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Review article

A review of stakeholders and interventions in Nigeria's electricity sector

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ABSTRACT

In this paper, we explored the interplay between the electricity market structure, methods of electricity trading and different stakeholder dynamics within the Nigerian Electricity Supply Industry (NESI) with a view to understanding how these interplays impact on various forms of interventions in the Nigerian electricity sector. We started off by exploring the market structure and electricity trading system within the Nigerian electricity sector and reviewed the various stakeholder groups within centralized and decentralized electricity systems in Nigeria's electricity sector by highlighting their core responsibilities and the dynamics at play in satisfying their interests. This study revealed that: (1) external stakeholder groups (such as donor agencies and multi-lateral organizations) exert more influence in Nigeria's electricity sector through financial interventions; (2) lack of coordination and engagement among various stakeholder groups pose a challenge to effective electricity infrastructure interventions that address the needs of people in society. The study concludes by highlighting the implications of these challenges and the need to address the rising complexities and uncertainties for better stakeholder involvement in addressing the salient challenges in the sector.

1. Introduction

Stakeholder engagement in electricity infrastructure provisions is a relatively new area compared with other fields such as environmental management [1, 2, 3], urban development [4, 5] and water management [6, 7, 8]. Energy and electricity is at the heart of the Sustainable Development Goals (SDG) targets, particularly SDG7 that focuses on achieving affordable, reliable sustainable and modern energy for all [9]. Achieving the SDG7 requires the consultation, participation and engagement of a diverse array of stakeholders involved in both on-grid and off-grid electricity systems [10]. These stakeholders play very vital roles in electricity infrastructure financing, provision, use, regulatory formation and compliance [11, 12, 13]. There is a need to know and understand the various stakeholders, their interest and how these interest shape electricity infrastructure provision and use. However, how do stakeholders participate in electricity infrastructure planning?

Understanding decision making of various stakeholders is a vital part of the changing electricity sector landscape [14]. Spath and Scolobig in their work on stakeholder empowerment through participatory planning services argued that there are three main phases in power grid projects requiring stakeholder participation [15]. These phases include:

1. *The need definition phase* - which aims at identifying and justifying the need for future electricity (grid and off-grid) projects while obtaining stakeholders' views about them.
2. *The spatial planning phase* – which focuses on defining the area of study and how to address economic and environmental aspects of the project, including consideration for the short and long term landscape impact.
3. *The permitting phase* – which begins with a request for declaration of public utility to ensure all legal aspects are tidied. It also includes the precise localization of the project determined through meetings with the authorities and stakeholders whose interest may be directly impacted by the project (e.g., land owners)

Indeed, the Nigerian electricity sector has experienced serial changes in infrastructure development over the past century [16, 17, 18]. These changes were necessitated by the need to address infrastructure challenges to meet the rising energy needs [19, 20, 21]. Various stakeholders played vital roles at various points in Nigeria's energy history through various forms of interventions. Some of these interventions took the form of regulations to aid infrastructure investment and private sector participation, while others took the form of direct technological intervention in infrastructure provision. These interventions, which started

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with the introduction of diesel-fired steam engines in the late 1800s, expanded to the extensive adoption and use of various fuels (such as coal, crude oil and natural gas) for electricity generation within the 20th century [18].

At the dawn of the 21st century, Nigeria experienced more private sector and multilateral organization participation in the provision of centralized and decentralized electricity systems [22, 23]. Arguably, the decision making culture in the electricity sector is characterized by a network of stakeholders, business interests and legal structures which proves difficult to change [24]. However, how did these changes come about? In what ways do various stakeholder groups within the Nigerian electricity sector shape infrastructure decisions? This paper attempts to review stakeholder dynamics in Nigeria's electricity sector and how they shape infrastructure decisions by answering the question:

- *Who are the key stakeholders in Nigeria's electricity sector and how do they intervene in electricity infrastructure provisions?*

In an attempt to answer the aforementioned question, we explored the Nigerian electricity market structure, electricity trading dynamics and the various stakeholder groups within centralized and decentralized electricity systems in Nigeria's electricity sector by highlighting their core responsibilities and the dynamics at play in satisfying their interests. This review also explored the dynamics of financial interventions by external stakeholder groups and how these shape electricity infrastructure provisions.

In structuring this paper, we present the theoretical lens, materials and methods in section 2. In section 3, we explored electricity trading system and the structure of the Nigerian electricity market. The various stakeholder categorizations in Nigeria's electricity sector and how they shape electricity infrastructure provision were presented in section 4. Section 5 delves into the financial interventions in Nigeria's electricity sector by various external stakeholder groups. The discussions and conclusions are presented in sections 6 and 7 respectively.

2. Theoretical lens, materials and methods

In this section, the theoretical lens, materials and methods used in this study are presented. Stakeholder theory was explored in relation to how it leads to the emergence of business interests by various stakeholder groups.

2.1. Stakeholder theory and the emergence of business interest

Stakeholder theory is a theory that deals with how business really works on-the-ground [25, 26, 27] and how value is created by different stakeholders in a given market [28]. It entails all activities and thinking that produces value for communities, employees, customers, suppliers and investors [27, 29]. This theory affirms that stakeholders do not work in isolation but as a network of people with shared interests. This theory has emerged as a valuable tool for understanding three interconnected business problems [30]:

1. In what ways do we understand how value is created and traded?
2. What are the inherent problems of connecting ethics and capitalism?
3. In what ways can managers be helped to think (and act) about the aforementioned problems?

The decision making dynamics in the electricity sector is characterized by a network of stakeholders, business interests and legal structures which proves difficult to change. While most utility companies make the effort to fulfil their obligations to serve their customers, they have very little economic or market incentives to share their decision making powers with any stakeholder group [31]. Arguably, stakeholder participation does not necessarily lead to improved decisions particularly when there is insufficient deliberation in the decision process [32, 33, 34]. Lack of sufficient expertise by some stakeholder groups in specific technical matters lead some decision makers to ignore (or even exclude) the inputs and contributions of certain groups from future planning efforts.

Indeed, the need to raise public awareness and trust in electricity infrastructure development requires a certain degree of stakeholder engagement. Stakeholder management helps to address issues of legitimacy in decision making. This requires participation and involvement by building relationships that helps each party to achieve a common goal. Figure 1 shows an example of the multiple interactions between a diverse array of stakeholders and a firm as explained by stakeholder theory.

2.2. Materials and methods

Using stakeholder theory as the theoretical lens, we developed a mapping of various stakeholders present in Nigeria's electricity sector. The mapping captured both internal (domestic) and external (foreign) stakeholder groups involved in infrastructure financing, regulatory formulation and compliance, infrastructure provision and maintenance, advocacy and energy use. It also places each stakeholder group (with respect to the part of the electricity market) where they are more active, either within centralized or decentralized electricity systems as outlined in section 4.

Following the stakeholder mapping, we used institutional archival sources and repositories from some stakeholder groups made up of local and international agencies as our main sources for data collection. We then validated the data collected from the various archival sources either by email or through semi-structured interviews of some members of the various institutional stakeholder groups. Some of the main institutions which served as data collection sources include:

1. Selected Nigerian grid-connected generation companies
2. Selected Nigerian grid-connected distribution companies
3. Transmission Company pf Nigeria (TCN)
4. Nigerian Electricity Regulatory Commission (NERC)
5. Rural Electrification Agency of Nigeria
6. International Energy Agency (IEA)
7. Energy Information Administration (EIA)
8. World Bank
9. African Development Bank

Data collection and validation was done from 1st March to 30th April 2020. Through semi-structured interviews and email communication, additional empirical data were obtained that provided some insights on the internal workings and latest thinking within those institutions on how they are addressing those electricity power sector issues within their domain and jurisdiction. The data collected were analysed using archival

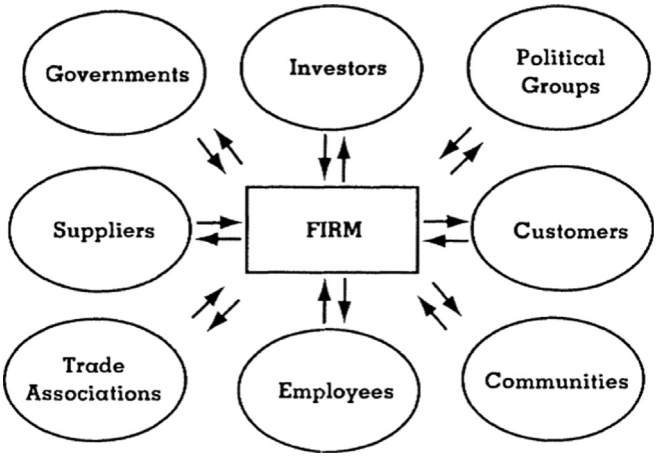

Figure 1. Stakeholder theory and the contrasting models of a corporation (source: [26] (pg. 69)).

data analysis. Archival analysis entails pulling secondary data from various existing records by studying historical documents. These data includes government and legislative documents, agency records and other forms of existing data. Figure 2 show the process followed in the data collection process while Table 1 shows a summary of the various stakeholders contacted and the date of conversation/interview.

3. Electricity trading and the structure of the Nigerian electricity market

The Federal Government of Nigeria initiated the electric power sector reforms in 2001 to pave the way for a competitive electricity market [22, 35]. The electricity sector reforms (which started in the early 2000s) had the aim of creating efficient market structures, within clear regulatory frameworks, that would allow for the birth and growth of a competitive market for electricity generation and trading [35, 36]. To this end, the Electric Power Sector Reform Act (EPSRA) of 2005 establishes a phased strategic transition to a fully competitive electricity market with optimal capacity for electricity generation, transmission and distribution [37]. Progress towards the fully competitive market was to be implemented in four distinctive stages of increasing competition which include [38]:

1. Pre-transition stage, with a monopolistic market structure
2. The transition market stage, with an oligopolistic market structure
3. Medium market stage, with a monopolistic competitive market structure
4. Long-term market stage, with a perfect competitive market structure.

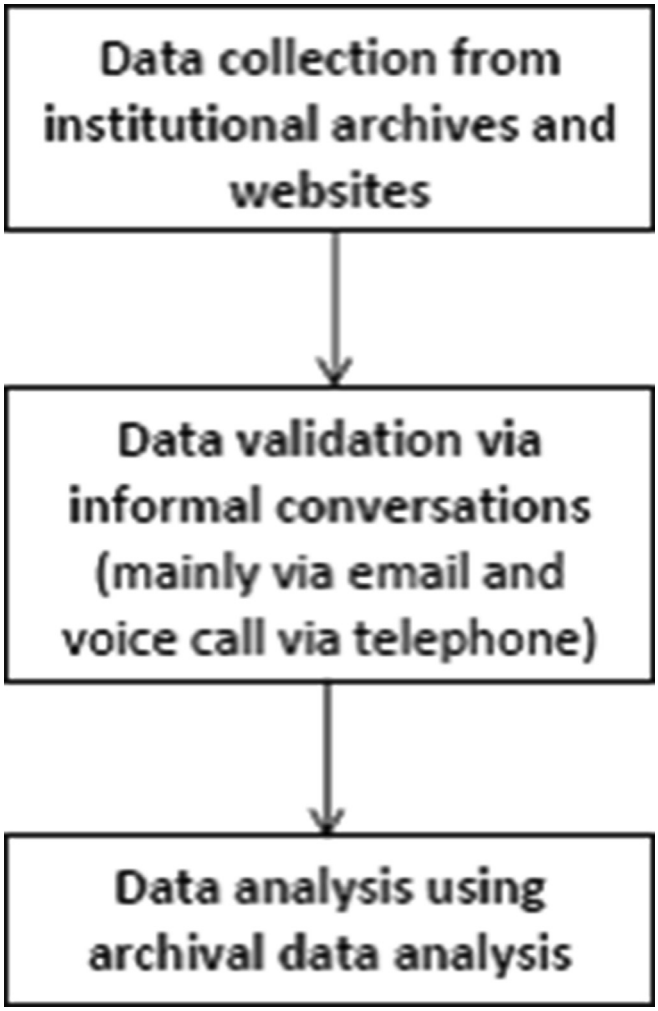

Figure 2. Research design process.

Table 1. Anonymized stakeholder groups, their expertise and date of interview.

s/n	Anonymized stakeholder group	Experience/Expertise	Interview/ discussion date
1	Decentralized electricity provider	Involved in the provision of decentralized renewable energy infrastructure	March 2020
2	Decentralized electricity planner	Responsible for rural electrification planning and infrastructure provision	April 2020
3	Utility-scale transmission company	Involved in the management and operation of centralized transmission grid	April 2020
4	Utility-scale generation company 1	Involved in the electricity generation for centralized grid connection.	March 2020
5	Utility–scale distribution company 2	Involved in the operations and management of centralized distribution grid.	April 2020
6	Multi-lateral energy financier 1	A major multi-lateral agency supporting energy-related projects	March 2020
7	Multi-lateral energy financier 2	A major multi-lateral agency supporting energy-related projects	April 2020
8	Multi-lateral agency 1	A major multi-lateral agency supporting energy-related projects	April 2020.

The Nigerian electricity supply industry is still at the transitional electricity market stage. The current market structure comprises some key stakeholders such as the generation companies, the transmission company of Nigeria, distribution companies, the bulk electricity trader, gas companies, financiers and electricity consumers. Figure 3 shows a network of players in the current Nigerian electricity market structure, highlighting the commodity (energy and gas) money/cash flows. The following sub-sections provide further details on the essential characteristics of the various electricity market stages.

3.1. Pre-transition stage

The pre-transition phase was characterized by a monopolistic market structure with a wholly state-owned initial holding company called the Power Holding Company of Nigeria (PHCN). The PHCN was established to take over the assets and liabilities of the National Electric Power Authority (NEPA) which was the only player in the Nigerian electricity market. An independent electricity sector regulator called the National Electricity Regulatory Commission (NERC) was also created at this phase to regulate the electricity sector reform programme and attract private investor participation.

3.2. Transitional electricity market stage

The Transitional Electricity Market phase was designed to closely resemble the oligopolistic market structure after the Power Holding Company of Nigeria (PHCN) was unbundled into successor companies with the exclusive rights to carry out the functions relating to the generation, transmission, trading, distribution, bulk supply and resale of electricity.

An oligopoly market consists of a small number of large companies that sell differentiated or identical products. Since there are few players in the market, their competitive strategies are dependent on each other. The PHCN was unbundled into 18 companies, made up of 6 generation companies, one transmission company and 11 distribution companies (as shown in Figure 4). Arguably, the successor companies were not created to compete against each other. Rather, the EPSRA empowered them to work like monopolies in clearly mapped out geographical areas for the distribution companies and assurances that generated power will be bought from the generation companies. In a way, the successor companies in the transitional electricity market phase operate as cartels.

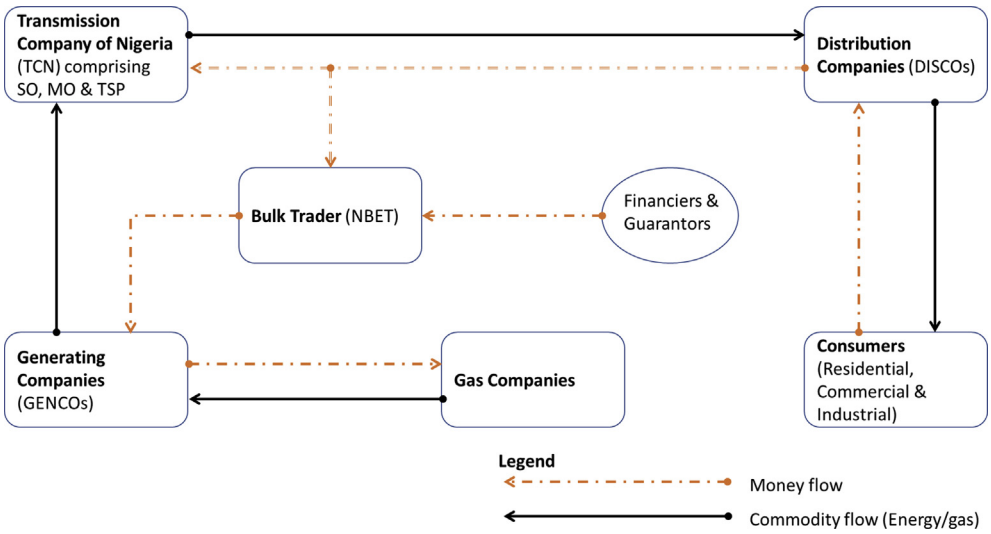

Figure 3. Transitional electricity market structure of the Nigerian electricity supply industry.

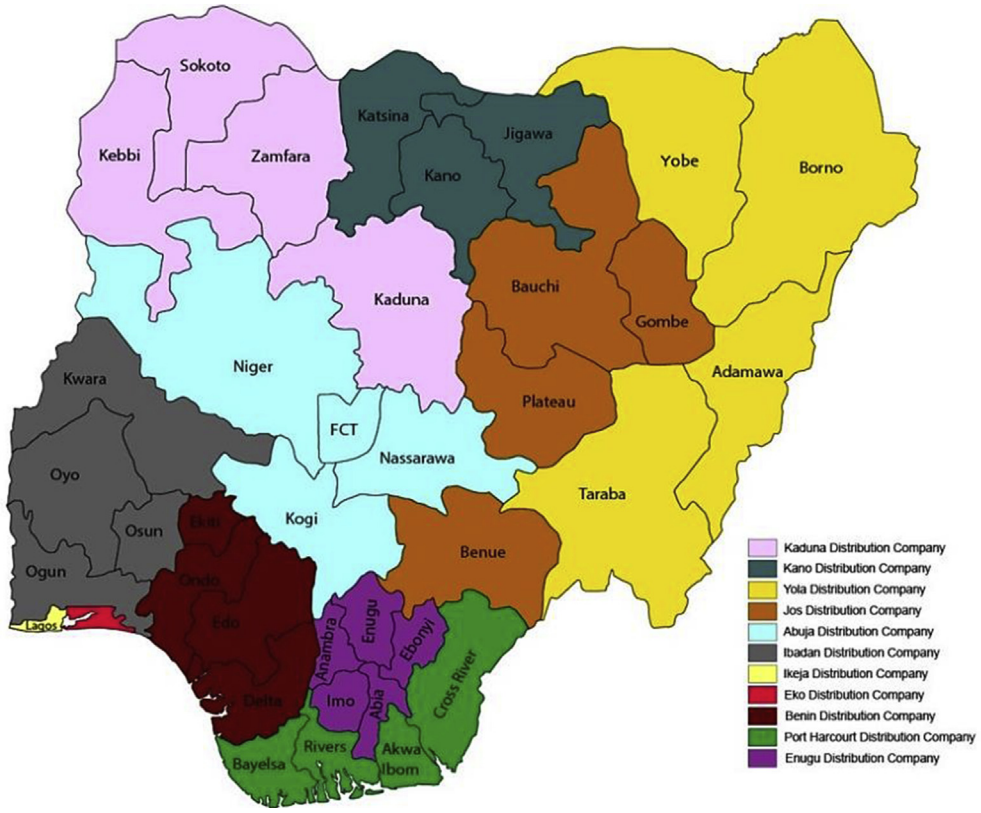

Figure 4. Distribution companies in Nigeria and their coverage area (Source: [39]).

Indeed, the Nigerian electricity supply industry is still at the transitional electricity market stage.

3.3. The medium market stage

This medium market stage would be characterized by a partly regulated and a partly unregulated market. Regulated prices will be dominant for the transmission and distribution segments based on building blocks and regulated loads. At this stage, the generation segment will be partly regulated based on wholesale contracts that match the regulated load.

3.4. Long term market stage

This market stage would be characterized by a case of perfect competitive market. The generation segment of the industry would be completely unregulated and electricity trading would be based on bilateral contracts. The transmission and distribution segments of the industry would experience regulated electricity prices based on building blocks while the electricity retail segment would have an unregulated pricing regime with all loads as contestable [38]. The fully competitive electricity market would be characterized by economic pricing of electricity that allows for full recovery of cost of electricity supply. Table 2

Table 2. Stages of the Nigerian electricity market (source: Adapted from [38]).

Market Segment	Market Stages		
	Transitional Electricity Market stage	Medium Electricity Market stage	Long-Term Electricity Market stage
Generation	Regulated prices using Wholesale Contracts based on life cycle cost of an efficient new entrant	Part unregulated (based on bilateral contracts)	Unregulated (based on bilateral contracts)
		Part regulated based on Wholesale contracts (matches the regulated load)	
Transmission	Regulated prices using building blocks	Regulated prices using building blocks	Regulated prices using building blocks
Distribution	Regulated prices using building blocks	Regulated prices using building blocks	Regulated prices using building blocks
		Regulated prices for the regulated load	Unregulated prices (all load is contestable)
Retail		Unregulated prices for the contestable load	

shows a summary of the various stages of the Nigerian electricity market development and what each stage entails.

4. Stakeholder mapping and categorization in Nigeria's electricity sector

Stakeholders at national and subnational levels play vital roles within the context of societal challenges associated with energy [40]. Stakeholders in the Nigerian electricity sector can be categorized into two major groups:

1. *Decision-making stakeholders* that are directly involved in decision making on electricity supply, provision, operation, management and upgrade of network infrastructure, mostly made up of regulatory agencies and utility companies with government interests [14, 41].
2. *Non-decision making stakeholders* (influencers) comprising environmental and consumer advocacy groups, energy consumers, some energy generators, private citizens and the renewable energy technology industry [31].

Within the decision-making stakeholder domain, there are those involved in decisions on *centralized* and *decentralized* electricity systems [42, 43]. While the non-decision making stakeholders experience more difficulty in influencing decisions in centralized electricity systems, their influence in the decentralized electricity space is more pronounced due to distributed political power that decentralized energy sources (particularly renewables) confer [44, 45].

The key decision-making stakeholders in the Nigerian electricity sector involved in decision making for centralized electricity systems comprises: the various generation companies that supplies electricity to the national grid; the Transmission Company of Nigeria (TCN); eleven distribution companies; and the Nigerian Electricity Regulatory Commission (NERC). Within the decentralized energy space, the Rural Electrification Agency plays a vital role in the provision of decentralized off-grid electricity solutions across Nigeria, particularly in rural communities without access to the electricity grid.

Several non-decision making stakeholders who are great influencers with considerable political power have been instrumental in engaging with government to ensure the right frameworks and policies were adopted to enable and accelerate provision of decentralized (renewable) energy sources. Examples of these frameworks include stakeholder engagement forums that led to the production of the Electric Power Sector Reforms Act (EPSRA), the National Energy Master Plan (NEMP) and the 2008 Electricity Master plan. Some of these stakeholders include: *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) [46]; the United States Agency for International Development (USAID) through the Power Africa program [47]; and other financing and donor agencies for both centralized and decentralized electricity infrastructure such as the World Bank, African Development Bank (AfDB) [48], European Union (EU), among others. Figure 5 shows a mapping of key stakeholders within the Nigerian electricity sector. It shows where (and at what level) each stakeholder tries to exert some influence in the decision making process on energy infrastructure provisions.

4.1. Grid-connected generation companies (GenCos)

The history of electricity infrastructure provisions dates back to the late 1800s, with the first power plant built in 1896 in Lagos [23, 49]. Since then, several electricity generation plants have been built and connected to the national grid. Most historical investments in grid-connected electricity generation plants have been state-funded projects. This includes coal-fired power plants that started-off in full scale in the 1920s, to hydropower plants that kicked-in from the 1950s, and later petroleum and gas based thermal power plants starting from the 1980s [18,50]. Decentralized renewables, through various off-grid and on-grid solutions kicked-in from the 2000s. Indeed, it was the liberalization and privatization of the electricity sector (which started in the 2000s) that provided the framework for private sector participation and investments in the Nigerian electricity sector [35, 51, 52].

Most of the petroleum or gas-fired thermal power plants have indeed been fully privatized while the three major hydropower plants (namely Kainji, Jebba and Shiroro plants) are currently managed under a long term concession agreement. The three hydropower plants mentioned accounts for 15–20% of electricity generation output in Nigeria [53]. The electricity generation sub-sector currently comprises about twenty-four grid-connected generating plants with an approximate total installed generation capacity of 10,800MW. Table 3 shows a list of the twenty-four grid-connected electricity generation plants in Nigeria and the approximate electricity installed capacity for each plant [54]. The figures presented in Table 3 are subject to variations due to simultaneous on-going expansion and upgrade projects in most power plants. The values presented are not exact but indicative.

The study revealed that the main interest of the players in the electricity generation sub-sector lies in the efficient generation and supply of electrical energy (at least in theory). However, in practice, their interest tends more towards making the highest possible margins without much regard for efficiency. They exert their influence in a manner that ensures they are able to evacuate the electrical energy produced and get adequate compensations for it. From a political standpoint, they try in whatever ways possible to ensure that the laws and regulations stand in their favour, particularly regulations around gas supplies to power plants and guarantees by the Transmission Company of Nigeria to evacuate all electrical power produced through the transmission grid [56, 57].

Indeed, a major challenge plaguing the electricity generation sub-sector is the inability of most generating companies to produce electricity at a rate close to the nameplate value of the power plants. Some players argue that aside the challenge of lack of funds to take on some necessary efficiency and upgrade projects for the power plants, a major challenge has been the low electricity wheeling capacity of the Transmission Company of Nigeria (TCN) of only 5,000MW [58, 59, 60]. Indeed, they argue that there is no incentive for them to produce more, or invest in increasing production capacity of the power plants, where there is no adequate means of evacuating the excess power generated. This is a major factor that explains the difference between installed capacity and actual generation capacity of the generation plants as shown in Table 2.

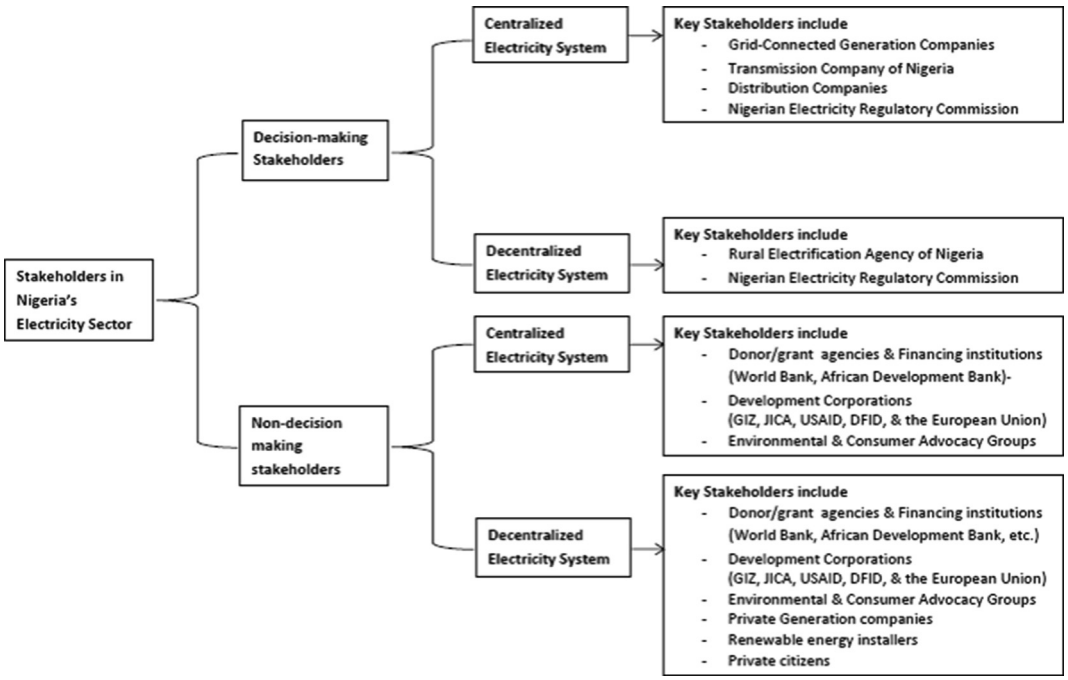

Figure 5. Stakeholder mapping of Nigeria's Electricity Sector (Source: Author compilation).

Table 3. List of grid-connected electricity generation plants in Nigeria (Source: Adapted from [55]).

	Name of Power Plant	Installed Capacity (in MW)	Actual Generation Capacity (in MW)	Fuel type
1	AES	270	0	Gas
2	AFAM IV – V	580	0	Gas
3	AFAM VI	980	523	Gas
4	Alaoji NIPP	335	110	Gas
5	Delta (Ugheli Power)	465	300	Gas
6	Egbin	1020	502	Gas
7	Geregu	414	138	Gas
8	Geregu NIPP	434	90	Gas
9	Ibom Power	191	92	Gas
10	Ihovbor NIPP	450	225	Gas
11	Jebba	578	255	Hydro
12	Kainji	760	181	Hydro
13	Okpai	480	391	Gas
14	Olorunsogo	336	232	Gas
15	Olorunsogo NIPP	675	87	Gas
16	Omoku	150	0	Gas
17	Omotosho	336	178	Gas
18	Omotosho NIPP	450	90	Gas
19	Rivers IPP	166	0	Gas
20	Sapele	135	81	Gas
21	Sapele NIPP	450	116	Gas
22	Shiroro	600	350	Hydro
23	Odukpani	70	0	Gas
24	Azura	450	0	Gas
	TOTAL	**10,775**	**3,941**	

4.2. The transmission company of Nigeria (TCN)

The Transmission Company of Nigeria is a government-owned company with responsibility for management, expansion, rehabilitation and maintenance of the Nigerian electricity transmission grid. Following the liberalization and unbundling of the Nigerian electricity sector, the TCN remained the only company (out of the eighteen successor companies) that retained government ownership. Manitoba Hydro International (MHI) had responsibility for the management and operations of the TCN (based on a four year contractual agreement) until 31st August 2016.

In February 2017, the TCN established a Transmission Rehabilitation and Expansion Program (TREP), a development objective targeted at expanding the electricity transmission wheeling capacity from 5000MW to 22,000MW by 2022 and stabilizing the grid to provide necessary flexibility and redundancies [60]. The TREP objective of the Transmission Company of Nigeria was anchored around four main pillars [60]:

- Achieving systems frequency control through automatic monitoring and speed control of generators in response to changes in demand
- Provision of adequate spinning reserve, which is the generating capacity that is connected but is not being used, otherwise referred to as the unused capacity of the system. This is important for making up for changes in electrical load demand
- Provision of functional Supervisory Control and Data Acquisition (SCADA) required for systems operations, monitoring and effective grid management.
- Investments in expansion and rehabilitation of transmission lines and substations.

The main interest of the TCN would be the adequate evacuation of electrical energy produced at the various power plants and subsequent injection of electrical power transmitted into the various distribution networks around the country. The operation, expansion, rehabilitation and maintenance of the electricity transmission grid are all aimed at achieving this goal in a more economical way. Figure 6 shows the map of the national electricity transmission grid of Nigeria. Indeed, the TCN has three operational departments as outlined below [61]:

- **Transmission Service Operator** (TSO), responsible for the physical infrastructure of the transmission grid and oversees the maintenance and development of electrical transmission infrastructure, including grid expansion (of power lines and substations).
- **System Operator** (SO), responsible for reliability and technical stability of the transmission grid. It achieves this through operational

Figure 6. National electricity transmission grid of Nigeria (Source: [61]).

planning, despatch and control of grid electricity flow from generation to distribution.

- **Market Operator** (MO), responsible for administration of the electricity market while promoting efficiency and the market rules.

The TCN's aggressive expansion and rehabilitation of the transmission lines across Nigeria also includes the provision of more substations. According to the interviewees, management outsourcing of the TCN to Manitoba Hydro International, lack of leadership on transmission infrastructure planning and lack of funds were factors that delayed these interventions. Since early 2018, the TCN had adopted three important simultaneous steps in addressing the transmission grid challenges using in-house skilled manpower to complete some abandoned installations. These steps include:

- Installation of transformers;
- stringing of transmission lines; and
- Assisting contractors to complete various projects.

Since 2017, the TCN had been able to resuscitate and complete some abandoned transmission line projects. As provision of necessary electricity transmission infrastructure is important for the effective evacuation of electrical power produced at the various power plants, the TCN adopted a measure of upskilling their in-house installation and maintenance staff to take on the responsibility of completing some abandoned installations of critical transmission substations. Table 4 shows a list of transformers installed by the staff of the TCN between 2018 and 2019 at various substations across Nigeria [62]. These initiatives were supported and financed by some donor agencies as presented later in section 5.

4.3. Distribution companies (Discos)

The distribution companies (Discos) have responsibility for making electrical power available to the end-users. There are eleven distribution companies in Nigeria. The various distribution companies and their geographical areas of coverage are shown in Table 5.

Arguably, the distribution companies have been very active in challenging the tariff regime as being non-cost reflective. They have had the continuous battle of dealing with numerous energy consumer challenges

Table 4. Substation transformers installed by the Transmission Company of Nigeria in-house staff (Source: Transmission Company of Nigeria).

	Location	Transformer Capacity
1	Dambua 132/33kV Substation	1 X 40MVA
2	Aja Lagos 330/132/33kV Substation	1 X 60MVA
3	Aja Lagos 330/132/33kV Substation (Mobile)	1 X 60MVA
4	Ejigbo 132/33kV Substation	1 X 40MVA
5	Umuahia 132k/33kV Substation	1 X 40MVA
6	Zaria 132/33kV Substation	1 X 40MVA
7	Funtua 132/33kV Substation	1 X 60MVA
8	Gombe 132/33kV Substation	1 X 30MVA
9	Auchi 132/33kV Substation	1 X 40MVA
10	Ilashe 132/33kV Substation	1 X 40MVA
11	Dan Agundi (rehabilitated burnt transformer)	1 X 60MVA
12	Ayede (Ibadan)	1 X 60MVA
13	Egbin Substation in Lagos	1 X 30MVA
14	GCM Onitsha	1 X 60MVA
15	Benin Transmission Substations	2 X 60MVA
16	Kumbotso	1 X 150MVA
17	Kubwa	1 X 60MVA
18	Kankia	1 X 30MVA

including energy theft, meter tampering and non-payment of energy bills [63]. However, in Nigeria many electricity consumers do not trust the distribution companies because they fail to meter their customers and they present estimated billings whose metric is unintelligible, complex, and in the final analysis amounts to a fraud.

Infrastructure challenges across the electricity distribution value chain have been a major cause of concern with poorly maintained distribution infrastructure leading to several forms of operational loses. Indeed, operational energy capacity is lost through various forms of technical loses (such as loses from cores and windings of transformers, cables, and other loses in the distribution system) which accounts for 16% of losses; while non-technical loses (from meter tampering, bypassing, faulty meters, false readings, and other human errors) accounts for 30% of losses [64, 65]. Total operational (technical and

Table 5. Distribution companies in Nigeria and their geographical coverage (Source: Nigerian Electricity Regulatory Commission).

Distribution companies	Geographies Covered
Abuja Disco	FCT, Niger, Nassarawa, Kogi
Benin Disco	Edo, Delta, Ekiti, Ondo
Enugu Disco	Imo, Anambra, Ebonyi, Abia, Enugu
Eko Diso	Lagos State (Victoria Island, Lekki, Lagos Island, Apapa, Ikoyi, etc)
Port Harcourt Disco	Rivers, Bayelsa, Cross Rivers, Akwa Ibom
Ibadan Disco	Oyo, Ogun, Osun, Kwara
Ikeja Disco	Lagos State (Ikeja, Surulere, Ikorodu, etc)
Jos Disco	Plateau, Bauchi, Benue, Gombe
Kano Disco	Kano, Jigawa and Katsina
Kaduna Disco	Kaduna, Sokoto, Kebbi and Zamfara
Yola Disco	Adamawa, Borno, Taraba and Yobe

non-technical) loses account for about 46% of loses on Nigeria's distribution network [66], compared with an average of 2–12% in the European Union countries and about 8% in South Africa [67].

Other salient issues such as energy theft and lack of cost reflective tariff also plague the electricity distribution subsector. Arguably, about 47% of pre-paid meters are by-passed in Nigeria [63]. This is a worrisome situation not only in Nigeria but in sub-Sahara Africa [68]. Nigeria's electricity tariff is not cost reflective as it does not consider the true cost of electricity generation [69]. The current tariff regime has a lot of government interventions (in the form of subsidies) along the electricity production value chain. Indeed, since electricity networks need significant investment to build and maintain, how do we generate funds to maintain existing electricity network infrastructure within a non-reflective energy tariff regime? How will investors recoup their investment costs and make some returns? Table 6 provides a summary of the distribution network infrastructure in Nigeria as of year-end 2019.

4.4. Nigerian Electricity Regulatory Commission (NERC)

The Nigerian Electricity Regulatory Commission (NERC) is a regulatory agency established under the Electrical Power Sector Reforms Act (2005) with the responsibility of establishing market rules and operating guidelines within the Nigerian electricity sector. It also has responsibility for the monitoring and regulation of activities within the Nigerian electricity industry.

As a regulator, the NERC ensures there is a fair and competitive electricity trading regime. The NERC achieves this through the Multi-Year Tariff Order (MYTO) which establishes and defines generation and consumer offtake prices. The NERC also has responsibility for reviewing and granting licenses for independent power plants greater than 1MW [46].

Table 6. Distribution network infrastructure in Nigeria (Source: Author compilation).

Equipment	Unit	Primary side Voltage (kV)	Secondary side Voltage (kV)	2018
Number of Customers				7,476,858
Injection Substations (IS)	#	33	11	729
IS Transformers	#	33	11	1,373
IS Transformer Capacity	MVA	33	11	12,628
Distribution Transformers	#	11,33	0.4	97,548
Distribution Substation (DS) Transformer Capacity	MVA	11,33	0.4	26,451
Distribution Transformers	#	33	0.4	16,761
DS Transformer Capacity	MVA	33	0.4	5,935
Distribution Transformers	#	11	0.4	80,787
DS Transformer Capacity	MVA	11	0.4	20,515
Transmission Length	Km	33,11		95,194

4.5. Rural Electrification Agency (REA)

The rural electrification initiative was first initiated in 1981 with the aim of extending the national grid to more towns and villages across the various local government areas in Nigeria. This programme was managed by the National Electric Power Authority (NEPA) in conjunction with the Federal Ministry of Power. In 2006, following the reforms in the electricity sector, the Rural Electrification Agency (REA) was established and charged with the responsibility of providing reliable electrical power to rural communities in Nigeria, irrespective of location. The REA has the mandate of:

- Promoting rural electrification in the country;
- Coordinating rural electrification programmes; and
- Management and administration of the Rural Electrification Fund (REF).

The study revealed that the REA has been championing the provision and utilization of decentralized off-grid electricity infrastructure to increase access to electricity through a centrally coordinated, demand driven and market oriented approach. The REA supports economic development and energy access through four main initiatives as highlighted below:

- **Stand-alone systems** – targeted at customers in remote locations with low electricity loads and low ability to pay. The aim is to support the provision of basic critical energy services and infrastructure alternatives that are better than the ones that are currently in use.
- **Minigrids** – are targeted at communities with electrical loads of less than 1MW. The aim of most minigrid projects championed by the REA is to promote economic activities in communities and to improve interconnection potential [22, 70].
- **Energizing education** – targeted at providing electricity to government owned tertiary institutions (particularly federal universities), teaching hospitals and neighbouring communities close to these institutions. This is achieved through the provision of solar hybrid and gas-fired independent power plants. The REA targets, through this initiative, to support and improve educational quality in Nigeria.
- **Energizing economies** – targeted at providing electricity to economic clusters with high commercial activities and economic growth potential. The REA's aim is to replace diesel generators in those economic clusters with centralized generation plants to provide electricity to support growth of micro, small and medium enterprises.

The REA, through several financial interventions and funding facilities from multilateral agencies and institutions, have been working on achieving the aims of the aforementioned initiatives. The World Bank's $350 million funding intervention facility approved in 2018 was a major stimulus for the swift execution of some of these initiatives [71]. Several projects funded by this facility are at different levels of completion (with some fully commissioned and in use) [72, 73]. The World Bank facility was targeted for the following uses:

- $150 million for minigrid projects comprising $70 million competitive bidding for portfolios of minigrid sites and $80 million for connecting new customers
- $75 million for Solar Home Systems (SHS) comprising $15 million accelerator grants to high-potential importers/distributors and $60 million output based grants
- $105 million for university and teaching hospital power systems targeted at 37 federal universities and 7 affiliated teaching hospitals.

- $20 million technical assistance fund for institutional support for the REA, investment pipeline development, regulatory support and financing needs assessment, among others.

The REA also leverages on other forms of private sector and donor support from various financing and development agencies to achieve their objectives.

4.6. Multilateral development corporations and donor agencies

Several multilateral and donor agencies have shown varying degrees of interest in the Nigerian electricity sector. Indeed, groups such as the World Bank, African Development Bank and other international financial institutions see a lot of development prospects in the Nigerian electricity sector. Inasmuch as it is argued that the Nigerian electricity market is unlikely to be profitable due to difficulty to change poor practices and less willingness to pay for electricity bills, a major motivation for the donor agencies lies in the high prospect for empowerment and improving livelihoods when energy is channelled towards productive use [74].

Arguably, the interests of some international development agencies has traditionally been aimed at providing new markets and expanding the reach of local businesses of their countries of origin. The *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) of the German government, the Department for International Development (DFID) of the British government, the United States Agency for International Development (USAID) of the United States government, the European Union (EU) (generally perceived as a body with neutral interests), the Japan International Cooperation Agency (JICA) of the Japanese government, and the French Development Agency (*Agence Française de Développement*, AFD) of the French government are the main international development agencies that are active in the Nigerian electricity sector. Indeed, within the centralized electricity infrastructure space, these development agencies exert their influence in the form of grants for technical support and assistance which are oftentimes provided by businesses from the countries they represent. The grants end up as payments for technical assistance/support and payments for the supply of equipment, materials and machines [75]. Arguably, this practice is possible and has been entrenched when there is limited local expertise available.

In the renewables space, most financial aid (particularly around solar infrastructure provision and expansion projects) have come through international agencies representing countries where there was high production level for solar PV solutions and solar home systems. Undoubtedly, the Chinese solar-PV dominated market in Nigeria is a result of retail activities by local businesses taking advantage of lower purchase and importation costs of such systems from China [76].

Many of these agencies have influenced several developments experienced within the Nigerian electricity sector in different ways. The Department for International Development (DFID) influenced the co-development of frameworks to enable government institutions and other private players within the electricity sector function properly. These influences, which come in form of interventions, include: support to the Nigerian Electricity Regulatory Commission (NERC) in the establishment of an investor-friendly electricity industry with efficient market structure that responds to the needs of Nigerians to deliver safe, reliable and affordable electricity; the Rural Electrification Agency (REA) in the establishment and implementation of a rural electrification strategy to address the energy needs of rural communities not connected to the grid; among others.

The United States Agency for International Development (USAID), through the Power Africa initiative supported the development of several initiatives in Nigeria's electricity sector. They exerted their influence through the provision of technical and financial support for the unbundling process of the Power Holding Company of Nigeria (PHCN), technical assistance to the Nigerian Bulk Electricity Trader (NBET) and support for the establishment of Independent Power Producers (IPPs). They have also been very active in providing funding for the provision of on-grid and off-grid renewable energy infrastructure such as solar home systems, among others.

The *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) has been very active in the Nigerian electricity sector since the planning phase of the sector's liberalization process. The GIZ was at the forefront of the Nigerian Energy Support Programme (NESP), providing support for the assessment and evaluation of various electricity planning and policy reviews through data collection and assessment. This support provided the Nigerian government an opportunity to strengthen existing regulations or to formulate new ones that provides an investor-friendly electricity market. Indeed, the GIZ have also been a major partner of the Nigerian government in addressing barriers to investment in renewable energy and energy efficiency initiatives.

Other development agencies such as the French Development Agency (Agence Française de Développement, AFD) and the Japan International Cooperation Agency (JICA) also played important roles in influencing certain infrastructure decisions which are explored in the next section. Table 7 show a summary of selected international development agencies, their country of origin and their vital areas of influence within the Nigerian electricity sector.

4.7. Energy consumers

The Nigerian energy consumers have been the recipient of a long-standing electricity subsidy regime that manifests itself in various forms of subsidy along the electricity production value chain. Edomah, in his book on *Electricity and Energy Transition in Nigeria* argues that there are four major electricity consumer categorizations based on their political consumption dynamics which is expressed in their willingness-to-pay and ability-to-pay for electricity bills as shown on the matrix in Figure 7 [18].

Consumer group 1 are those energy consumers who are willing-to-pay but unable-to-pay for electricity bills. Their inability to pay is mainly due to their poor economic conditions (which is transient). They appreciate the value that energy services confer and are willing to pay what they can afford within their limited resources. Their willingness to pay is reflected in the actual payment of part of the electricity bills received [18]. Following an assessment of electricity consumers within the geography of one of the distribution companies, this group represents about 35% of energy consumers. Figure 8 shows (in percentages) the various energy consumer categories in Nigeria based on their willingness and ability to pay for energy bills.

Consumer group 2 are those who are willing-to-pay and able-to-pay. This group of energy consumers value the benefits that energy services confer and they actually pay for those services promptly. They do not engage in some unethical practices such as energy theft. For this consumer group, the utility companies incur less administrative cost for bill collection. The utility companies, where possible, tries to prioritize electricity supplies to those geographies where this consumer group are dominant. This group constitutes about 20% of energy consumers [77].

Consumer group 3 comprise of energy consumers who are unwilling-to-pay but are able-to-pay for electricity bills. They constitute a challenge for the utility companies. It is within this consumer group that you find those involved in many unethical practices such as energy theft, meter tampering, etc. The challenge the utility companies at the slightest opportunity through various means, including litigation. In response, some utility companies retaliate by ensuring that those geographical locations where this consumer group are dominant do not get priority attention once electric power is available [18]. This group comprises about 25% of energy consumers.

Consumer group 4 comprises energy consumers who are unwilling-to-pay and are unable-to-pay. Poor economic conditions are the main reason for the inability of this consumer group to pay for electricity bills. Their unwillingness to pay stems from the idea they have that electricity infrastructure is a right and ought to be provided at no cost by the government to its citizens. It is possible that the unwillingness to pay for

Table 7. Selected development agencies in Nigeria and their areas of influence (Source: Authors compilation).

Development agencies and corporations	Country of origin	Areas of influence and interventions in Nigeria's electricity sector
Department for International Development/United Kingdom Agency for International Development (DFID-UKAID)	United Kingdom	- Assisted in conducting customer enumeration surveys for the distribution companies - Supported the Nigerian Electricity Regulatory Commission (NERC) in developing a guideline for the measurement, verification and communication of aggregate commercial, technical and collection losses on the distribution networks - Provided support in the assessment of the financial strength and viability of the distribution companies to determine liquidity, solvency, profitability and capital adequacy. - Supported the NERC to develop a framework for processing customer complaints. - Assisted the Rural Electrification Agency (REA) to conduct an energy audit of rural communities to provide data at household levels that will feed into the mini-grid tender program. - Developed a monitoring and evaluation framework for the REA - Developed with the REA an implementation approach to deliver the rural electrification strategy.
United States Agency for International Development (USAID-Power Africa)	United States	- Assistance in the unbundling process of the Power Holding Company of Nigeria (PHCN) - Assisted the first independent power producer (IPP), Azura Edo Project in 2015 to reach a financial close. - Provided technical assistance to the Nigerian Bulk Electricity Trader (NBET) - Assisted the Nigerian government to finalize power purchase agreements to some utility-scale solar IPPs - Providing project preparation assistance to some distribution companies on reducing technical and commercial losses while modernizing their network - Development of ≈3000MW electricity generation projects
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	Germany (European Union)	- Supported data assessment and electrification planning which served as a basis for policy reviews and the provision of private sector market intelligence - Supported the strengthening of regulations which served as the basis for improving access to sustainable (on-grid and off-grid) electricity sources. - Supporting the government in the provision of an enabling environment to support investments in renewable energy and energy efficiency measures and quality standards.

electricity bills by this consumer group may change if their economic conditions improve. This group comprises about 20% of energy consumers [77].

4.8. Civil society and advocacy groups

The civil society is a complex domain of heterogeneous non-market activity operating outside the state [78]. It encompasses trade unions, business associations, non-governmental organizations, social movements, cooperatives, professional associations and voluntary community groups that hold government and businesses accountable by making demands and pressing for just rights to be respected. They can generate pressures that unsettle incumbent energy regimes which in turn force decision makers and other stakeholders to act.

Energy advocacy groups play a vital role in the energy access conversation through the championing of solar off-grid energy solutions within decentralized electricity systems. They are also active in the discourse and debates on implementing a just energy transition that addresses the needs of the most vulnerable groups in society. In defining energy advocacy, Roberts argues that:

> "Energy advocacy is any activity designed to persuade a third party to make a decision or a change that ameliorates or improves the market situation of consumers of energy, particularly small to medium consumers" [79] (pg. 3).

An understanding of the socio-political environment is important for effective energy advocacy. Roberts argues that there are four important factors necessary for modelling interactions for energy advocacy. These are [79]:

1. Having a sound understanding of consumer needs and how the market affects them
2. Reconciling different consumer needs and issues with diverse consumer groups
3. Focusing on consumer goals which implies taking responsibility to initiate action and respond to threats
4. Building a constituency for change while persuading decision makers to work towards one's goals.

Indeed, the aforementioned factors stress the importance of skills, know-how, contexts and relationships as critical infrastructure required for effective energy advocacy. Within the Nigerian electricity space, there are three important groups that have played a vital role in defining policy direction on grid-connected and off-grid electricity sources. These groups are:

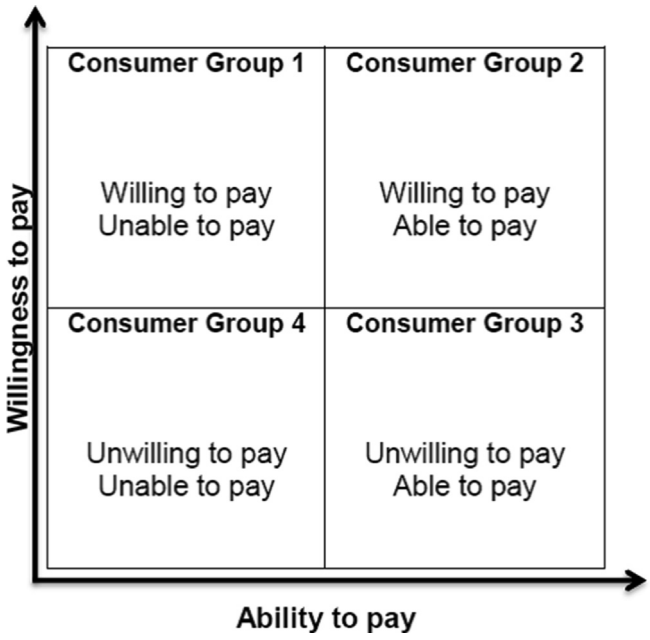

Figure 7. Four different energy consumer groups in Nigeria (Source: [18] (pg. 113)).

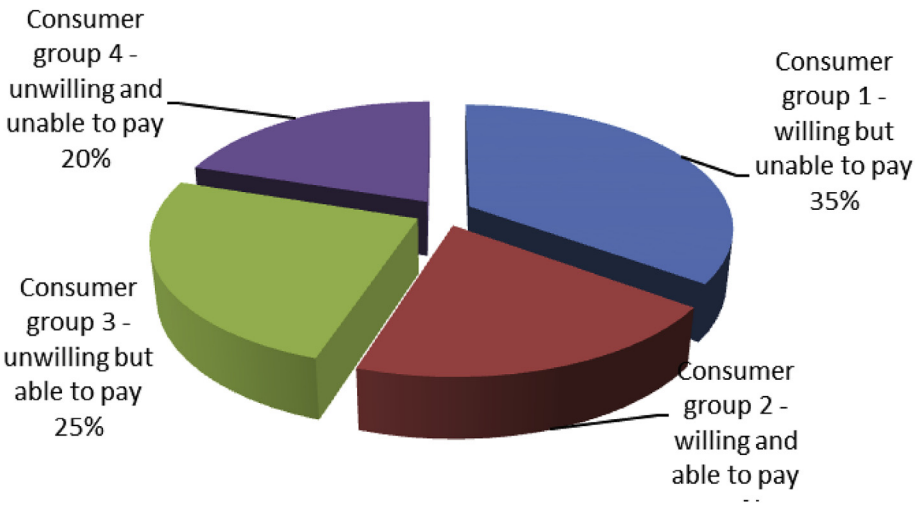

Figure 8. Willingness and ability to pay of energy consumers in Nigeria (expressed in percentages).

1. The Nigerian Economic Summit Group (NESG)
2. Heinrich Boll Stiftung (HBS) Foundation
3. The Nigerian Renewable Energy Roundtable (NiRER)

The Nigerian Economic Summit Group (NESG) is a private sector-led think thank and policy advocacy group. It is an apolitical, non-partisan, not-for-profit organization whose mandate is to champion economic reforms through an open private sector-led economy that improves Nigeria's competitiveness. The NESG have contributed immensely to national development through the establishment of several policy commissions targeted at addressing issues of policy (implementation) deficit across various sectors of the Nigerian economy. Some of these policy commissions include; energy, science and technology, manufacturing and solid mineral development, agriculture and food security, sustainability, governance and institutions, among others.

The Heinrich Boll Stiftung (HBS) foundation is a German public policy think tank, affiliated with the German Green Party, whose aim is to develop and respond to issues on ecology and sustainability, democracy and human rights, and self-determination and justice by promoting non-violence and proactive peace policies in the regions where they operate. The HBS in Nigeria have been active in projects which include climate and ecology, sustainability, energy policy and governance, among others. They were instrumental in conducting a study on the true cost of electricity generation from various sources in Nigeria in 2017 (together with the NESG) whose output led to the formation of the Nigerian Renewable Energy Roundtable (NiRER) [80].

The Nigerian Renewable Energy Roundtable (NiRER) was established in 2017 as a partnership of relevant stakeholders in government departments, private sector, civil society and academia to resolve issues that limit the expansion of on-grid and off-grid renewable energy market in Nigeria. NiRER has been instrumental in effecting a call for an effective policy framework and smart financing mechanisms for the development of renewable energy sources in Nigeria. This has led to renewed efforts in the production of a new renewable electricity bill.

Indeed, these three groups have been working together in many ways with relevant stakeholders to address some challenges within on-grid and off-grid electricity systems. They jointly conducted a study on renewable energy legislative gap analysis in Nigeria which now paves the way for the introduction of a new renewable electricity bill.

4.9. Renewable energy installers

Renewable energy installers form a vital part of the renewable energy value chain. They serve as enablers in providing and guaranteeing employment along the value chain. The renewable energy value chain encompasses various aspects of: manufacturing and distribution of renewable energy equipment; project design and development; civil construction works associated with renewable energy deployment and development; installation and site services for renewable energy infrastructure; operation and maintenance of renewable energy infrastructure; and a wide range of cross-cutting activities and services at the end-use/final consumer section of the value chain [81].

Installers of renewable energy solutions also play a vital role in mainstreaming renewable solutions within decentralized electricity systems. Over the years, they have been gaining momentum in influencing the deployment of renewable energy solutions (particularly solar) through various channels. A prominent way is through the formation of various associations that can be used as a channel to make their issue position felt and heard. Examples of such associations include: the Abuja Solar Systems Dealers and Installers Association (ASSDIA), whose aim is to promote the personal and business interest of their members while making their voice heard in the decision making sphere where solar energy decisions are made; the Renewable Energy Association of Nigeria (REAN), whose interest is to promote strategies that will improve renewable energy deployment in order to achieve 30% of Nigeria's energy mix by 2030 using renewables such as solar, wind power, hydroelectric power, bioenergy and geothermal energy; among others.

Indeed, several renewable energy installers through REAN exercise some influence by working closely with the energy policy commission of the Nigerian Economic Summit Group and the Nigerian Renewable Energy Roundtable. These groups are regularly consulted by the Nigerian government on policy (implementation) related matters since they are mostly private sector-led, with competent technocrats that can provide insights on addressing policy implementation challenges.

5. Financial interventions in Nigeria's electricity sector by external stakeholder groups

Historical engagement with various donor agencies has led to different forms of financial interventions in Nigeria's electricity sector [82]. However, poor implementation has characterized most donor-sponsored projects in the sector. The Transmission Company of Nigeria argues that there are four major implementation challenges for most donor financed projects. These are [83]:

- Lack of adequate supervisory control and oversight function for most donor financed projects
- Slow response of donor agencies to call for procurement requests
- Lack of coordination in project implementation for various state-funded and donor-funded projects

- Historical donor funded projects were not designed to attract the best players in the industry.

In this section, we delve into the dynamics of various forms of interventions in the Nigerian electricity sector by different donor agencies, funding bodies and development corporations. The motives and interests of each agency in the Nigerian electricity sector that led to decisions to intervene through financial intermediation and interventions are also discussed. Indeed, many of the external stakeholders in Nigeria's electricity sector started becoming more active when the liberalization process in the sector started in the early 2000s.

5.1. World Bank interventions in electricity infrastructure upgrades

Arguably, the World Bank Group has shown very keen interest in investing in Nigeria's electricity sector through various forms of financial interventions. In 2018, the World Bank approved an International Development Association (IDA) credit of the sum of $486 million aimed at upgrading the wheeling capacity of the Nigerian electricity transmission grid, including the rehabilitation and expansion of transmission substations across Nigeria [84]. The IDA is an initiative of the World Bank that aims to provide low or zero interest loans for development projects in the world's poorest countries [85, 86, 87].

As of year-end 2019, there were seven active electricity infrastructure projects sponsored by the World Bank where Nigeria has been a primary beneficiary. These projects, the project cost and the approval dates are listed in Table 8.

The World Bank's strategy in Nigeria's electricity sector is entrenched through the provision of funding facility for the purpose of supporting three infrastructure initiatives:

- Electricity grid expansion and rehabilitation
- Gas infrastructure improvement
- Electrification for those without access to the grid.

5.2. African Development Bank interventions in electrification projects

The African Development Bank (AfDB) has been a major stakeholder in providing development assistance financing for several electrification projects. The interest of the AfDB in the Nigerian electricity sector lies in the provision of adequate funding for electricity infrastructure provision that supports economic activities and livelihood of people in communities. The AfDB have provided funding facility to the Rural Electrification Agency (REA) for several rural electrification projects [88] and the Transmission Company of Nigeria (TCN) for the construction and rehabilitation of sections of the electricity transmission grid. The AfDB financial interventions, through the REA, are aimed at increasing access to electricity services for households (particularly in rural areas without access to the electricity grid); micro, small and medium enterprises; and public institutions (including teaching hospitals and tertiary educational institutions). As of year-end 2017, the REA had completed over 2800 projects comprising minigrids, solar standalone systems and solar hybrid solutions [89, 90].

The AfDB provided a facility of the sum of $300 million to the TCN for the purpose of expansion and rehabilitation of existing northern corridor transmission lines particularly in the north-west and north-central regions. This facility aided the construction of three new 330KV DC transmission lines; Kainji–Birnin Kebbi–Sokoto; Katsina–Daura–Gwiwa–Jogana-Kura; and Sokoto-Kaura Namoda-Katsina. The facility also includes the reconstruction of several 330KV substations. Table 9 provides a summary of recent interventions in Nigeria's energy sector.

Another facility provided by the AfDB was a $410 million funding for the Nigerian electricity expansion project to address the electricity transmission challenges mainly along the north-east and south-south geopolitical zones. The facility also provided funding for some pending projects along the north-central and north-west corridors. This facility, among other things, was aimed at the reconstruction of the Alaoji-Owerri-Onitsha and Benin-Ughelli 330KV transmission lines. This facility also aided the provision of 132KV transmission lines and some 330KV substations around the north-central and north-east regions.

Table 8. Selected on-going World Bank financed power projects (Source: World Bank Reports).

s/n	Project title	Country	Project ID	Commitment Amount (in million $)	Approval Date
1	Regional Off-Grid Electrification Project	Western Africa	P160708	150.00	April 17, 2019.
2	Nigeria Electrification Project	Nigeria	P161885	350.00	June 27, 2018
3	Solar Development in Sub-Saharan Africa - Phase 1 (Sahel)	Western Africa	P162580	21.00	July 6, 2018
4	Nigeria Electricity Transmission Project	Nigeria	P146330	486.00	February 15, 2018
5	Nigeria Electricity and Gas Improvement Project (additional financing)	Nigeria	P126182	100.00	June 19, 2012
6	ECOWAS-Regional Electricity Access Project	Western Africa	P164044	225.00	December 13, 2018
7	WAPP-APL4 (Phase 1): Cote d'Ivoire, Liberia, Sierra Leone and Guinea Regional Interconnector-Additional Financing	Western Africa	P163033	122.38	November 17, 2017

5.3. Interventions by foreign development agencies in electrification projects

As of year-end 2019, the Transmission Company of Nigeria had raised the sum of $1,661 million concessionary funding from various donors for the implementation of several grid expansion and electrical substation projects [60, 83]. The changing dynamics of international and foreign aid plays out in a very unique way within the Nigerian electrical power sector [91]. The funding agencies would normally specify how the aid funds should be spent and what projects would be eligible for funding. Table 10 shows some notable recent interventions by some development agencies that have played a vital role within the Nigerian electricity sector.

The French Development Agency (Agence Française de Développement, AFD) is a public financial institution owned by the French government whose aim is to promote and finance development projects in Africa, Asia and the Middle East. It provided a funding facility of $170 million to the Transmission Company of Nigeria for the Abuja transmission ring expansion project. This project entailed the construction and expansion of new 330KV and 132KV transmission lines. It also included the provision of two 150MVA, 330KV/132KV and three 60MVA, 132KV/33KV substations.

The Japan International Corporation Agency (JICA) finalized plans for a $238 million funding facility for the construction and expansion of transmission lines and substations in Lagos and Ogun states, southwest Nigeria. This funding facility was meant to facilitate the provision of several 330KV/132KV and 132KV/33KV electrical substations and associated 330KV and 132KV transmission lines. JICA have also provided funding facilities for capacitor bank project to improve the power factor on the electrical network and the upgrade of several electrical

Table 9. Recent interventions of the African Development Bank in Nigeria's energy sector (Source: African Development Bank).

Project Code	Title	Commitment (in million USD)	Starting Date	Status
P-NG-FA0-011	Nigeria - Nigeria Transmission Expansion Project Phase 1	160.00	26 Nov 2019	Approved
P-NG-F00-020	Nigeria - Nigeria Electrification Project	150.00	29 Nov 2018	Implementation
P-NG-FD0-003	Nigeria - Dangote Industries Limited - (Refinery and the fertilizer projects)	300.00	13 Jun 2014	Implementation
P-NG-FD0-002	Nigeria - Indorama Fertilizer Plant	100.00	30 Jan 2013	Implementation
P-NG-FA0-002	Nigeria - The Economic and Power Sector Reform Program (EPSERP)	138.00	28 Oct 2009	Completion
P-NG-FD0-001	Nigeria Liquified Natural Gas	90.00	20 Nov 2002	Completion

Table 10. Summary of financial interventions by selected agencies (Source: Author compilation).

Agencies	Intervention(s)	Amount
French Development Agency (Agence Française de Développement, AFD)	Transmission infrastructure expansion around Abuja metropolis and neighbouring states.	$170 million
Japan International Cooperation Agency (JICA)	Transmission infrastructure expansion within the southwest region of Nigeria.	$238 million
Japan International Cooperation Agency (JICA)	Capacitor banks for power factor improvement along Apo and Keffi in Nasarawa state, north-central Nigeria.	$13 million
Japan International Cooperation Agency (JICA)	Rehabilitation and upgrade of Apapa road 132KV substation and rehabilitation of Akangba 330KV substation., both in Lagos, south-west Nigeria	$21 million
European Union (EU)	Electricity transmission infrastructure along the northern corridor, particularly around the north-west and north-central regions of Nigeria	€25 million

substations. JICA has been a major partner of the transmission company of Nigeria in preparing and generating a 20 year least-cost transmission master plan that can help the TCN evacuate power in a very effective way at the least possible cost.

The European Union €25 million funding facility was used for some projects along the northern corridor of Nigeria to aid the evacuation of electricity from a solar independent power plant generation complex in Gwiwa, Jigawa state.

6. Discussions

Lee and Yang argues that transitioning from one form of energy to another necessarily leads to social change [92]. These changes materialize through higher labour productivity, better quality of life and improved production methods. Lee and Yang further argues that from a historical standpoint, eventual transition in energy systems has been highly dependent on the type of political system in place. This implies that there must be a causal relationship between energy systems change and changes in political systems. Arguably, a major tool in effecting changes within a political system is political power. All of these come to play during stakeholder consultation and engagement that leads to eventual infrastructure supply or policy interventions [91, 93, 94].

The dynamics of stakeholder interactions and other forms of interventions within the Nigerian electricity sector (as highlighted in the preceding sections) show that sustainable energy and electricity systems are complex socio-technical systems comprising a network of many actors who, together or independently, develop, operate and maintain technical infrastructure [34, 95, 96, 97]. This is evident (in sections 3, 4 and 5) in the kind of financial interventions opted by many international donor agencies. Indeed, not too many interventions by external stakeholder groups occurred prior to the electricity sector liberalization era which started off in the early 2000s. Most financial interventions were channelled to government owned institutions, such as the Transmission Company of Nigeria (TCN) and the Rural Electrification Agency (REA) where government could serve as guarantor for such investments. However, distribution companies which are mostly privately owned companies do not have the benefit of such interventions. This is not only because they are privately owned, but mainly due to their low profitability. Indeed, most interventions in the electricity distribution segment comes from the federal government [98].

Foreign interventions in the renewable energy space in Nigeria is motivated by the perceived impact it promises in addressing the energy access challenge, particularly in rural communities without access to the grid [46, 99]. This was the motivation of the World Bank and the African Development Bank interventions in rural electrification and (renewable) energy access [48, 84, 100, 101]. Indeed, these interventions have supported many solar minigrids and standalone projects (including solar hybrid solutions) implemented by the REA and targeted at addressing energy access challenge in rural communities [89].

7. Conclusion and policy implications

In exploring the relationship between distributed renewable energy and political power, Burke and Stephens argue that in distributed energy politics, distributed energy technologies and sources provides a basis for enabling and organizing distributed political power [102]. This implies that renewable energy systems may have a greater chance of offering a more democratic energy future [44]. Indeed, how do tensions for democratic energy relate to technology, governance and other competing agendas of various stakeholder groups?

To transition to a more sustainable energy future, there is a need to consider the market dynamics, regulations, societal acceptability and support of different stakeholder groups [103]. This means that the diverse components within energy systems in itself and the interdependencies with components outside the energy sector needs to be considered since they add to the rising complexity of energy infrastructure provision. These complex interdependencies in energy systems include extraction and conversion processes, fuel sources, investors, infrastructure workers, trade unions and different end-use sectors. This is the main motivation that enables some external donor agencies to fund diverse energy projects.

Changes in market rules results in some risks and uncertainties that various market participants and stakeholders need to cope with. These uncertainties could manifest in the forms of regulatory, climate or technological uncertainties [87]. Arguably, good policies may help reduce these uncertainties. This is evident through various forms of political pressures and policy incentives targeted at increasing investments in renewable energy technologies [104]. These uncertainties raise questions about the policy and governance dynamics that can aid renewable energy technology deployment. Indeed, a good policy within the Nigerian context is one in which the formulation process involves the various stakeholders in such a manner that the resulting policies can help them fulfil their various objectives.

As an aid to address issues of stakeholder interests, it is recommended that the Nigerian government strengthen stakeholder involvements through various public engagement forums that provide avenues for various interest groups to make necessary inputs before final decision is made on electricity infrastructure provisions. Government agencies

responsible for centralized electricity infrastructure provision can start to entrench this culture through their public engagement units.

In this paper, we started off by exploring the various stakeholder groups in Nigeria's electricity sector within centralized and decentralized electricity system and how they exert their influence in satisfying their interests. The role of some external stakeholders within the Nigerian electricity sector, manifested through various forms of financial (and latent technological) interventions was also explored. This study shows that there is need for a systematic approach towards stakeholder engagement which requires the active participation of relevant government agencies and institutions. This systematic approach should include some policy guidelines on stakeholder identification, recruitment, engagement and retention in order to achieve desired outcomes and reduce the possibility of unintended consequences.

Declarations

Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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