and income generating activity – and as such poverty alleviation. The local context and the stakeholder engagement elements mainly address the socio-economic aspects of sustainable development such as community empowerment, economic development and local services/amenities for example health and education; they also address environmental sustainability to some extent by raising awareness on climate change issues. Another important feature of the model is its replicability due to its intrinsic flexibility and adaptability – in terms of location, individual actors and technology.

8.4 Concluding summary

This Chapter provided a thorough discussion of the prevailing local conditions that will facilitate the prospects for OBRE development. The discussion particularly focused on key themes identified from Chapter Seven as pertinent towards achieving the study's aim. Unpacking these themes, the discussion revealed that despite the fact that OBRE could play a key part in helping to provide access to electricity and broader climate change target in Nigeria, it is very clear that the contemporary prevailing local conditions to facilitate its transition remain ineffective. Indeed the discussion has also re-affirmed previous analysis that RE remain weakly developed in Nigeria; especially when one considers the inherent complexity and multi-faceted nature of the socio-technical regime components whose interactions influence the broad diffusion of energy transition. While the concept of RE is now globally recognized, the trajectory of actual development in Nigeria has been one with negligible positive impact.

Another key element suggesting the ineffectiveness of REM development is the limited stakeholder engagement. The development of the REM has mainly been facilitated by MDAs where policy design (through the support of international agencies) are mostly undertaken without corresponding local capacity to implement. Other pertinent actors including state government; civil societies; and, business communities have been passive actors towards RE development. This practice is in conflict with the transition theory, which provides a useful perspective that development programs are likely to succeed when organised based on a broad range of stakeholders engagement and collaborative implementation processes. Not surprising that these issues, (based on the study's findings) mirrors one of the key obstacles to delivering effective RE, which will be of particular disadvantage in the context of OBRE development.

Another key issue as shown from the study findings is the lack of the incumbent socio-technical regime's policy governance structure. According to Loorbach and Rotmans (2010), they argued that there is the need to put in place a favourable structural framework within which to operate if THE socio-technical regime’s policy governance are to influence transition processes. There was also adequate evidence to suggest significant dissatisfaction amongst some MDAs towards FMOP’s role and mandate as the coordinating institution for REM development. This perhaps, has led to the failure within the IMC to effectively influence RE development programme. However, this does not suggest that the incumbent actors of the institutions are not pertinent, but suggests a lack of appropriate state of affairs, including low awareness of RE concept, the lack of skills and knowledge, adverse social conflict amongst key actors (ECN and FMOP), and importantly, the lack of management structure. Therefore, it can be argued that the current RE regime poses on itself, a fundamental barrier towards the prospects for any form of RE development. Additionally, it can be claimed that the general prevailing RE regime has not reached the effective phase (take-up) to be able to influence OBRE transition.

The research showed that SNM appears to trigger a form of socio-technical innovation, which is particularly reliant on knowledge and information dissemination through learning by interaction and doing (Lundvall 1988). Specifically, from the learning from interaction perspective, there is evidence from the findings to suggest that certain technological innovation for OBRE development, particularly in form of resource assessment has yet being shared between niche developers. Likewise, the broader socio-technical innovation relationship (OBRE niche-to-socio-technical regimes relationship) has been lacking. Therefore, findings from the study showed that the analytical approach (SNM) utilized in the prospects for OBRE development has proven useful in discovering further, the lack of niche-to-socio-technical regimes interaction including with the broader social system. The research raises the question on how OBRE might be implemented in light of the concerns surrounding the RE landscape in Nigeria because one could argue on whether Nigeria can effectively provide the required enabling environment for OBRE development (design and implementation). Findings however, suggest that there exist three critical success factors that when considered could facilitate the prospective transition towards OBRE development. Interestingly, these critical success factors were obtained from research participants, including incumbent socio-technical regime actors.

Thus, the emergent critical success factors arising from the discussion was interwoven with pertinent transition theory and frameworks, generating an intervention conceptual model called the 'OBRE Transition Model', comprising of the following elements:

- **Local Context** in which the Technology Development Innovation of OBRE is espoused and; underpinned by the following components: *Delivery Energy Systems, in this case decentralised energy system* and *Renewable Energy source which in this case is OBRE*

- **Stakeholder Engagement** which is governed by the third element below;
- **Transition Management** – This includes the processes and philosophies.

The model emphasises a clear OBRE transition strategy, which states that through meaningful engagement with all stakeholder categories, the design and implementation of a transition programme for OBRE development can be accomplished.

CHAPTER NINE

Summary, conclusions and recommendations

9.1 Introduction

This Chapter answers the research questions set out in Section 1.2.1. Furthermore, the chapter goes on to highlight the key contributions to knowledge, the impact and limitations of the research. The Chapter concludes with a set of recommendations as well as outlining future research.

9.2 Summary of research findings and addressing the research questions

This study aimed to critically evaluate prospects for a transition towards OBRE innovation through identifying critical success factors as well as developing a model to effectively facilitate the transition in Nigeria. In order to achieve this aim, research questions arising from the research study was developed. Therefore, the next sections discuss the answers to the research questions.

9.2.1 Summary of the answer to sub-question one - What are the key limiting factor(s) that may hinder the transition towards OBRE development in Nigeria?

Research sub-question 1 was focused on understanding the barriers that could limit the prospective transition towards OBRE development in Nigeria.

Several limiting factors were found that could hinder OBRE development in Nigeria. These factors are inherent to the existing renewable energy sector in Nigeria and appear to be consistent to the global barriers associated with OBRE development, as discussed in Section 3.3 and 6.3.2.2. Accordingly, these factors are considered too vital to be ignored in the context of this study, and are discussed below.

9.2.1.1 Lack of policy implementation

Nigeria has drawn up a plethora of policies in order to facilitate renewable energy development. Although the policy formulation has made significant transition foundations for renewable energy development, effective implementation of the policy is still a major concern. Thus, the lack of effective policy implementation was perceived to be one of the persistent limiting factors hindering renewable energy development in Nigeria. Instances of such is seen in the OBRE developmental agenda put together by ECN in 2005; defining the year 2007 as the period for OBRE development. Thus far, no form of developmental activities amongst the public authorities for OBRE uptake has occurred. In addition, the current policy called NREEEP, which has also focused on developing OBRE as a potential renewable energy mix for the future, failed to build on the ECN (2005) OBRE programme agenda. This truly brings into focus the extent of skills and competency within the key MDAs actors responsible for implementing the various forms of RE policy documents in Nigeria. Hence, lack of policy implementation is a key barrier and in relation to the transition to OBRE development in Nigeria, it might just be another aspiration with no solid political will.

9.2.1.2 Lack of clarity in the roles and responsibilities

The formation of institutions and steering committees to harmonise the diverse interests of the institutional actors and at the same time facilitate renewable energy development in Nigeria, demonstrates to some extent, the Nigerian government's effort to actualise renewable energy development. It is suggested that a form of symbiotic relationship should exist amongst all the institutions in order to catalyse the sector's development (GIZ 2014). Contrary to this, the various institutional actors as presented in Table 2-1 and Table 2-2 may have actually contributed to the limited development of the sector, in particular, with their conflicting roles and responsibilities as observed in the study's findings in section 7.3.2.

Research study findings presented in section 7.3.2. revealed a discrepancy in the literature with regards to roles and responsibilities of public institutions, specifically ECN, FMOP and FMOE, where all three have indicated similar functions in relation to policy design and implementation. This again reconfirms ECREEE's assertion about lack of clear direction and governance from governmental agencies (public institutions) in West Africa countries resulting in an ad-hoc development within the renewable energy sector (ECREEE 2014). The unclear nature of the mandates of public institutions within the renewable energy sector is an inherent risk towards the potential success of developing OBRE in Nigeria.

9.2.1.3 Limited involvement of other key stakeholders'

The current members of the IMC are assumed to belong to the 'statutory' categories of stakeholders where policies and regulatory decisions are taken to facilitate the uptake of renewable energy development in Nigeria. Broader categories of stakeholders as presented in Section 2.6.2.2 appear to be fundamentally missing which includes state government representatives, business and civil societies, community representatives, the financial and perhaps symbiotic stakeholders' representatives such as oil and gas firms. The research study confirms that the absence of these broader stakeholders undermines the long-term transformation objectives towards RE technologies and it has the potential to limit the transition towards OBRE development in Nigeria.

9.2.1.4 Absence of effective stakeholders' engagement

In addition to the inadequate number of stakeholders associated with the renewable energy market in Nigeria, ineffective stakeholder engagement exists amongst the various MDAs actors - specifically within the IMC. Further, there appears to be lack of principles underpinning stakeholders' engagement range of activities - informing, consulting, involving, collaborating and empowering - in order to consolidate individual efforts and initiate wider promotion of renewable energy programs. This issue can actually be traced back to the similar mandates being embarked on by three key institutes: FMOP, ECN and FMOE, which were discussed in Chapter 7. In fact, a general view that emanated from the study – see section 7.5.1.3 - revealed that many of the public actors operate in several diverse, sometimes conflicting ways with either minimal or no stakeholder engagement. The current ineffective nature of stakeholder engagement within the RE sector has the potential to hinder OBRE's development in Nigeria.

9.1.2.5 Lack of awareness on renewable energy potential in Nigeria

Roger (2003 p. 172) asserted that the transition-decision process should entail "information-seeking and information-processing activities, in which an individual (or work group) is motivated to reduce uncertainty about the advantages and disadvantages of an innovation". This argument is notably missing within the RE sector of Nigeria and has resulted in the inadequacy observed, towards providing the enabling framework such as legal and regulatory backings that could facilitate renewable energy innovations in Nigeria, especially from the National Assembly. Little wonder that several supporting statements in policy documents are yet to be ratified by the National Assembly and signed into law by the Executive (GIZ 2014). The lack of awareness of renewable energy concepts and principles may have also created further technological lock-in with the existing energy system of fossil fuel in the country, which often acts as a significant barrier against renewable energy innovations (Nelson and Winter 1982; Unruh 2000).

9.2.1.6 Absence/limited knowledge capability and capacity

This study also revealed that the challenges presented from section 9.2.1.1 to 9.2.1.5 might stem from the low level of knowledge within the country to facilitate RE development. Even though this study acknowledges the presence of certain research centres for R&D in renewable energy (ECN 2005) and institutions with the responsibility to govern the sector, the socio-technical planning towards a robust design and implementation tends to be missing. Often, design and implementation of RETs are commonly unfinished and even when completed, are not sustainable in terms of usage. This may be solely because contractual awards to unskilled agents/developers are often the norm for deploying renewable energy programs within the country. These contracts are usually awarded by the same public institutions responsible for governing the RE sector of Nigeria. Though it appears that international development agencies such as GIZ, UNIDO and UNDP are currently fostering capacity development within the RE sector, these agencies are also limited in knowledge capacity of the local socio-cultural setting in Nigeria.

Indeed, it can be argued that Nigeria may have some potential capabilities as demonstrated in the activities related to OBRE development however; such capabilities are more or less insubstantial in relation to real term OBRE innovation. This is because a major critical factor for OBRE development is the element of capability/capacity to deliver on OBRE innovation as discussed in Chapter 3. It is thus clear from the research findings that the knowledge capability needed to drive renewable energy remains one of the many imperfections associated with the renewable energy sector in Nigeria, particularly as perceived amongst the public authorities. Thus, absence of such elements could potentially hinder OBRE development in Nigeria.

9.2.2 Summary of the answer to sub-question two - What are the underlying critical success factors that could be considered central to OBRE development in Nigeria?

Beyond the limiting factors that are consistently associated with the RE sector in Nigeria, the prospect of developing OBRE as part of a future energy mix comes with its market applicability as discussed in section 3.4. There were a number of the critical success factors from the research study findings, which may aid in addressing some of the unique limiting factors identified in 9.2.1 and simultaneously facilitate the prospects for a transition towards OBRE development in Nigeria. Some of these factors included political advocacy (Section 7.7.1.3), demonstration activities (Section 7.7.1.2), and learning and knowledge development (Section 7.7.1.4) however, they all seem to be underpinned within the confinement of the two key factors (meaningful and broad stakeholder eneggagement and appropriate and effective level of political governance respectively), which will be discussed subsequently in Sections 9.2.2.1 and 9.2.2.2. It is believed (by the Researcher) that when these two key factors are adequately designed and implemented, the other factors will be successively achieved (Geels 2012; Smith 2012; Loorbach 2007; Tigabu *et al.* 2013; Corsatea 2014).

9.2.2.1 Meaningful and broad stakeholders' engagement

Guiding activities that should be considered in a bid to respond to the limiting factors have been suggested in the study. Amongst the most important guiding element is undertaking a strong consultation process with all pertinent stakeholders. It is expected that the positive result of the engagement will yield a form of pilot demonstration to further make evidence on the beneficial nature of OBRE within Nigeria's electricity sector and socio-economic development. Following this argument is the notion that stakeholder engagement is a critical success factor for OBRE development as perceived by the research participants – see Section 7.7.1.1. Particularly, the development of OBRE in Nigeria would require diverse stakeholder engagement that evolves through a series of engagement activities to the point where participants in the process are empowered by their involvement (Midin 2016). Thus, identifying relevant stakeholders can help to define a good stakeholders engagement process in light of understanding their values and perspectives towards the prospective transition to OBRE development in Nigeria. For instance, research study findings revealed the coastal communities within the Niger Delta region as one of the most significant stakeholders to be engaged based on OBRE's market applicability (Bryden 2010). A further rationale is that the coastal communities' lives, interests and welfare can be positively affected by the OBRE innovation when developed – facilitating socio-economic development with a potential of swaying the communities' interest away from the oil and gas market as discussed in Section 4.4.

Other potential stakeholders to be included are FMOP, ECN and FMOE and their respective agencies, all regarded as strategic and statutory stakeholders (BWEA 2007). A fact that cannot be overlooked is that coordinating the three institutions towards harmonising their diverse interest requires strong motivation as the current relationship appears to be unsatisfactory as discussed in Section 8.2.2. Furthermore, due to funding being identified one of the limiting factors associated with renewable energy development in Nigeria, the financial institutions such as the banking sector are seen as key stakeholders to be engaged in relation to OBRE development. This argument concurs with the research findings on the basis that the financial institutions in Nigeria are currently undergoing some form of reform where their core business activities/ operation must be underpinned by the three sustainability pillars – social, economic and environment (Nigeria Sustainable Banking Principles 2012). This will further aid in integrating RETs such as OBRE into the financial institutions investment portfolios. Likewise, one of the categories within the stakeholder's group as discussed in Section 8.3.2 are oil and gas actors, which could form 'a symbiotic stakeholder' within the OBRE transitioning process (BWEA 2007). The oil and gas industry is seen as a pivotal private sector investor that could aid in facilitating OBRE development in Nigeria. This argument relates to their Corporate Social Responsibility (CSR) role in the various coastal communities where they operate.

Thus, facilitating OBRE development through CSR activities could be an important platform towards OBRE potential development.

9.2.2.2 Appropriate and effective level of political governance

Policy statements for facilitating renewable energy development in Nigeria have largely remained broad statements of intention lacking ways to influence its implementation from a governance perspective. Thus, without strategic and management intervention both at policy formulation and implementation stages, meeting the objectives for a wide renewable energy development to combat electricity challenges in Nigeria becomes elusive. The reality of policy-design and project implementation has become that of governance - structuring and coordinating seemingly autonomous interactions between different stakeholders' categories at different levels (Loorbach 2007).

So, due to the unclear nature of the renewable energy sector in relation to policy design and project implementation, a well thought out governance led approach is suggested to be one of the guiding principles to be adopted in facilitating OBRE development within a complex system practices such as is seen in Nigeria. The approach is expected to assess the country's capability and capacity towards a potential OBRE development, by providing the necessary information in order to analyse and evaluate performance of existing renewable energy projects while providing data to plan towards the goals, objectives and outcomes of delivering OBRE development. The approach is also expected to provide the much needed local context towards enhancing OBRE development both from a National and sub-national perspective.

The next section addresses the main research question and thereby allowing the researcher to achieve the aim of this research study.

9.2.3 Addressing the main research question in relation to the aim of this research study

While sections 9.2.1 and 9.2.2 have addressed part of the research study's aim, this section brings into context OBRE perspective in relation to the main research question - *How and in what context can OBRE be developed sustainably in Nigeria?* Indeed, an indicative interest for OBRE development is being considered in Nigeria; however, findings show that the prevailing local environment and perhaps, the wider OBRE landscape (local and international) appear to be unfavourable for its development. In Section 9.2.2, two critical success factors were identified as key towards an OBRE transition: with the objective, that the development of an OBRE programme will be facilitated through extensive stakeholder engagement underpinned by an appropriate and effective governance mechanism. Furthermore, evidence from this research study revealed that barriers hampering the global development of OBRE technologies as discussed in Section 6.3.2.2 are to be considered within the frame of a prospective transition to OBRE. In particular, the argument made by Lovdai and Neumann (2011) and IRENA (2014b) on the lack of ineffective political governance approach to facilitate OBRE global development.

In terms of transition theory – which has underpinned this research - the prevailing local and global conditions can be operationalised as the socio-technical regime settings, which has helped to explain the limited development of RE in Nigeria and the global OBRE development. Given that contemporary socio-regime conditions seems unsupportive to RE development and of course, will have an impact on emerging RETs including OBRE, evidence from the research study showed that a form of effective governance is necessary. A study conducted by Rotmans and Loorbach (2010), which focuses on the transition process, places emphasis on the importance of 'governance' that aims to steer transition process towards desirable social outcomes, through a multi-actor engagement method, involving key socio-technical regime actors such as the government, societal organisations, companies, knowledge institutes and intermediary organisations. Thus, it can then be argued that the success of OBRE development in Nigeria to a large extent, is determined by how the socio-technical regime system functions and how they are governed as elements of a collective system of knowledge creation and use (Hoogma *et al.* 2002; Rotmans *et al*. 2001; Loorbach 2007). Therefore, evidence from the research study showed that OBRE development within a transition system may be underpinned by consequences of the activities of diverse actors' interactions and collaboration (stakeholder engagement) who are influenced by specific institutional characteristics (political governance and institutions) including government policies and regulations, market structure, and user preferences (Hekkert at al. 2007). Additionally, evidence from this research study posits that the transition system could be described as the set of institutions, which jointly and individually contribute to the adoption of new processes, services or products; and provides the framework, within which strategies are designed and implemented in a bid to influence the transition process for OBRE adoption (Samara *et al*. 2012).

Indeed, in addressing the main research question - *How and in what context can OBRE be developed sustainably in Nigeria* - three interlinked critical factors were found to be most essential to support in the design and implementation of OBRE in Nigeria as revealed from the findings of this research study:

1. Local context consideration;
2. Stakeholder engagement; and,
3. Transition management (governance processes and philosophies).

The integration of these three factors and how they conceptually address the research study's aim was extensively discussed in section 8.3. In summary, the three critical success factors as presented above are conceptualised as a model with Decentralised Energy Systems and Ocean Based Renewable Energy, both forming the technological development innovation component that is set within the local context. Transition management processes and philosophies govern the stakeholder engagement element. This is in order to address the core issues raised in the study including the lack of cross-sectoral interaction and collaboration, inadequate supporting policies and capability within a participatory action oriented approach (WCED 1987). This also harmonises stakeholders' diverse interest towards a single common goal – OBRE development in Nigeria.

This recommended model is to be utilised towards the proposed OBRE project in Bayelsa state – as accepted by GEF/UNIDO, significantly drawing upon the role of agency, power and politics with fundamental attention to social innovation concept, which is a key contribution to this research study. Furthermore, the model addresses the limited research on the lack of integrating the various structures, such as the diverse actors, institutions, and infrastructures associated with OBRE development and the contextual culture (norms, behaviours and practices) in order to achieve a significant level of OBRE uptake.

9.3 Research contribution to knowledge and impact

9.3.1 Contribution to knowledge

The contribution to knowledge from this research study is provided from three perspectives: theoretical contribution and contribution to practical.

9.3.1.1 Theoretical contribution to knowledge

1. In the process of conducting this research, various theoretical frameworks from the extant literature were reviewed. Transition was considered as an appropriate theoretical lens through which to guide the study. Within the research study context, less attention has been paid to utilising transition to extend the investigation on how to facilitate the transition towards renewable energy development in Nigeria (Osunmuyiwaa and Kalfagianni 2016), let alone using it to investigate the potential for OBRE development. Osunmuyiwaa and Kalfagianni (2016) utilized transition in form of MLP to investigate the limited RE development in the sub-national section of Nigeria. Therefore, this study theoretically contributes to knowledge by extending such research through the application of sustainability

transition theory, but using SNM concept to empirically investigate the prospect of a transition to OBRE development in Nigeria. Prior to this study, no empirical evidence existed regarding these approaches, however, there are other empirical studies in some developing countries such as in Tanzania where transition towards biofuel was undertaken (Van Ejick 2007). Thus, the research outcome has added further theoretical depth to literature on transition theory to renewable energy development through integrating the conceptual work of SNM with an empirical study and formulating a theoretical intervention model that could be further applied or tested as future research.

2. From the conceptual model also comes a fulfillment to the critics of one of the transition approaches - transition management - of it having neither clear conceptualisation of the individuals engaging in the transition experiments, nor a basis for monitoring or assessing changes occurring at the level of the participating individuals of the transition experiments (Scholz 2011). This study filled in this gap through conceptually designing an interaction interface between the TDI of local context element with the broader transitions process (Smith and Kern 2009; smith 2012; Cortesa 2014). This expected broad and deep interaction across multiple levels of stakeholders' as applied within the OBRE conceptual framework extends sustainability transition literature in relation to rooting implementation plans in 'on the ground' realities (local context) as well as tackling the existing lack of monitoring or assessing changes occurring at the level of the

participating individuals of the transition experiments. Thus, it can be fair to conclude that this research study was the first of its kind to develop a conceptual framework for facilitating transition in the context of OBRE in a unique landscape context. It achieved this by drawing from the two transition approaches: transition management and the technology innovation system.

3. Existing research on the constructs of transition theory and approaches have not analysed data inductively that is moving from data to the development of a conceptual model but rather, deductively applying the theory and literature to a specific research context (Kern and Smith 2008; Tigabu at al. 2013; Osunmuyiwa and Kalfagianni 2016; Strachan *et al*. 2015). This is the first study to employ the inductive reasoning approach using thematic content analysis to inform the research study's final conceptual model as well as deductively applying the theory and literature within the research study context.
4. This research study also extended the application of transition theory that were conducted in a developed economic environment to a developing economic environment such as in Nigeria through the replication of the transition framework and re-testing their constructs and theories. This is consistent with Collins' (1985) argument which states that replication of previous or existing studies is imperative for the generation of knowledge, while Hubbard and Armstrong (1994) concluded that replication is the key to generalisation for the advancement of science. Even though researchers have made

adequate and robust efforts in developing the transition framework, the fact that these studies were carried out in a developed economy suggests scope for further replication and extension studies. In addition to the contemporary transition themes as presented in section 5.4, (Twomey and Gaziulusoy 2014), this research study adds to the body of knowledge by confirming that 'trust' between developing and developed economies actors' in relation to technology innovation development is an important determinant for a successful transition process to occur within developing economies context.

5. This research study reflects on the current situation of the renewable energy system in Nigeria specifically identifying and documenting the unsociable relationship amongst the public authorities associated with renewable energy development. Existing literature and empirical studies within the context of renewable energy study in Nigeria has yet to pick up this persistent friction despite the several future research recommendations that are being presented by research scholars including Oyedepo (2014); Awogbemi and Komolafe (2011); and, Osunmuyiwaa and Kalfagianni (2016). Accordingly, this study has become the first theoretical and empirical investigation that critically studied the relationship amongst the key public authorities mandated to facilitate the uptake of renewable energy in Nigeria. Thus, the discovery and documentation of the nature of the renewable energy system is a novel contribution because information relating to the inadequacy of the social relationships amongst the RE stakeholders are mostly not disclosed. However, the situation is not

the same here as stakeholders were able to present a more realistic picture underlying the ineffective nature of the renewable energy political governance landscape.

6. The study has contributed to knowledge by identifying the key critical success factors that might support facilitating the transition towards OBRE development in Nigeria. Prior to this study, no empirical evidence existed regarding these findings, particularly in the Nigeria context. Though, there are other empirical studies of OBRE in some developing countries such as South Africa and West Indian Ocean (Wikus 2014; Hammar *et al.* 2014) but in the Nigerian context, this is the pioneer empirical study especially from the intervention model design.

9.3.1.2 Contribution to Practice

1. This research study also enhances the understanding of practitioners, including policymakers, research institutes etc, working within the Nigerian RE industry on how to design and foster system transformation, in this case, energy system. This is against the backdrop of the persistent problems limiting RE development in Nigeria. It is obvious that shifting from a predominantly fossil fuel based energy system towards an energy system based on sustainable energy forms such as OBRE is not simple task due to the inherent complexity and multi-faceted nature of global and local landscape components whose interactions influence the broad diffusion of renewable energy development practices and

requirements within the study area. Thus, the conceptual framework was designed through critical analysis of theoretical and empirical construct of the global and local landscape environment, which is underpinning the prospect for OBRE development; thereby aligning to Rotmans *et al.* (2004) in Loorbach (2007) in which their basic theory was that:

"*through the understanding of structural societal change processes [like transitions], it must be possible to formulate governance principles, methods and tools to deal with these societal change processes" (Loorbach 2007 p 17).*

Additionally, this is also the first time that regional practitioners driving RE development in the West African sub-region such as the ECREEE actors in Cape Verde, served as research participants. They were used in a bid to objectively seek their opinions on the contemporary nature of the renewable energy market in Nigeria.

2. Cryer (2006) and Phillips and Pugh (2000) suggested that a contribution to knowledge can also be observed from 'a portfolio of work based on the research study'. Accordingly, the researcher initiated an OBRE implementation project during the period of the research study as discussed earlier in Sections 1.2 and 6.3.2.2 - 'Marine Renewable Energy development in Bayelsa, Nigeria. Additionally, the project is underpinned by the novel OBRE Transition model concept.

9.3.2 Impact of research study

The impact of the intervention strategy proposed in this thesis is assessed based on political, socio-economic and personal development perspective (Korhonen et al. 2014). These political and socio economic impacts are estimated from the contribution to practice perspective of the research study as discussed in Section 9.3.1.2. Thus, the impact of the research study is discussed:

9.3.2.1 Impact of research study

The political impact of this research study is depicted in the acceptance of the proposed conceptual intervention framework, OBRE Transition model by GEF/UNIDO towards a potential use to facilitate the design and implementation of OBRE in Nigeria, specifically in Bayelsa State. Accordingly, details of impact of research study is presented below:

1. Global Environmental Facility/United Nations International Development Organisation (UNIDO) has funded an initiative: 'Marine Renewable Energy Design, Deployment and implementation using Bayelsa State as a case study' in Nigeria. This potential piece of work has shown that there is confidence given by the international development organisation to the argument put forward in this thesis. Furthermore, the partnership and endorsement of this project explicitly support the prospective transition towards OBRE as evident in Appendix 9 and 10. Additionally, the conceptual OBRE framework developed in this thesis is taken as a potential approach to influence

the future of OBRE development in Nigeria and perhaps, other potential countries in the West Africa region that are under the umbrella of ECREEE.

2. The Bayelsa Sate Government and other MDAs such as Federal Ministry of Power (FMOP) and the Energy Commission of Nigeria (ECN) have endorsed and agreed to collaborate as an active counterpart and advance party to the GEF/UNIDO funded Marine project in Bayelsa State. For instance, an expression of interest towards the design and development of an enabling environment for mini-grid implementation was submitted by the FMOP to African Development Bank in which one of the project rationale detailed the proposed Marine Energy project for Bayelsa State. The Nigeria Institute of Oceanography and Marine Research (NIOMR) has also endorsed and agreed to collaborate as an active counterpart to the preliminary work of the funded project in Bayelsa State.

These partnerships above are based on the mutually shared vision of influencing policy development and implementation in the context of providing electricity access to remote societies including the coastal communities spread out in Nigeria.

3. An academic institute in Nigeria, Petroleum Training Institute (PTI) has signed a letter of intent with RGU to collaborate in developing indigenous capabilities in the research, teaching, and training for sustainable energy development and OBRE implementation through the establishments of in-country Centres of Excellence

4. In Nigeria, there is a wide gap between the electricity demand and supply with either limited or no access to remote villages and communities such as the coastal regions. These challenges have had a profound impact in the socio-economic and human development prospect in the country. Hence, the research study has an imperative socio-economic development transformation implication for the Nigeria's renewable energy sector. For instance, implementation of OBRE in Nigeria can lead to improved living conditions for the coastal communities and foster economic development in the area where OBRE is to be developed.
5. A fundamental outcome from this study is also the prospect for the researcher (personal development in the field of transition theory) to be part of an organising committee for a conference to be held in 2017, in France. The theme of the conference is on 'energy poverty in developing economies in Africa, Energy and Justice – Africa. The conference will afford the researcher opportunities to discuss in details the OBRE Transition Model and how it is been applied to facilitate OBRE's demonstration project in Nigeria and its potential applicability in the broader context of energy and sustainability.

9.4 Limitation of the study

To a certain extent, bias is always an issue within any form of research, especially applied research, where the researcher acts as both participatory and researcher. While the researcher strives to maintain an objective standpoint, given the involved nature of this applied study (an insider as earlier mentioned in Section 6.3.2.1), it is important to acknowledge issues to do with subjectivity and perspective, as well as the role the reflexivity of the researcher plays in addressing this within the research process. In addition, the data obtained was mainly derived from the input of respondents across various stakeholder groups. This would suggest that the data gathered from the participants might perhaps, marginally limit some of the results of the study. Indeed, this is is a common issue in social science research, as participants may have decided not to provide an objective view, for many reasons (Creswell 2007; Creswell and Plano Clark 2010). For instance, some respondents may not have been willing to supply information that contradicted their organisation's official standpoint or may be limited by memory.

In light of this and in mitigating the issues above, initial unstructured exploratory data were derived from the phase two pilot group informal discussions, which helped shaped the interviews design where pertinent human resources, actively involved in the sustainable forms of energy development in Nigeria were selected. This shaping was largely influenced by discussions and informal focus groups sessions with industry and local authority officials lending some form of credibility to the research result. The role of the phase two pilot group aligns with the researcher's positionality as discussed in Section 6.2.3.1 which:

> *"address issues of social justice and suggests that "that inquiry needs to be intertwined with politics and a political agenda... that may change the lives of the participants, the institutions in which individuals work or live, and the researcher's life"* (Creswell 2009, pp.9-10).

Furthermore, the researcher solicited the audience of non-Nigerians (International development agencies such as OBRE 011) who are actively working in Nigeria (in the field of energy policy and planning) who could provide a more 'independent' feedback on findings – as independent assessors - to ensure that the nature of research study inquiry is free of bias to the barest minimum. This also included a significant interaction with both GEF and UNIDO official, both agencies providing some form of independent reviewer of the results obtained from this research study.

Moreover, having a community of inquiry in the form of the departmental research group (CUSP, earlier mentioned in Section 6.5) also played a crucial role in limiting the bias element of the research study. Hearing the researcher's ideas out loud while presenting them to the group, as well as having some of those ideas questioned and challenged was an essential part of forging ideas into concrete research findings, as well as the continued development of the study. Finally, this research study was conducted with the help of an efficient, ethically sound model that maximises selected development impact factors. The researcher's experiences and familiarity with the country in which the investigation is examined also help in ensuring the observation of basic ethical issues concerned with investigating policy intervention and culture.

9.5 Recommendations

The study's recommendation is classified into two categories: firstly recommendation for practice and secondly recommendation for future research.

9.5.1 Recommendations for practice

Literature suggests that the success of the adoption and implementation of technology innovation including OBRE is in part dependent on the socio-technical transition system (see Chapters 4 and 5). Consequently, it is fair to say that a well performing socio-technical transition system accelerates technology innovation, while a poorly structured and functioning socio-technical system hampers the technology innovation. The findings of this thesis reveal that it is clear that fundamental changes are necessary within the country's current socio-technical transition system responsible for facilitating the transition towards a more appropriate and sustainable forms of energy development including OBRE which is fit for purpose in the context of delivering electricity to coastal communities. Therefore, this study recommends that the socio-technical transition authorities should seek for guidance in terms of the utilisation of resources and trained expertise in transition and governance functions towards providing an overarching support for facilitating the transition towards a more appropriate and sustainable form of energy development.

The recommendation in practice will not be complete if the researcher fails to mention the proposed OBRE project in Bayelsa. Thus, another recommendation in practice is aimed at the actual delivery of an OBRE based electricity generation to a coastal community. The demonstration is being conducted using the conceptual OBRE transition model as discussed in Section 8.3. This recommendation is therefore consistent with progressing from ‘loop 1’ to ‘loop 2’ of the action research concept, observed in Figure 6-1.

9.5.2 Recommendations for future research

The aim of this research study was to explore the critical success factors that could configure the opportunities for OBRE niche innovation development, in practice and also in light of the perceived shortfalls limiting the transition towards RE in Nigeria. In doing so, this research study developed a conceptual framework within the research context that draws from the literature reviewed and the data gathered. Therefore, further refinement and modification of the constructs proposed by this research study may be necessary in order to take into account the other specific context of future research studies. Future research studies should, therefore, consider applying the conceptual model on other research contexts including flooding concern in Nigeria and corporate social responsibility (CSR) development in the Niger Delta region as mentioned by one of the research participants, specifically by OBRE 005 in Chapter 7.

Furthermore, a comparative research study in a chosen case study country such as Cape Verde (mentioned earlier in Section 6.3) could complement this research study. This will help to ascertain the practice, and the strengths and weaknesses on the transferability of the designed conceptual model. This also includes re-testing of the model on other renewable energy sources including solar and bioenergy sources. Thus, conclusions could be drawn that may help in enhancing the conceptual framework.

Additionally, this research study supported the relevance of the various contemporary transition concepts as presented in section 5.4. This was further expanded in this research study to take into account the element of ‘trust’ within the context of technology innovations transfer from developed economies to developing economies. However, this might not be the only new construct upholding contemporary transition concepts. Hence, further research could explore other important transition concepts that may provide new insights to the conceptual framework developed in this research study. This is because the research sample utilized, in particular for the interview based focus group pilot, came from Bayelsa state only. Consequently, future research studies should consider drawing samples from other Niger delta states including Delta and Rivers states in order to have diverse opinions and views from research participants, which will likely inform new ‘contemporary transition concept’ constructs.

Finally, the transition framework appears to concentrate on the activities of actors (government, public and private firms, non-governmental, academics, civil societies, consumers) who are influenced by specific institutional characteristics. On the other hand, another area of consideration is to critically investigate the policy network element within the activities and how that has affected the renewable energy development in the states and local government territories (Cowell *et al.* 2016). Thus, it is recommended that another research study should be conducted particularly on policy networking. The need for research in this area coincided with the proposed OBRE project in Bayelsa where it is fair to say that significant resources deployment for any RE development in Nigeria appears to be governed by the National government authorities. A critical review of policy networks could help further understand policymaking and implementation of RE within the broader energy sector of Nigeria including state and local authorities participation.

9.6 Relevance of transition theory in developine economies

This thesis integrates an interdisciplinary analytic approach (Chapter 5, 6 and 7) with descriptive discussions (Chapter 2, 3 and 4) and a reflexive evaluation of both - interdisciplinary analytic approach and descriptive discussions - (Chapter 9), giving rise to a prescriptive intervention conceptual model, which achieved the aim of the research study. The thesis thus concludes that, so far, transition studies have provided a way of thinking that governance takes a central stage for sustainable forms of energy implementation but also simultaneously allows scope for integration, interaction, collaboration and experiment. This leads to important questions about the sense of seeing transition theory and concepts as a tool for transforming systems of energy provision, in this case, in a developing economies context.

Indeed, this research study generally found that transition theory and concepts are useful for explaining the prospects towards the transition to sustainable forms of energy; it, however, sees a need to add a brief final remark about applying the framework within a developing country context such as Nigeria. A widespread assumption of the transition studies and concepts framework is that niche development and transitions are strongly influenced by dynamics operating within individual countries. In this thesis, the research study found that 'trust' is a key influential principle for technology innovation to occur, especially when one considers that technology, organization and perhaps, financial resources often flow from developed to developing economies.

Additionally, the transition prospects towards sustainable forms of energy in developing economies can be positively influenced and completed by effective participation and consultative decision-making (strong and meaningful stakeholders interaction) procedures, which are able to significantly improve the transition strategy and facilitate the best option of the energy object. For example, this research study showed that the unsuccessful nature of Nigeria's transition towards sustainable forms of energy sources has been the outcome in the inadequacy of a strategic steering process of transition navigation, over a long period. Without a doubt, as long as there is a group of normatively unaligned, loosely distinct lead actors (policy makers) across the niche and regime levels, which collectively exclude key ingredients such as collaborative, integration and interaction within transition theory, the shape, direction and speed of transition may be limited.

Finally, this research study concludes that the developed conceptual framework is a tool capable of facilitating the transition towards OBRE development in Nigeria, thereby providing an alternative form of electricity generation, specifically in the coastal communities. Additionally, it is envisaged that the application of this conceptual model will perhaps help to foster the transition towards the broader spectrum of the RE market in Nigeria.

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APPENDICES

APPENDIX 1: ENDORSEMENT LETTER FOR OBRE IMPLEMENTATION.

FEDERAL MINISTRY OF ENVIRONMENT

HEADQUARTERS, MABUSHI, ABUJA.

Ref No. FMENV/PRS/954/1/138

Date: 11th May, 2015

Mr. Philippe R. Scholtes
Managing Director
Programme Development & Technical Cooperation
United Nations Industrial Development Organization (UNIDO)
Vienna, AUSTRIA

ENDORSEMENT FOR GEF/UNIDO SUPPORT FOR "MARINE RENEWABLE ENERGY DESIGN, DEPLOYMENT AND IMPLEMENTATION USING BAYELSA STATE AS CASE STUDY"

In my capacity as the GEF Operational Focal Point for the Federal Republic of Nigeria, I write to confirm that the above project title (a) is in alignment with my Government's national priority of promoting renewable energy sources for productive and domestic uses; and (b) the project was discussed extensively and approved at the national GEF Steering Committee meeting held in November 2014.

In view of the above, I am pleased to endorse the preparation of the project proposal with the support of UNIDO as a GEF agency. The project will be prepared and implemented in collaboration with the Bank of Industry, the Small and Medium Enterprises Development Agency of Nigeria, and the private sector. I request the GEF agency to provide a copy of the project document before submitting it to the GEF Secretariat for the CEO endorsement.

The total financing from GEFTF being requested for the project is US$1,100,000, inclusive of project preparation grant (PPG), if any, and Agency fees for project cycle management services associated with the total GEF grant. The financing requested for the Federal Republic of Nigeria for the project is detailed in the table below:

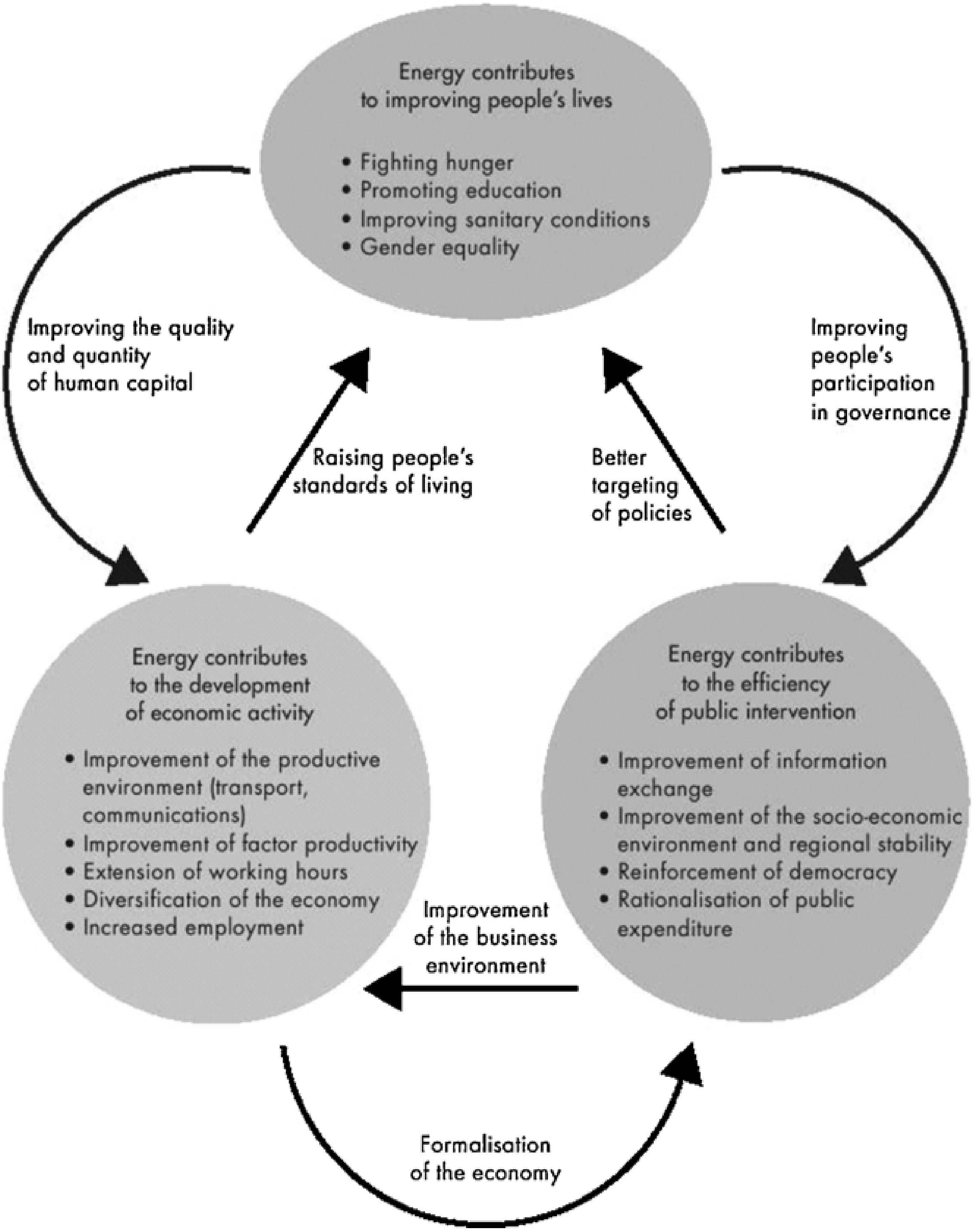
Sources of Funds	GEF Agency	Focal Area	Amount in US$			
			Project preparation	Project	Fee	Total
GEFTF	UNIDO	Climate Change	-	1,000,000	100,000	1,100,000
Total GEF Resources				**1,000,000**	**100,000**	**1,100,000**

I consent to the utilization of Federal Republic of Nigeria's allocations in GEF-6 as defined in the System for Transparent Allocation of Resources (STAR).

Yours sincerely,

Yomi Johnson Ladapo
Director/GEF Operational Focal Point

APPENDIX 2: LINKS BETWEEN ACCESS TO ENERGY AND SUSTAINABILITY



APPENDIX 3: BARRIERS ARISING FROM SYSTEM LOCK – IN

Structural Elements	**Likely barriers**
Institutions	**Institutional barriers** • Lack of regulatory and legal framework [requisite institutions] • Variable or contradictory institutions • Existence of institutions hindering renewable energy innovation
Infrastructure communication and energy supply infrastructure (supply chain); science and technology	**Infrastructure barriers** • Low accessibility of infrastructures • Poor quality of infrastructure • Lack of reliable infrastructure • Unavailability of infrastructure
Actors Policy-makers, change agents, innovators and end-users	**Capabilities' barriers** • Lack of key actors • Lack of awareness by actors such as policy makers, innovators and users • Lack of business resources [capital, knowledge, technology] • Deficiency in sustainable innovation • Lack of resources – end users
Actors' networks formation.	**Network barriers** • Weak interaction failure • Strong interaction failure

APPENDIX 4: INTERVIEW QUESTIONS SCHEDULE

1. What role does your ministry play towards renewable energy development in Nigeria?
2. In your opinion, what is the main reason or driver for renewable energy development in Nigeria?
3. In your opinion, what factors have been designed to promote renewable energy in Nigeria?
4. In your opinion, what persistent problems (barriers) are hindering its development?
5. Are you aware of the current NREEEP and were you involved during the development process?
6. Are you familiar with Ocean Based Renewable Energy?
7. Are you aware of its inclusion within the NREEEP?
8. Are you aware of any related activities associated with OBRE in Nigeria?
9. In your opinion what guiding principles should be considered for a prospective transition towards OBRE development in Nigeria?
10. In your opinion, who are the stakeholders to drive OBRE transition in Nigeria?

APPENDIX 5: LETTER OF CONSENT FROM RGU

Dear participant,

INVESTIGATING THE PROSPECTS FOR A TRANSITION TOWARDS OCEAN BASED RENEWABLE ENERGY INNOVATION IN WEST AFRICAN SUB-REGION: A CASE STUDY OF NIGERIA.

Research purpose

You are being invited to take part in research that aims to evaluate the potential development of offshore renewable energy and instigate a governance framework to improve its development in Nigeria. This study is postgraduate research which is part of a PhD degree award. Before you decide whether or not to take part, it is important you understand why the research is being done and what it will involve. Please take time to read the following information carefully.

Why have I been invited to participate?

You are being invited to participate in the study because you have been identified as either: directors, director-general, managers, general managers, academics, commissioners, deputy directors, energy policy experts, technical assistants, special advisers, research advisers, chief executive directors, executive directors, senior managers, general secretaries, consultants, project managers or specialists with comprehensive knowledge of the current study variables.

Do I have to take part?

Taking part in this research is exclusively a voluntary exercise. If you decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. In the event that you decide not to take part again before or during the research, you are free to withdraw without giving any reason. If you have received this information sheet/e-mail from your colleague or manager, you are under no obligation to take part and taking part or not in the study will have no bearing on your employment with the company.

What will you have to do and how long will it take?

The interviewer will want to interview you on your opinion regarding the research paradigms. The interview will take a semi-structured format with open and closed ended questions. This should take no longer than 25 to 40 minutes and will take place at your office or a place agreed by you. The interview will be recorded but you will be asked to give consent prior to the interview and may be asked to also give consent at a later stage.

What will happen to information collected?

The information collected will be used by the researcher to write a thesis in partial fulfillment of PhD degree award. Only the researcher and supervisor will be privy to the notes, documents, recordings and paper written. Afterwards, notes and documents will be destroyed and recordings erased. The researcher will keep the transcriptions of the recordings and a copy of the paper but will treat them with the strictest confidentiality. No participant will be identified in the publications and no reference will be made to you in person or the company you represent. In other words, the information will be treated as confidential and anonymous.

Declaration to participants

If you take part in the study, you have the right to:

- Refuse to answer any particular question, and to withdraw from the study at any time (including after the interview or questionnaire has been completed).
- Ask any further questions about the study that occurs to you during your participation.
- Be given access to a summary of findings from the study when it is concluded.

Who's responsible?

If you have any questions or concerns about the project, either now or in the future, please feel free to contact either:

Doctoral Researcher:

Name: Victor Osu

Robert Gordon University

Dept.: Engineering

School of Engineering

Garthdee, Aberdeen, Scotland, UK

E-mail- v.o.osu@rgu.ac.uk

Tel: +44 (0) 7516318262

Supervisors:

Dr Abhishek Agarwal (Principal Supervisor)

Robert Gordon University

Dept/School: Aberdeen Business School

Garthdee, Aberdeen, Scotland, UK

E-mail: a.agarwal@rgu.ac.uk

Dr Joanneke Kruijsen

Robert Gordon University

Dept.: Centre of Understanding Sustainable Practice [CUSP]

School of Engineering

Garthdee, Aberdeen, Scotland, UK

E-mail: j.h.j.kruijsen@rgu.ac.uk

INVESTIGATING THE PROSPECTS FOR A TRANSITION TOWARDS OCEAN BASED RENEWABLE ENERGY INNOVATION IN WEST AFRICAN SUB-REGION: A CASE STUDY OF NIGERIA.

Consent Form for Participants

I have read the **Participant Information Sheet** for this study and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I also understand that I am free to withdraw from the study at any time, or to decline to answer any particular questions in the study. I understand I can withdraw any information I have provided up until the researcher has commenced analysis on my data. I agree to provide information to the researchers under the conditions of confidentiality set out on the **Participant Information Sheet**.

I agree to participate in this study under the conditions set out in the **Participant Information Sheet**.

Signed: ____

Name: ____

Date: ____

Researcher: Victor Osu

Supervisors: Dr Abhishek Agarwal Dr Joanneke Kruijsen

APPENDIX 6: TIME TABLE FOR INTERVIEW SCHEDULE IN NIGERIA

Participant's Profile	Initial date and time for interview	Actual time and date for Interview	Location/remarks
ORE 001	Date: 20/5/2015 Time:10.00am	Date: 20/5/2015 Time:10.00am	Nigeria, Abuja
ORE 002	Date: 15/5/2015 Time:3.00pm	Date: 15/5/2015 Time:4.37pm	Nigeria, Abuja
ORE 003	Date: 19/5/2015 Time:11.00am	Date: 19/5/2015 Time:11.40am	Nigeria, Abuja
ORE 004	Date: 13/5/2015 Time:10.30am	Date: 13/5/2015 Time:10.30am	Nigeria, Abuja
ORE 005	Date: 8/5/2015 Time:11am	Date: 8/5/2015 Time:12.30pm	Nigeria, Abuja
ORE 006	Date: 18/5/2015 Time:1.00pm	Date: 18/5/2015 Time:4.35pm	Nigeria, Abuja
ORE 007	Date: 11/5/2015 Time:5.00pm	Date: 11/5/2015 Time:5.10pm	Nigeria, Abuja
ORE 008	Date: 17/4/2015 Time:3.00pm	Date: 17/4/2015 Time:3.00pm	UK, Aberdeen
ORE 009	Date: 14/4/2015 Time:1.00pm	Date: 14/4/2015 Time:1.00pm	UK, Aberdeen
ORE 010	Date: 19/5/2015	Date: 19/5/2015	Nigeria, Abuja

	Time:2.30pm	Time:2.40pm	
ORE 011	Date: 12/5/2015 Time:1.00pm	Date: 12/5/2015 Time:1.00pm	Nigeria, Abuja
ORE 012	Date: 29/5/2015 Time:2.00pm	Date: 29/5/2015 Time:2.00pm	Nigeria, Lagos
ORE 013	Date: 20/5/2015 Time:11.00pm	Date: 20/5/2015 Time:11.25pm	Nigeria, Abuja
ORE 014	Date: 29/4/2015 Time:7.00pm	Date: 29/4/2015 Time:7.15pm	Nigeria, Osun
ORE 015	Date: 23/4/2015 Time:9.00pm	Date: 23/4/2015 Time:9.00pm	Nigeria, Lagos [over dinner]
ORE 016	Date: 30/4/2015 Time:3.00pm	Date: 30/4/2015 Time:3.00pm	Nigeria, Lagos
ORE 017	Date: 17/4/2015 Time:11.00am	Date: 17/4/2015 Time:11.03am	UK, Aberdeen [via skype as participant was in Cape Verde]
ORE 018	Date: 15/5/2015 Time:1.00pm	Date: 15/5/2015 Time:2.00pm	Nigeria, Abuja
ORE 019	Date: 25/5/2015 Time:8.00pm	Date: 25/5/2015 Time:8.45pm	Nigeria, Delta
ORE 020	Date: 14/5/2015 Time:10.00am	Date: 14/5/2015 Time:11.30am	Nigeria, Abuja
ORE 021	Date: 15/5/2015 Time:3.00pm	Date: 15/5/2015 Time:3.52pm	Nigeria, Abuja
ORE 022	Date: 14/5/2015	Date: 14/5/2015	Nigeria, Abuja [over

	Time:2.00pm	Time:3.15pm	lunch]
ORE 023	Date: 19/5/2015 Time:10.00am	Date: 19/5/2015 Time:10.01am	Nigeria, Abuja
ORE 024	Date: 28/4/2015 Time:12.00pm	Date: 28/4/2015 Time:12.00pm	Nigeria, Lagos
ORE 025	Date: 18/5/2015 Time:11.00am	Date: 10/6/2015	Sent through e-mail from Lagos.
ORE 026	Date: 4/6/2015 Time:11.00am	Date: 4/6/2015 Time:11.00am	UK, Aberdeen
ORE 027	Date: 24/4/2015 Time:2.00pm	Date: 24/4/2015 Time:2.00pm	Nigeria, Lagos

APPENDIX 7: CODING PROCESS ILLUSTRATED

Unit for analysis (interview schedule focus)	Open coding – emerging themes from interview transcripts	Categories/concepts (Axial coding) – based on frequency of occurrence and comparison with other codes
Motives for facilitating the transition towards renewable energy development in Nigeria	Increase in energy demand to meet the lack of access to electricity in Nigeria Self-generation for electricity consumption energy diversification energy security rural electrification more long term sustainable option because it is sustainable environmental friendly development Strategy towards clean development using renewable energy sources Socio-economic development Reduces environmental pollution	• Improve access to energy (27 occurrence across interview transcript) • Sustainability consideration (16 occurences across interview transcripts)

APPENDIX 8: CODING PROCESS ILLUSTRATED - II.

Open coding – emerging themes from interview transcripts	**Categories/concepts (Axial coding) – based on frequency of occurrence and comparison with other codes**	**Selective coding (Core-categories)**
Policy statement Regulatory scheme Cross sectoral interaction RE research centres/institutes International and national partnership Enabling policy Policy Policy Legal structure Feed in Tarfiff Inolvement of NERC IMC Individual practises NGOs activities Institutions involvement No drivers	Political and regulatory structure Social actors interactions Institutions formation Research and Development Stakeholders roles	Structural and institional mechanisms Key stakeholders mandates and engagement

APPENDIX 9 INTERVIEW CODE SHEET

1. Motives for facilitating the transition towards renewable energy development in Nigeria

1.1. Improve access to energy in Nigeria, specifically electricity delivery

1.2. Sustainability consideration

2. Mechanisms facilitating the renewable energy market in Nigeria

2.1. Institutional framework

2.1.1. Policy and regulatory schemes

2.2. Stakeholders' arrangement

2.2.1. Key stakeholders' mandate towards renewable energy development in Nigeria

2.2.2. Key stakeholders' engagement forum towards RETs development in Nigeria

3. Reflection on the developmental process for renewable energy programme

3.1. Roles and responsibility of the Federal Ministry of Power

3.2. Stakeholders' engagement in the NREEEP's development process

4. Opinions on the limiting factors hindering renewable energy development in Nigeria

4.1. Institutional and governance barriers

4.1.1. Weak political will and legal structure

4.1.2. Lack of funding

4.1.3. Lack of coordination/ meaningful engagement

4.2. Capability/Capacity barriers

4.3. Infrastructure barriers

5. Prospect of OBRE development in Nigeria

5.1. Expectation on OBRE development

5.1.1. Awareness of OBRE towards its potential development in Nigeria

5.1.2. Future market for OBRE, in particular electricity generation

5.2. Formation of social actors' network

5.2.1. Interaction amongst niche actors

5.2.2. Collaboration between niche and socio-technical regime actors

5.3. Learning process

6. Potential critical success factors considered for facilitating the transition towards OBRE development in Nigeria

6.1. Principles to be considered for OBRE transition

6.1.1. Broad stakeholders' engagement

6.1.2. Demonstration activities

6.1.3. Political advocacy

6.1.4. Learning and knowledge development

6.2. Key stakeholders’ to be considered for OBRE transition

APPENDIX 10: LETTER OF COMMITMENT FROM BAYELSA STATE

BAYELSA STATE GOVERNMENT OF NIGERIA

MINISTRY OF POWER
1st floor Secretariat Annex 1, P.M.B 135, Yenagoa

22nd August, 2014

Global Environmental Facility (GEF)
Federal Ministry of Environment
Abuja
Nigeria.

Attention: Halima Kolo, focal point GEF, Nigeria

Subject: Collaboration with Centre of Understanding Sustainable Practices (CUSP) for Marine Renewable Energy development in Bayelsa State, Nigeria.

This letter serves to intimate you of our strategic intent regarding the development and implementation of Marine Renewable Energy technology in Bayelsa State for sustainable development for our coastal communities. In pursuing this course of action, we are collaborating with the Centre for Understanding Sustainable Practice (CUSP) at Robert Gordon University (RGU), Aberdeen, United Kingdom who are experts in the field of marine renewable energy development.
Substantial engagement/consultation between the state and CUSP has ensued regarding this prospect and we are fully committed to this project.

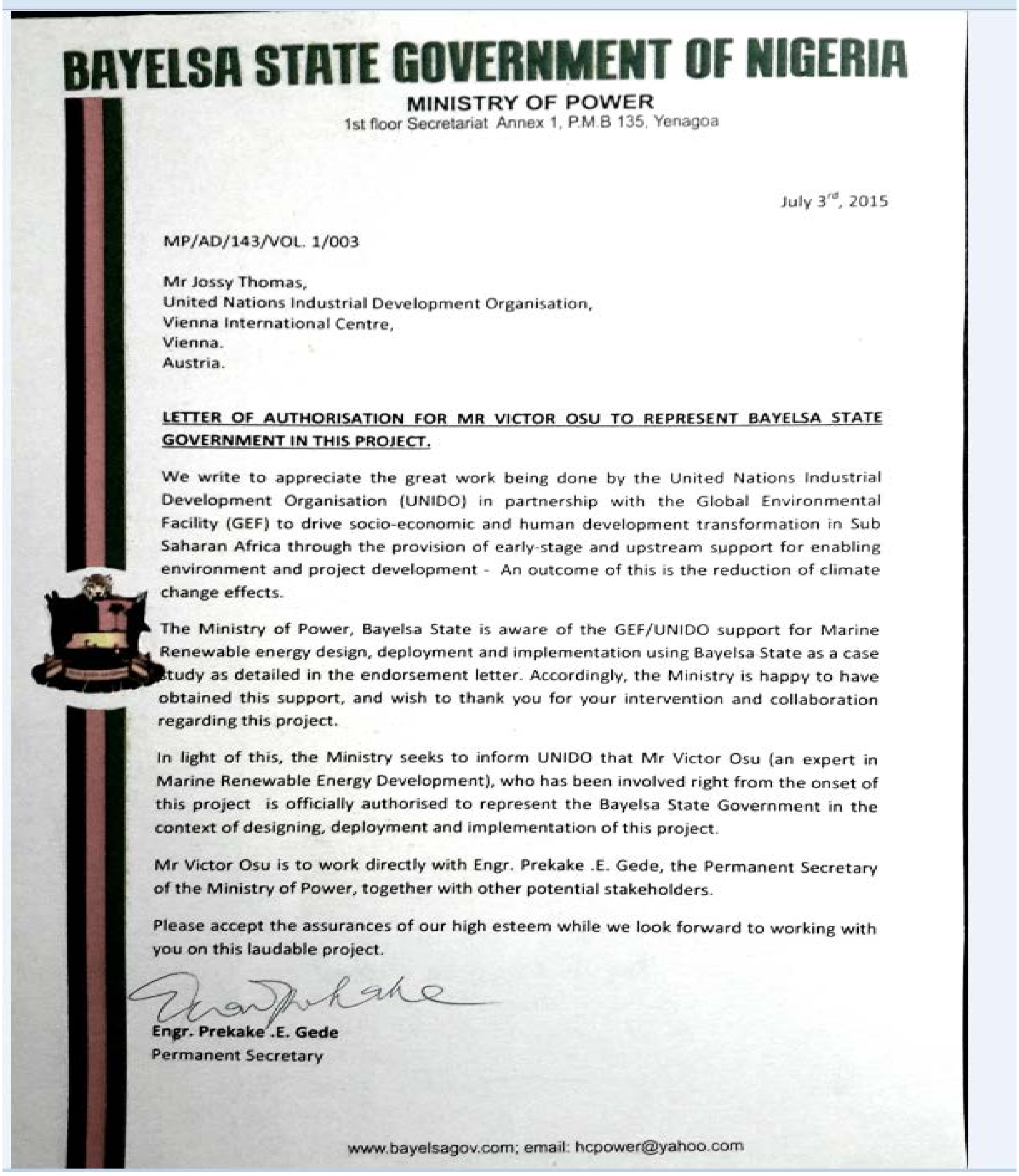
As part of CUSP commitment, they seek for international support and collaboration in the form of funding, project management and monitoring which will further strengthen the project success. Accordingly, we wish to state that we are fully in support of this project, and solicit that all required assistance from your organisation towards this course is made available to CUSP.
Furthermore, with your support, this project will no doubt contribute significantly to reduction of carbon emission in addition to the achievement of sustainable development in the coastal region.

Please accept the assurances of our high esteem.

Engr. Prekake E. Gede
(Permanent Secretary)
For. Hon. Commissioner

www.bayelsagov.com; email: hcpower@yahoo.com

APPENDIX 11: LETTER OF AUTHORISATION



BAYELSA STATE GOVERNMENT OF NIGERIA

MINISTRY OF POWER
1st floor Secretariat Annex 1, P.M.B 135, Yenagoa

July 3rd, 2015

MP/AD/143/VOL. 1/003

Mr Jossy Thomas,
United Nations Industrial Development Organisation,
Vienna International Centre,
Vienna.
Austria.

LETTER OF AUTHORISATION FOR MR VICTOR OSU TO REPRESENT BAYELSA STATE GOVERNMENT IN THIS PROJECT.

We write to appreciate the great work being done by the United Nations Industrial Development Organisation (UNIDO) in partnership with the Global Environmental Facility (GEF) to drive socio-economic and human development transformation in Sub Saharan Africa through the provision of early-stage and upstream support for enabling environment and project development - An outcome of this is the reduction of climate change effects.

The Ministry of Power, Bayelsa State is aware of the GEF/UNIDO support for Marine Renewable energy design, deployment and implementation using Bayelsa State as a case study as detailed in the endorsement letter. Accordingly, the Ministry is happy to have obtained this support, and wish to thank you for your intervention and collaboration regarding this project.

In light of this, the Ministry seeks to inform UNIDO that Mr Victor Osu (an expert in Marine Renewable Energy Development), who has been involved right from the onset of this project is officially authorised to represent the Bayelsa State Government in the context of designing, deployment and implementation of this project.

Mr Victor Osu is to work directly with Engr. Prekake .E. Gede, the Permanent Secretary of the Ministry of Power, together with other potential stakeholders.

Please accept the assurances of our high esteem while we look forward to working with you on this laudable project.

Engr. Prekake .E. Gede
Permanent Secretary

www.bayelsagov.com; email: hcpower@yahoo.com