a Scoping Study on the

Niger Delta Electricity Value Chain

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During this scoping study on the electricity value chain in the Niger Delta, the DAI and SDN team interviewed more than fifty individuals from across the on and off grid electricity value chains; representing major companies, Nigerian government institutions, international donors, private sector companies, and local communities. A list of all participants can be found in the Annex. The analysis also benefitted from high levels of technical guidance and participation from NDPI, Partnership Initiatives in the Niger Delta (PIND) senior management, Chevron Gas (based in Houston, Texas), and the PIND Economic Development Center team in Nigeria.

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Glossary

AfDB	African Development Bank
ATC	Aggregate Technical and Commercial Losses
BEDC	Benin Electricity Distribution Company
BuC	Bonny Island Utility Company
BPE	Bureau of Public Enterprise
CAPEX	Capital Expenditure
CCTG	Combined Cycle Turbine Generator
CSR	Corporate Social Responsibility
CAPMI	Credited Advance Payment for Metering Implementation
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
DisCo	Distribution Company
DHS	Domestic Household Survey
DSO	Domestic Service Obligation
EASE	Energizing Access to Sustainable Energy
EEDC	Enugu Electricity Distribution Company
EU	European Union
FGN	Federal Government of Nigeria
GACN	Gas Aggregator Company of Nigeria
GSAA	Gas Supply and Aggregation Agreement
GSA	Gas Supply Agreement
GE	General Electric
GenCo	Generation Company
GW	Gigawatt
GVE	Green Village Electricity
GDP	Gross Domestic Product
HDI	Human Development Index
IEDN	Independent Electricity Distribution Network
IPP	Independent Power Plant
IRP	Interim Rule Period
IFC	International Finance Corporation
IOC	International Oil Company
kWh	Kilowatt hour
MHI	Manitoba Hydro International
MO	Market Operator
MW	Megawatt
mWh	Megawatt hour

mmbtu	Million british thermal unit
MYTO	Multi-Year Tariff Order
NASENI	National Agency for Science and Infrastructure
NEPA	National Electric Power Authority
NIP	National Implementation Plan
NIPP	National Integrated Power Project
NDDC	Niger Delta Development Commission
NDPI	Niger Delta Partnership Initiative Foundation
NDPHC	Niger Delta Power Holding Company
NREA	Nigeria Rural Electrification Agency
NBET	Nigerian Bulk Electricity Trading PLC
NERC	Nigerian Electricity Regulatory Commission
NESI	Nigerian Electricity Supply Industry
NESP	Nigerian Energy Support Program
NIAF	Nigerian Infrastructure Advisory Facility
PRG	Partial Risk Guarantee
PHED	Port Harcourt Electricity Distribution company
PHCN	Power Holding Company of Nigeria
PIND	Foundation for Partnership Initiatives in the Niger Delta
PPA	Power Purchase Agreement
PTFP	Presidential Task Force on Power
PPP	Public-Private Partnership
REEP	Renewable Energy and Energy Efficiency Program
REF	Rural Electrification Fund
SDN	Stakeholder Democracy Network
SO	System Operator
Mcf	Thousand cubic feet
TEM	Transitional Electricity Market
TCN	Transmission Company of Nigeria
TSP	Transmission Service Provider
TUOS	Transmission Use Of Service
DFID	UK's Department for International Development
UNIDO	United Nations Industrial Development Organization
USDAF	United States African Development Fund
USAID	United States Agency for International Development
VC	Vesting Contract

Executive Summary

Improved access to dependable electricity for industry, business, micro-enterprises, and households, coupled with other enabling factors, increases economic growth, generates meaningful employment and entrepreneurial opportunity, and produces an overarching higher quality of life as measured by the United Nations' Human Development Index.[1] The Nigerian energy sector is therefore directly linked to one of the Niger Delta Partnership Initiative's (NDPI's) primary goals—to promote market-driven expansion of pro-poor economic opportunities in the Niger Delta.[2] Given the potential positive impact that improved access to electricity would have on its stakeholders in cities and rural environments alike, NDPI and its Nigerian partner, the Foundation for Partnership Initiatives in the Niger Delta (PIND), have partnered with DAI's Extractives Group to deliver a Scoping Study that establishes a reliable foundation of information on the current market dynamics of the power sector in the Niger Delta. The core objective of this analysis is to identify opportunities (if any) for NDPI and PIND to engage in this sector and help bridge the gap that is currently a strong impediment to private sector market growth and productivity. Depending on the information uncovered, this analysis could inform and put finer shape to subsequent PIND-driven activities.

Despite internal and external pressures for large-scale reform and investment in the power sector in Nigeria, power supply continues to be significantly inadequate relative to the country's economic growth potential. This is true throughout the country and in particular the Niger Delta. Despite the recent privatization efforts and some of the successes that are starting to bear fruit (new external private investment in the Azura Independent Power Project as an example), progress remains slow and frustrations amongst the private sector high.

On and Off Grid Electricity in the Niger Delta

Even as market reforms have occurred over the last ten years, the national grid remains dominated by the public sector. Transmission remains in the domain of the public sector through the Transmission Company of Nigeria, and distribution has not yet shifted to the Transitional Electricity Market (TEM) stage of Nigeria's ongoing privatization process. Distribution is challenged by poor levels of collections and inconsistent (and sometimes non-existent) metering. As such, financial losses for companies and public sector entities are common and payment risk a constant shadow limiting deeper private sector investment at all levels of the production-to-consumption value chain. The political economy of the sector is equally complex and results in disappointing levels of progress as measured against the stated government goals. This is especially true now as Nigeria heads into the 2015 election period which is expected to further delay much-needed sector investment and reform. Multilateral development partners, bilateral donors, and large institutional investors such as banks and infrastructure funds and operators, will continue to play key roles in the development of the infrastructure and emerging market mechanisms in the formal on grid power context.

Off grid segments of the sector supplement power supply to a material extent in Nigeria in general and the Niger Delta in particular. Most estimates agree that off grid generated power is equal or greater to on grid actual power supply at peak times. A significant degree of this off grid electricity is self-generated from costly, loud, and inefficient small and medium diesel generators. They are also inefficient in providing power to an aggregate number of off grid consumers. Non-diesel alternative off grid power generation solutions exist yet have not produced the expected results regarding scalability and commercial viability. Limited information on the precise cost build up in the off grid value chain restrains the ability to identify exact

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[1] UNDP, 2014
[2] NDPI, 2014

opportunities. However, due to the diversity in which commercial, residential, community, and other electricity off-taker groups rely on off grid alternatives to unreliable grid power, there are some contexts in which NDPI, PIND, and other partners can further explore means to foster or catalyze improvements in reliable and quality electricity access.

One particular segment that the report identifies that could present opportunities for greater investment, new business models, or commercially viable electricity provision are clusters of existing economic activity that are geographically isolated from the national grid, and which will likely remain so into the foreseeable future. Under such circumstances, off grid solutions such as a micro-grid that distributes electricity from a generation plant < 1 MW or a regulated independent electricity distribution network may be commercially feasible.

Potential Next Steps Following this Study

To explore the commercial viability potential of such investments, however, a validation process involving further investigation, analysis, and synthesis is needed, potentially to include: (1) **Cluster Selection:** identifying specific geographic areas in the Niger Delta and carrying out initial analysis. Select initial set of clusters to propose for studying according to key criteria to be developed. (2) **Political Economy Analysis (PEA):** establishing a reliable understanding of the political economy related to the power sector in the Niger Delta with a focus on mapping the stakeholders involved in the provision, transmission, distribution, and consumption of electricity. (3) **Cluster Mapping:** completing a cluster-specific geographic information system (GIS) mapping overlay to visually display the proximity of focus clusters relative to existing and planned on grid infrastructure and off grid systems in place. (4) **Cluster Electricity Demand Analysis:** carrying out surveys within each sector to understand the access, provision, cost, consumption and demand for electricity; and to get a clearer view of the types of businesses and microenterprises in each cluster. And (5) **Additional supporting sector analyses:** financing mechanisms and existing local financing options for off grid investments, regulatory and institutional environment for electricity in the Niger Delta, and possible technological solutions that may be applicable (solar, gas, diesel, etc.).

1. Introduction

Nigeria has experienced an average 8 percent GDP growth over the last decade.[3] It is the largest exporter of oil in Africa and holds the continent's largest proven reserves of natural gas.[4] However, an estimated 100 million Nigerians (or approximately 65 percent of the population) do not have access to electricity.[5] In other words, they are neither connected to the national grid nor own a means of generating power themselves.

Even for the 40 percent of the population who are connected to the national electric grid,[6] reliable power remains a significant issue. In 2010, 83 percent of firms surveyed by the World Bank identified access to power as the primary constraint on their business,[7] up from 63 percent in 2007.[8] Nigerian businesses experience an average of 239 hours of power outages per month, leading to about 7 percent in lost sales.[9]

As a result, households and businesses must forego electricity consumption or rely on forms of self-generation which are nearly always more costly than reliable grid energy. The result is an estimated at $80 billion USD cost to the economy per annum (with some estimates of loss as high as $250 billion annum).[10] The African Development Bank (AfDB) estimates that power outages result in a loss equivalent to three percent of the country's GDP.[11] To put this in a comparative context, Table 1 estimates the Cost of Unserved Energy in Nigeria compared with South Africa. South Africa has ten times the available generation capacity of Nigeria despite having only one third of the population. Electricity consumption is nearly seven times greater in South Africa than Nigeria despite the former having a lower national GDP.

TABLE 1: COST OF UNSERVED ENERGY IN NIGERIA, BENCHMARKED TO SOUTH AFRICA

Country	Population (mn)	2012 GDP (bn US$)	Available Generation Capacity (MW)	Annual Electricity Consumption* (bn kWh)
Nigeria	170.5	450	4,000	35
South Africa	51.2	307	40,000	237

Source: CSL Research

SECTOR PRIVATIZATION AND THE TRANSITIONAL ELECTRICITY MARKET

In 2005, the Federal Government of Nigeria (FGN), already aware of the issues within the electricity value chain, embarked on a multi-year privatization of the state run power sector. The previous National Electric Power Authority (NEPA) was disbanded and all of its assets, liabilities, and staff were transferred to the newly created Power Holding Company of Nigeria (PHCN). PHCN then subdivided itself into 22 different entities to be resold: ten generation companies (GenCos), 11 distribution companies (DisCos), and a state owned transmission company. Two new institutions were also created: a state owned bulk buyer and reseller of

[3] World Bank, 2014
[4] US EIA, 2012
[5] World Bank, 2014, USAID, 2014
[6] AfDB, 2014
[7] World Bank, 2014
[8] World Bank, 2007
[9] World Bank, 2014
[10] CSL Stockbrokers, 2014
[11] AfDB, 2014

electricity named Nigerian Bulk Electricity Trading PLC (NBET), and an independent regulator for the power sector, the Nigerian Electricity Regulation Commission (NERC).[12]

In 2005, the FGN also established that additional infrastructure investment would be required to allow the country to meet new generation, transmission, and distribution targets. As a result, it created the Niger Delta Power Holding Company (NDPHC) to manage an $8.4 billion USD investment fund aimed at the implementation of National Integrated Power Project (NIPP). The NIPP was mandated to create 5,153 MW of new generation and transmission capacity over a period of three years (i.e. by 2008). As of 2012, it had only reached a third of its generation target and 46 percent of its transmission target.[13]

In 2010, President Goodluck Jonathan relaunched the power reform process, with the development and publication of Presidential Road Map for Power Sector Reform and the creation of a Presidential Advisory Committee on Power (PACP), supported by the Presidential Task Force on Power (PTFP) to monitor implementation of the Road Map target.[14] President Jonathan then made access to electricity a key element of his successful 2011 presidential electoral platform. In 2013, after having encountered several obstacles in the implementation of the Roadmap, however, a revised version was released. It still set targets for the sector in line with the vision the FGN had laid out in its Vision 20:20 document, including very high electricity generation targets.

When originally devised between 2005 and 2009, the electricity market's development was to undergo four stages: pre-Transitional Electricity Market (pre-TEM), Transitional Electricity Market (TEM), the Medium Term market, and the Long Term Market. An established time frame was not set for these stages, however multiple launch dates of the TEM have come and gone. In late 2013, NERC announced that a new stage would be undertaken between the Pre-TEM and TEM stages: the Interim Rule Period (IRP). Although the IRP was initially to last only until March 2014, it remains the regulatory rule of the land as of early 2015. Key elements of each stage[15] are described here:

- **Pre-TEM:** The pre-privatization market as it had been run for years as a de facto state monopoly, with multiple state and quasi-state institutions dominating the electricity sector.
- ***Interim Rule Period (IRP) – not initially planned:*** This period mixes aspects of both Pre-TEM and TEM, while most notably delaying the active role of NBET and the implementation of all PPAs and VCs. In essence, this postpones the contract-based foundation of the market. Existing pricing continues in this intervening period. Further, the Market Operator (MO, a unit of the TCN), continues to be in charge of paying GenCos and collecting money from DisCos.
- **Transitional Electricity market (TEM):** This was to be the initial form of the private sector market and was to begin prior to privatization. For the first time, participants in the electricity value chain would be bound by contracts and subject to a greater degree of market forces. For example, Power Purchase Agreements (PPA) would define the amount of power and the price at which the GenCos would sell to buyers (the bulk trader or DisCos). Similarly Vesting Contracts (VCs) were supposed to help secure the supply and sale of electricity between the bulk trader and DisCos. There would be no centrally administered balancing mechanism for the market. Instead, NBET would come into existence and serve as an intermediary between the different actors in the on grid

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12 CSL Stockbrokers, 2014

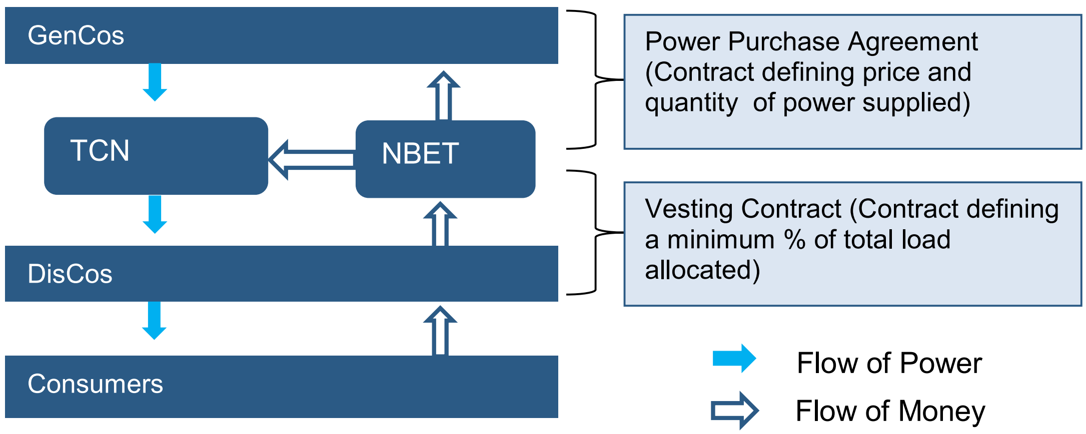
13 CSL Stockbrokers, 2014

14 PTFP, 2010

15 Many elements taken from CSL Stockbrokers, 2014

electricity value chain. PPAs would be signed between GenCos and NBET, and VCs would be signed between NBET and DisCos. NBET would serve as a party within the contracts between the different actors. While it is expected that most contracting under TEM will be with NBET, bilateral GenCo/DisCo contracts are possible under defined circumstances. The TEM is also intended to introduce transparent procedures on how to manage shortages in power within the system. Figure 1 presents a simplified market operations in the TEM stage.

FIGURE 1: SIMPLIFIED VIEW OF POWER AND MONEY FLOWS UNDER TEM



- **Medium Term Market:** This phase would see the elimination of NBET as an intermediary between DisCos and GenCos for PPAs and VCs; at which point GenCos and DisCos would contract directly with each other. A spot electricity price should emerge at this point in the process as well.
- **Long Term Market:** This final, permanent stage envisions the emergence of true retail competition, in which consumers choose their own suppliers and thus there would be competition among generation companies. There would be open access to the distribution and transmission network for new entrants under an efficient and transparent regulatory regime.

Throughout 2014 and into 2015, Nigeria continues to be in the uncertain environment of the Interim Rule Period with no clarity on when it might end and transition to the TEM. Thus, this study focuses on the reality facing the sector as it exists under the IRP structure. This further guides next steps recommendations; albeit acknowledging that the TEM may very well be activated at any time.

Scoping Study Outline and Goals

Following this introduction, the report will explore the following topic areas separated into five sections covering Nigeria and the Niger Delta states specifically: an overview of power sector actors, electricity supply and demand, the on grid electricity value chain, the off grid electricity value chain, and conclusions for NDPI and PIND moving forward in this context. Annexes provide additional information and references.

The goals of this study are to inform future potential NDPI and PIND programming in the Niger Delta power sector through investigating, analyzing, and drawing conclusions on the sector's fundamental dynamics in relation to the national grid and formal privatization context, off grid solutions, and self-generation. Where might there be opportunities for new approaches, business models, or commercially viable investment that will improve electricity access and help establish a greater foundation for pro-poor economic growth in the Niger Delta.

2. Power Sector Entities

This section will present the institutional landscape of the regulated power sector which includes institutions within the federal government of Nigeria (FGN) and local and state level agencies; international donors and multilateral lenders; and private sector market participants. While this phase of the report did not include a full systems mapping nor a Political Economy Analysis of the electricity sector, the below summary of the institutions shaping the sector underscores some of the sector's weaknesses and impediments to realize sustainable growth.

Federal Government of Nigeria (FGN) Entities

Nigerian Electricity Regulation Committee (NERC). NERC is the power sector regulator and is responsible for fuel cost pass-through pricing within the energy value chain. It is mandated to monitor compliance of and make amendments to draft market rules, set tariff rates received by all actors in the value chain via the Multi Year Tariff Order (MYTO), and oversee consumer welfare.[16] NERC is seen as a relatively independent institution with a notable degree of technical capacity. It has been supported by the World Bank and the United Kingdom via its Nigeria Infrastructure Advisory Facility (NIAF). As MYTO is a "building block" tariff system, in which the tariff is derived from cost assumptions for GenCos, DisCos, and TCN, NERC's assumptions and its understanding of costs play a central market role as it defines revenue, via the pricing mechanism, for all value chain participants.

Nigerian Bulk Electricity Trading PLC (NBET). NBET is a government company that is currently in operations, however will significantly ramp up its role once TEM is declared. It will be a bulk purchaser and reseller of electricity, acting as a financial intermediary between GenCos and DisCos. NBET was created to provide a more secure counterparty between GenCos and DisCos in the newly privatized market. It is the party that enters into PPAs and VCs, and will take on the responsibility for any such pre-existing contracts once TEM is declared. It also has a key role in the execution of the World Bank's Partial Risk Guarantees (PRGs, see below discussion on multinational donors). NBET has received training and capacity building via USAID and NIAF, and is seen as one of the strongest institutions within the value chain.

Transmission Company of Nigeria (TCN). This state owned enterprise is currently responsible for all transmission related infrastructure, operations, and payment. The TCN is subdivided into three sections:

- Transmission Service Provider (TSP): Responsible for all transmission infrastructure installation and maintenance.
- System Operator (SO): Coordinates the flow of electrical power from GenCos to DisCos.
- Market Operator (MO): Administrator of the Nigerian Electricity Supply Industry (NESI). In addition, it handles administrative charge payments to the different service providers within the value chain such as SO, NBET, TSP, and NERC. As mentioned above, during Pre-TEM and the IRP, the MO handles both payment and settlement. Once TEM starts, NBET will handle payments but settlements will continue to be administered by the MO.

TCN is not a private company and so does not negotiate tariffs. Rather, the TSP receives a Transmission Use of Service (TUOS) charge, which was set under MYTO II (with separate

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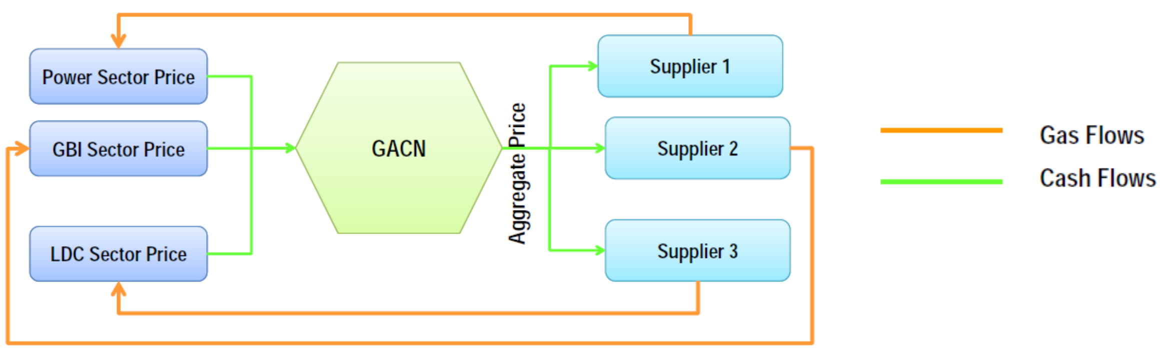
[16] NERC 2014

charges for the MO and SO). These charges are passed through to customers and appears as part of the retail tariff.

The TCN inherited a grid that needs extensive improvements. As will be discussed in the supply section of this report, the country's transmission and generation capacity is in need for greater investment, upgrade, and improved maintenance practices. To illustrate this, in 2014 the FGN allocated $156 million to the TCN, 40 percent of its total expenditure on the power sector.[17] However, funding allocation does not necessarily translate into actual capacity improvements.

Gas Aggregation Company of Nigeria (GACN). Gas currently provides the majority of Nigeria's power and, based on the President's Roadmap for the Power Sector, it is likely to do so for a number of years to come. GACN plays an intermediary role between gas input suppliers and the GenCos, as illustrated in Figure 6 below. Gas suppliers and distributors enter into Gas Supply Agreements (GSAs) with GenCos. These GSAs determine the quantity of gas which GenCos are to receive, and the corresponding price. Under TEM, the successor GenCos will develop Gas Supply and Aggregation Agreements (GSAAs) with suppliers along with transportation agreements. The GSAAs are based on gas under the DSO, however additionl gas can be suplied outside of this arrangement. Gas flows from supplier to consumer (including GenCos) at different prices, the government collects (aggregates) all revenue, and then redistributes cash to the suppliers at a fixed cost per Mcf (thousand cubic feet). The GSAs and GSAAs are important agreements as they are requirements for GenCo financing. Further, without these agreements, gas powered generation plants could not guarantee even a minimum amount of electricity.

FIGURE 2: THE GAS AGGREGATION COMPANY OF NIGERIA (GACN)



Source: GACN

Bureau of Public Enterprise (BPE). BPE is the main implementing organization for privatization in Nigeria. It holds a variety of board positions and shares of institutions operating within the power sector. For example, it is the primary shareholder of NDPHC (until the privatization sales occur), owns 80 percent of NBET, and sits on the Board of TCN.[18] It is responsible to ensure that private sector actors meet the needs of stakeholders in the value chain. As such, it has established a number of requirements for private investors, such as setting performance targets set up in Performance Agreements (PAs) attached to all sales of DisCos and GenCos, and setting limits on debt to equity ratios to 70:30 in first five years, and 75:25 thereafter.

Niger Delta Power Holding Company (NDPHC). NDPHC was created as the vehicle to implement the NIPP initiative, thereby improving generation, transmission, and some distribution. Regarding generation, the results have been significantly slower, and lower, than

[17] CSL Stockbrokers, 2014
[18] CSL Stockbrokers, 2014

originally anticipated: created in 2005 with mandate of expanding power by 5,000 MW in three years, NDPHC has only added about 2,000 MW of capacity eight years later. It has fared better on transmission. Having reached 46 percent of their target in August 2014,[19] it is on track to finish the rest of planned grid expansion by March 2015. According to Robin Evans, the Head of Transmission at NIPP, most of the major transmission lines were scheduled to be completed by December 2014. The maps in the Annex present the current and planned grid at the national level.

NDPHC is eventually slated to divest itself of majority ownership of the generation plants constructed under the NIPP, however keeping a 20 percent stake in each that would be created upon sale of the plants. There are ten of these companies and the NDPHC has undergone a roadshow to attract investors. Seven preferential bidders have been retained for seven of the plants.[20] However, as of November 2014, none of the purchase deals have been concluded. According to individuals involved in this process, this is due to the bidders' inability to secure adequate levels of financing in international markets at economically viable interest rates under current pricing and payment assumptions. Due to the large size and complex operations of NIPPs, they require international financing rather than being purely financed with domestic Nigerian private sector actors.

Nigeria Rural Electrification Agency (NREA). The NREA is mandated to extend the grid to rural areas and to support the creation of and access to micro-grids where appropriate. It does this via the Rural Electrification Fund (REF), which has approximately 10 billion Naira ($60 million USD) available for this purpose. The NREA currently works with GIZ, the German government's international development agency, which has recently assisted NREA to create a plan to optimize the locations and type of transmission infrastructure investment. Although a national plan has been developed, challenges persist in gaining consistency with state or local plans, including in the Niger Delta. Since various state and government agencies, as well as IOCs, all take part in rural electrification by different means, this lack of coordination proves problematic and is something GIZ intends to help address. As a final note on rural grid expansion, in the Nigerian context where generation is low relative to existing transmission capacity, the extension of the grid's transmission network will not improve electricity access in isolation. It is not a solution in and of itself.

The Federal Ministry of Power. As the institution that sets policy at the national level, the Ministry has always been involved in the power sector. Chinedu Ositadinma Nebo, the minister of power since February 2013, is viewed as relatively effective and with an interest in renewable power and private sector involvement.

State Government and Other Niger Delta Entities

State Ministries of Power. As Nigeria is federal, state governments are involved in the power sector through their state-level ministries of power. State ministries are specifically to be involved in the implementation of electricity sector programming and infrastructure development. However, since there are rarely established plans at the state level, electrification assets are generally distributed on the basis of political considerations more than other factors such as need, economic justification, or private investment opportunity. These assets tend to include transformers and other parts of the distribution network. Generally these transformers are handed out without coordination with the DisCo, which itself is not only responsible for the distribution network but is now also responsible for the assets that the state ministry has given away. Since the DisCo was not consulted, the transformer might not work correctly with the rest

[19] CSL Stockbroker, 2014
[20] CSL Stockbrokers, 2014

of the network, leading to faults, technical losses, and wasted government spending. This lack of coordination extends to the NREA and other actors involved in local electrification.

Niger Delta Development Commission (NDDC). The NDDC was created in 2000 to support development in the Niger Delta. It is primarily funded and supported by the numerous IOCs working in the region. The NDDC has a large remit, with improving access to power one of the areas listed on its 20-point Master Plan. Like state ministries of power, it has handed out electrification assets without adequate co-planning with the DisCos. It has also involved itself in other power related projects, such as the distribution of small solar powered boreholes. A follow up analysis by the NGO Stakeholder Democracy Network (SDN) found that 65 percent of the installations were no longer functioning.[21] Although a similar initiative, taken up by the Niger Delta Wetlands Center, a local NGO, occurred at fewer sites but found a significantly higher success rate.[22]

International Donors and Multilateral Institutions

World Bank. The World Bank has been actively involved in the privatization of Nigeria's power sector both as an advisor to different FGN agencies and as a partner to promote private investment in the power sector. The development and provision of Partial Risk Guarantees (PRGs) are the Bank's key structural tool to accomplish this. PRGs act as a form of insurance on the numerous contracts in the power sector (PPA, GSA, VC, etc.). In essence the PRG protects the two contracting entities that enter into these contracts from the other party's default risk.

PRGs for Nigerian electricity sector investment can provide financial protection guarantees for up to $395 million USD of a deal's value. This is in addition to financing provided by other sources inside and outside of the World Bank Group, such as the International Finance Corporation has provided in the form of loans to private businesses (for example $132 million USD was provided to Azura Edo to this end).

As of November 2014, only one PRG had been awarded—to Azura Edo Independent Power Project. Azura, a 450 MW open cycle gas turbine plant under construction is the first greenfield, fully private and internationally financed gas plant in the country, is being used as a "trial run" by NERC and other market participants. A second PRG deal for a greenfield gas plant built by Exxon is fairly far advanced. However, because PRGs cover contracts that come into effect under TEM, they are effectively inactive at this time. Further, both plants are not expected to be online for a few more years to come.

African Development Bank (AfDB). Since 2013, the AfDB has a similar PRG program to the World Banks, which is targeting financing support to three new GenCos. Given the time required to negotiate all the requisite contracts, and the constraints previously mentioned when discussing the World Bank's program, it is unlikely that any of these PRGs will be issued before 2016. The AfDB is also supporting capacity building and advisory services for NBET and NERC. The AfDB will provide about $180 million USD in total across the PRGs and $5 million USD for NERC and NBET capacity building.

United States Agency for International Development (USAID). USAID is involved at multiple levels within the power sector, both in terms of on grid and off grid energy. Through the Power Africa initiative and others before it, USAID has provided technical support to NBET, helping it

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[21] iied, 2013
[22] iied, 2013

create PPAs. It has also mobilized multiple credit facilities to help support DisCos with capital expenditures, though this program has not yet been finalized as of November 2014.[23]

USAID is also starting a program more focused on renewable energy, with a view of providing micro-grids and eventually embedded energy from renewables into the grid. The four year Renewable Energy and Energy Efficiency Program (REEP) was awarded in 2014 to Winrock International and is in its initial strategy phase. Key to REEP is a $9 million USD credit guarantee facility that will help provide credit to renewable energy Small and Medium Enterprises (SMEs) as well to consumers. As of late 2014, Ecobank was the main bank for the credit guarantee, and one microfinance institution, FORTIS had also agreed to provide funds for consumers and SMEs interested in renewables.[24]

European Union (EU). The EU started funding the €27 million Euro Energizing Access to Sustainable Energy (EASE) project in 2013. These funds were primarily given to the German agency GIZ for its activities (see below), though some funds were allocated for the creation of the Sungas project, a planned small gas power plant in the Niger Delta.[25] Starting in 2014 and lasting until 2020, the EU will invest according to its National Implementation Plan (NIP) of an additional €150 million Euro to assist sustainable energy and access to energy. The three areas targeted will be: support to states in developing regional energy and electrification plans, support for vocational training for technicians to be able to work in the renewable energy sector, and support power generation infrastructure from renewable sources.[26]

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). GIZ is currently implementing the EU EASE project until 2018 under its Nigerian Energy Support Program (NESP), which has four units:

- Policy Reform and On Grid Renewable Energy: working at the federal level to help harmonize policies and responsibilities split between different FGN ministries and entities.
- Energy Efficiency: Creation of an efficient energy building code, as well as promotion of solar water heaters.
- Rural Electrification and Sustainable Energy Access: Working with 5 states (Sokoto, Niger, Plateau, Ogun, and Cross Rivers) to develop a rural electrification plan and to promote coordination with other rural electrification bodies.
- Capacity Development and Training: The former NEPA has its own training facility, the National Power Training Institute of Nigeria (NAPTIN). This component assists it to improve course content and offerings.[27]

United Kingdom Department for International Development (DFID). DFID's primary role in the Nigerian electricity sector is to fund and support the **Nigeria Infrastructure Advisory Facility (NIAF)** through a £92 million GBP, 5-year program. It supports various public institutions including the federal Ministry of Power, TCN, NBET, NERC, BPE, and PTFP. It helped develop a grid monitoring tool and trained NERC staff on how to use this monitoring tool. Having begun working in the power sector in 2007, NIAF is now in its second phase through 2016. DFID also has launched a £70 million GBP project to support solar power in Nigeria.

[23] USAID, 2014
[24] Interview with REEP COP, 2014
[25] EU, 2012
[26] EU 2014
[27] GIZ, 2014

United Nations Industrial Development Organization (UNIDO). UNIDO places a strong emphasis on hydropower, partially due to the presence of a regional center for small hydro power in Abuja. It is currently piloting several captive generation pilot projects: one that provides 400 KW of hydro power to a tea transformation plantation in Taraba,[28] a second that supplies 5 MW of biomass power to rice hullers in Ebonyi ($14.6 million USD).[29] It also works to attract private investment into Nigeria's small hydropower space. UNIDO is also working with NERC to seek to modify current generation rules, which essentially treat all generation above 20 MW as appropriate to regulate identically. UNIDO proposes the notion that there is a difference between a 50 MW hydro power plant and a 200 MW gas plant, and that regulations should be revisited in that context.[30]

Private Sector Market Participants

Port Harcourt Electricity Distribution Company (PHED). PHED is one of the two main DisCos present in the Niger Delta. It covers Rivers, Cross Rivers, Akwa Ibom, and Bayelsa States. It was purchased using local financing and is locally owned. PHED is currently losing between 800 million and 1 billion Naira ($4.8-$6 million USD) a month, mainly because of collection losses, as well as a general lack of power to on sell.[31] Jon Abbas, the CEO, is a veteran of other privatizations in the former Soviet Union.

Although there is a cross-subsidy system integrated into the current MYTO system (generally speaking the intention is to avoid cross-subsidies between regions and between customer categories), the current on grid market dynamics support servicing the highest paying clients first. PHED is interested in receiving additional generation directly (embedded generation in Nigerian terminology), but no prospective supplier promising to build a plant has been able to approach him while having both a valid GSA and financing.[32]

Benin Electricity Distribution Company (BEDC). BEDC is the other main DisCo covering the Niger Delta, with a responsibility for Edo, Ondo, Delta, and Ekiti states. It is essentially in a similar situation to PHED, except its losses are currently even higher, ranging between 1 billion and 1.5 billion Naira ($6 to $9 million USD) each month. It similarly blames collection losses, and a lack of provided power.

Azura West Africa. Azura West Africa is the company behind the 459 MW Azura Edo Independent power plant (IPP). It is the first, and currently only company, to have benefitted from the World Bank's PRG program. It is also the first new greenfield power plant funded via international financiers.[33]

Azura strategically chose the location of its power plant to be close to an existing gas line and a [currently under construction] transmission substation (belonging to the NIPP transmission lines and to be completed by the end of this year). Though this has lowered the total costs, Azura find the MYTO rate promised to generation still too low. Therefore, Azura is now working with NERC under an "open book" agreement whereby Azura shows its accounting reports indicating all true costs associated with the project, and NERC allows it to charge a higher generation rate. This is important because the cost assumptions underlying MYTO are based on international best construction practices in terms of construction cost and efficiency, and therefore do not reflect an accurate cost of construction and running a business in Nigeria.

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28 UNIDO, 2014
29 UNIDO, 2014
30 Interview with UNIDO staff
31 PHED, 2014
32 Interview with Jon Abbas
33 World Bank, 2014

As a result, Azura has become a test case on generation for the entire sector, helping NERC re-evaluate costs while also being the first recipient of PRGs. It has broken ground on the site of its new plant earlier this year, and has hired the Nigerian construction services firm Julius Berger to ensure that construction will be completed within the next three years. Azura is also already looking at a new site for a plant in Akwa Ibom, and will likely be looking for investors in the relative near future.

Geometric Power Ltd. Geometric Power has the distinction of being the only fully vertically integrated power company in Nigeria. Geometric owns its own 140 MW gas fired plant in Abia State, near the main city of Aba, as well as its own DisCo and network. It was created to provide exclusively Aba with power, notably the industrial and high worth residential clients located in that city. The plant was to begin its activities in the second quarter of 2014. However, with the privatization and the sale of the Enugu DisCo, the Geometric project became a highly contested issue. The Enugu DisCo would not want to see one of the most attractive parts of its distribution network disappear to a competitor. Similarly Geometric was concerned not to obtain its target returns on its investment. This situation has led to various legal maneuvers and many believe most or all parties will seek to settle and find a solution to the core issue.[34] With the exception of captive generation or embedded generation, the current market rules make any further vertical integration highly unlikely.

General Electric (GE). This U.S. multinational corporation is the main supplier of gas power turbines in the country. It builds power sector infrastructure and has been pre-selected as one of the final bidders on several large projects for the TCN. GE sells a variety of products, including more efficient light bulbs. It has tried to interest several ministries to adopt LED lights for both their buildings and other projects, but so far have not been successful. GE also provides grants to energy related companies through a partnership with the United States African Development Fund.

Schneider Electric. A French company that specializes in power solutions, Schneider provides a variety of on grid and off grid products. Like GE, it has been approached as a pre-selected finalist for several of TCN's infrastructure bids. Schneider is also a primary wholesaler of small solar products in Nigeria. It sells these primarily to IOCs, the FGN, state governments, and NGOs. Direct sales to consumers are virtually nil as of late 2014.

International Oil Companies (IOCs). There are five IOCs that are active in the Nigerian power sector: Chevron, Shell, Eni, Total, and Exxon. IOCs play a role in the power sector in through the extraction and delivery of gas, within Nigeria via the legally binding Domestic Supply Obligation (DSO); which is the primary input for the majority of Nigeria's power, methanol, and fertilizer plants. Remaining gas produced by IOCs is used to service international markets and as required internal IOC needs. IOCs have at times constructed power plants required by the FGN as part of their concession acquisitions. For example, Shell and Eni both have built two plants that are currently connected to the national grid and which account for 20-27 percent of all on grid electricity generation in Nigeria.[35]

A critical enabler that cuts across the interactions between all these core value chain players is the availability and reliability of information. This is generally absent in the market place and contributes to some of the sectors most foundational challenges. This is particularly true in information exchange between providers and end consumers, both commercial and residential.

[34] http://businessdayonline.com/2014/07/geometric-powers-future-still-hangs-in-the-balance/#.VGSkfmeRMTA
[35] NERC and own calculations

3. The Demand for and Supply of Power in Nigeria

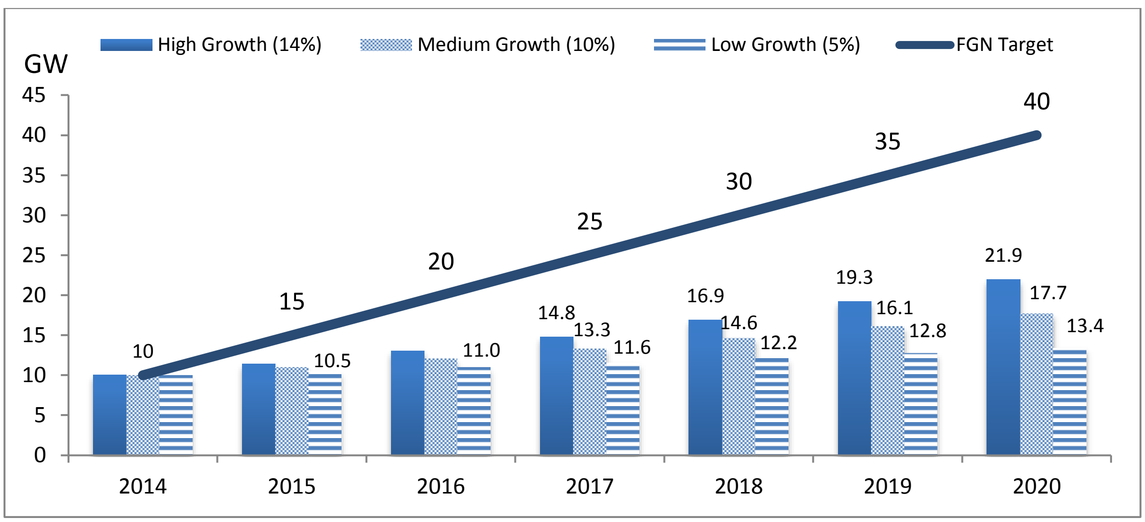
Precise data on consumer demand is not widely available in Nigeria, and the data which is available and which was gathered as part of this scoping study are all informative individually and collectively. Yet they do not provide a holistic picture of the demand for electricity by a meaningful degree of segmentation—all in the Niger Delta context.

THE DEMAND FOR ELECTRICITY

With the above caveat in mind, a number of international institutions and FGN bodies have undertaken analyses and estimation exercises to provide estimations and insights into probable present and future demand for electricity. For example, the World Bank and African Development Bank tend to agree that 2014 effective peak demand is approximately 10 GW, with the grid only providing a maximum of 4 GW during peak load demand periods. The remaining 6 GW of effective demand unmet by the national grid is met by some combination of off grid distributed power solutions, self-generation using fossil fuel or solar/renewables, substituted with non-electrical light and/or heat (e.g. fire, candle, charcoal), or foregoing all of the above and tolerating the absence of supply to meet the consumer's willingness and ability to pay.[36] However, the approximation of 10 GW being the effective peak electricity demand at 2014/2015 price band assumptions is broadly agreed upon, and will be used as the 2014 baseline for calculations and discussion in this study.

The World Bank has developed 3 scenarios for the growth of peak electricity market demand through 2020: a high growth rate of 14 percent, a medium growth rate of 10 percent, and a low growth rate of 5 percent. On the supply side, the FGN set a generation target growth forecast in its Vision 20:20 program, which states that peak generation capacity should reach 40 GW by 2020. These three scenarios and the FGN supply target are presented in Figure 3.

FIGURE 3: NIGERIA PEAK ELECTRICITY DEMAND ESTIMATION AND TARGET SUPPLY FOR FGN (IN GW)



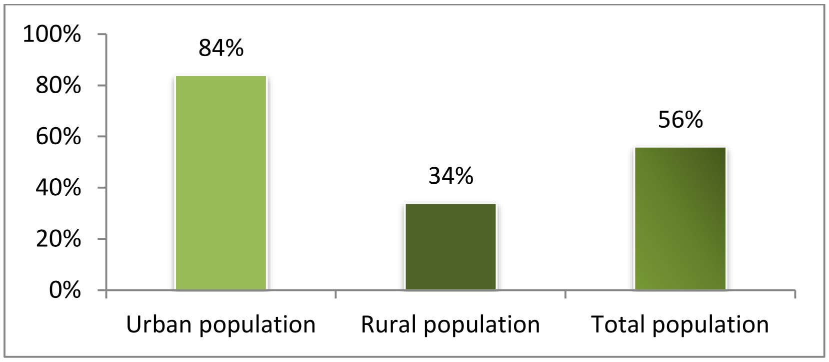
Source: World Bank 2013, DAI calculation estimates

[36] World Bank 2014 & AfDB, 2014

ELECTRICITY CONSUMERS IN NIGERIA

The total number of people connected to the grid ranges from 40 to 51 percent of the population.[37] However, the number of individuals who have access to electricity in one form or another is likely higher, given the presence self-generation and distributed power networks in the country. Therefore, the Demographic Household Survey (DHS) is a more effective measure of how many residential individuals have access to electricity, provided by the national grid, or not. The 2013 DHS conducted by the FGN with the support of a variety of international donors provides insights into the Nigerian consumer. Households own a variety of items that consume electricity, including radios, mobile phones, and small televisions. Figure 4 illustrates the percentage of individuals who have access to electricity (regardless of whether it is grid or self-generated). Data on commercial and industrial electricity consumers was not included in this survey.

FIGURE 4: NIGERIAN POPULATION WITH ELECTRICITY ACCESS (INC. SELF-GENERATION)



Source: DHS 2013

These numbers contrast with the percentages commonly associated with on grid connections. Access to electricity increases by six to ten percentage points when comparing access to electricity versus access to the grid. This highlights the role self-generation and distributed power solutions play in fulfilling the effective peak demand for power.

CONCLUSIONS ON NATIONAL DEMAND FOR POWER

Peak load is estimated at 10 GW, with approximately 40 percent provided by the national grid and the remaining 60 percent met by a combination of self-generation, distributed power networks, non-electrical alternatives, or the foregoing of power entirely.

The most commonly owned items are those which can generally function for a material amount of time without access to power (cell phones and radios). However, the ubiquity of cellphones implies that there are likely associated costs of charging them. Indeed, charging cellphones has become a business for rural entrepreneurs.

Assuming a medium growth scenario (traditionally taken as a 10 percent increase in demand by both the World Bank and AfDB), this would lead to an estimated demand of 17 GW by the end of the decade. This is higher than the projections of the World Bank, which assumes that demand is 7 GW in 2014, resulting with a medium term demand of 10.3 GW. Based on the Bank's own admission of the estimate of current self-generation,[38] the higher figure is arguably more accurate.

[37] World Bank, 2014 USAID, 2014

[38] World Bank, 2014

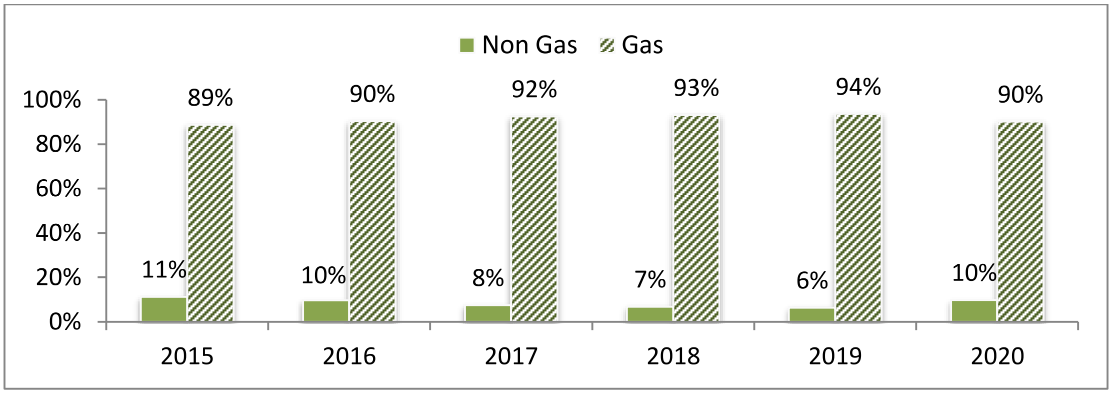
THE SUPPLY OF ELECTRICITY

The Nigerian national grid currently provides between 3.5 GW and 4 GW of electricity to consumers. This is the actual amount of electricity produced, transmitted, and distributed, which is lower than the theoretical capacity of the system, which is closer to 6 GW.[39] This section seeks to understand that discrepancy, looking first at the gas market in Nigeria, then to generation and transmission in the uncertain regulatory environment. For this section's calculations, we make an assumption of a conversion factor of 1 mmbtu (million British thermal unit) to 1 mcf (thousand cubic feet of gas).[40]

GAS MARKET IN NIGERIA

In 2014, gas thermal power plants provided 75 percent of Nigeria's total energy production.[41] According to the Presidential Roadmap for the Power Sector Reform, gas power plants are expected to play an even larger role in the future (see Figure 6). This is largely due to Nigeria's large reserves of natural gas and an established institutional and regulatory apparatus to continue to extract the natural resources within its borders.

FIGURE 5: FUEL SOURCES OF ON GRID ELECTRICITY (%) 2015-2020



Source: Roadmap for the Power Sector, 2013

Nigeria has established a Domestic Service Obligation (DSO) applied to international extractives companies which extract and transport gas within Nigeria's borders. This DSO is a minimum amount of gas that must be supplied to the local Nigerian market before the oil company can export for its own revenue. The DSO is purchased at an FGN-negotiated price, which is generally below the world market price for gas. Over the past five years, the DSO price was $0.80 and $1.50 USD per mcf.[42] DSO supply is used to provide power to three central industries: plants for power, methanol, and fertilizer. Electricity production takes the majority of the DSO production, representing 80% of current gas demand. Figure 7 highlights the primary gas supply chain interactions.

After TEM is declared, the GenCos will have Gas Supply and Aggregation Agreements with suppliers, based on DSO gas at a fixed price, and will have an additional gas transportation agreement. Suppliers can supply outside the DSO if they have fulfilled their quota, and new IPPs will need to contract in that manner (as will some successor GenCos if they need additional gas supply for domestic electricity generation). Thus, there are two categories of gas;

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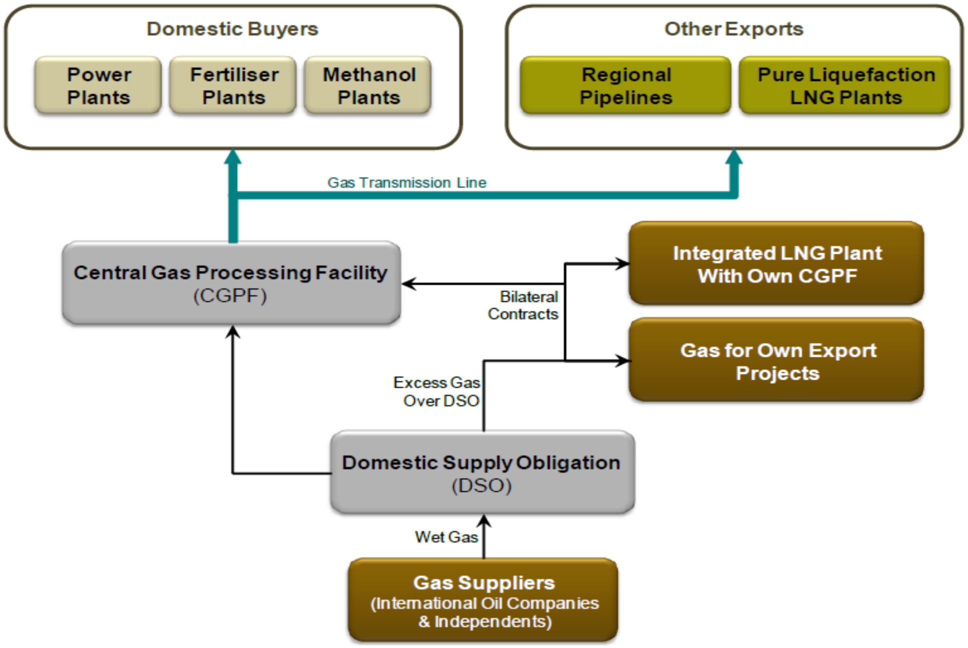
39 NERC 2014, World Bank 2014, AfDB 2014
40 Jackson, 2008
41 NERC, 2014
42 NERC, 2012

first DSO-price driven and second negotiated gas, which is likely to be at a higher, market-driven price.

FIGURE 6: OVERVIEW OF THE NIGERIA GAS VALUE CHAIN



Source: CSL Stockbrokers 2014

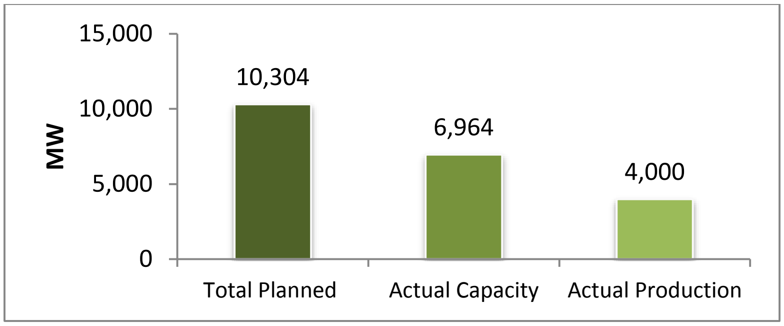
FGN-announced targets for gas production change somewhat regularly, yet in 2014 it announced a goal to have production grown from 4,000 mmscf/day in 2014 to 11,000 mmscf/day by 2020.[43] Such a jump would require considerable investment in the sector and the effective functioning of a TEM or post-TEM regulatory environment. And such investment takes time to plan, finance, build, and start up. This is problematic, today, for the power sector, since according to NERC, as about 3 GW of generation is lost daily because of downed power generating turbines, transmission losses, and the lack of gas.[44]

Current and Future Generation and Transmission

According to the 2013 revised Roadmap for Power Sector Reform, the country was to have installed 10 GW of generation capacity by 2014, versus the nearly 7 GW of installed capacity which it ended up establishing by end-of-year 2014. Figure 8 demonstrates the relationship among planned, actual, and output GW production.

[43] Bloomberg, Sept 2014
[44] NERC, 2014 see Appendix

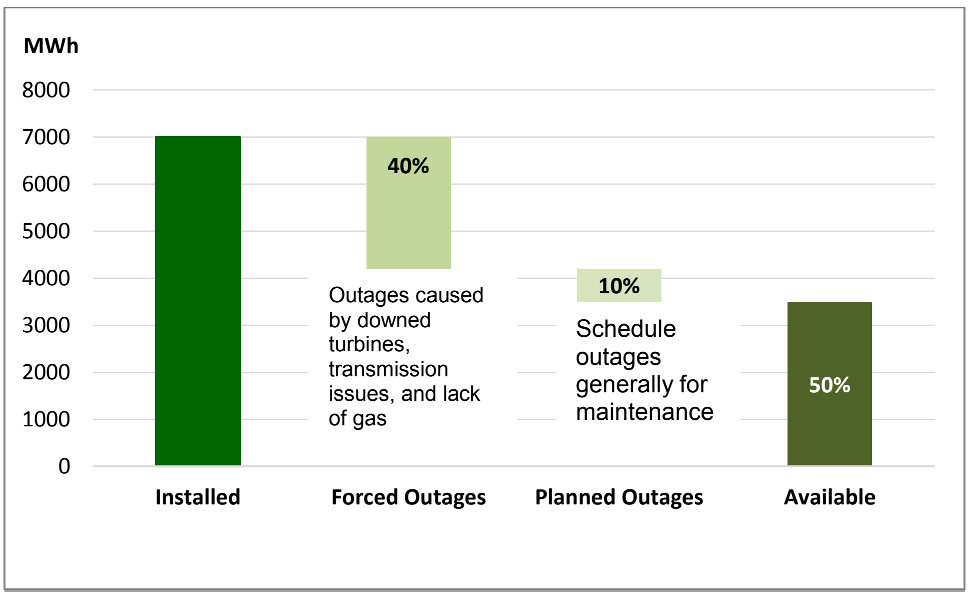
FIGURE 7: 2014 PLANNED CAPACITY, ACTUAL INSTALLED, AND ACTUAL OUTPUT



Source: Roadmap for the Power Sector 2013, NERC 2014

The difference between planned and actual capacity is due to a variety of factors, including a lack of investment and the delay in NIPP electricity generation. The lack of availability between actual production and capacity is due to a combination of poor maintenance, transmission constraints, distribution system overloads, and, at times, a lack of fuel. The grid rarely supplies 4 GW at peak or average load times, and generally hovers closer to 3.5 GW.[45] Figure 13 below highlights the primary reasons for these outages visually.

Figure 8: Installed versus Available Capacity in Nigeria in 2014



Source: Parsons Brinkerhoff 2012, NERC 2014, calculations

Figure 10 demonstrates four different scenarios of future on grid electricity installed capacity: the planned capacity based on the Roadmap for Power Sector Reform, a high growth scenario based on the original Roadmap to power and taking into account delays and abandoned projects, a medium estimate growth that has generation capacity growing by 2 GW/year, and a low growth scenario where generation only grows by 1 GW/year.

However, generation capacity is only one part of the equation. The transmission system must be able to manage the amount of electricity produced; in both wheeling capacity and peak demand contexts. Currently, the transmission wheeling capacity is approximately 4.8 GW with a

[45] NERC, 2014

peak of 6 GW.[46] With the completion of the NIPP transmission system in March 2015, that should bring wheeling capacity up to 6 GW and peak to 7 GW, and up to 7 GW wheeling and 8 GW peak by 2016 at latest. From that point it is safe to approximate that wheeling capacity will grow to 10 GW and peak to 12 GW by 2020.[47] In addition to the transmission constraint, the potential for gas constraints remain.

FIGURE 9: DIFFERENT SCENARIOS OF INSTALLED CAPACITY IN MW 2015-2020

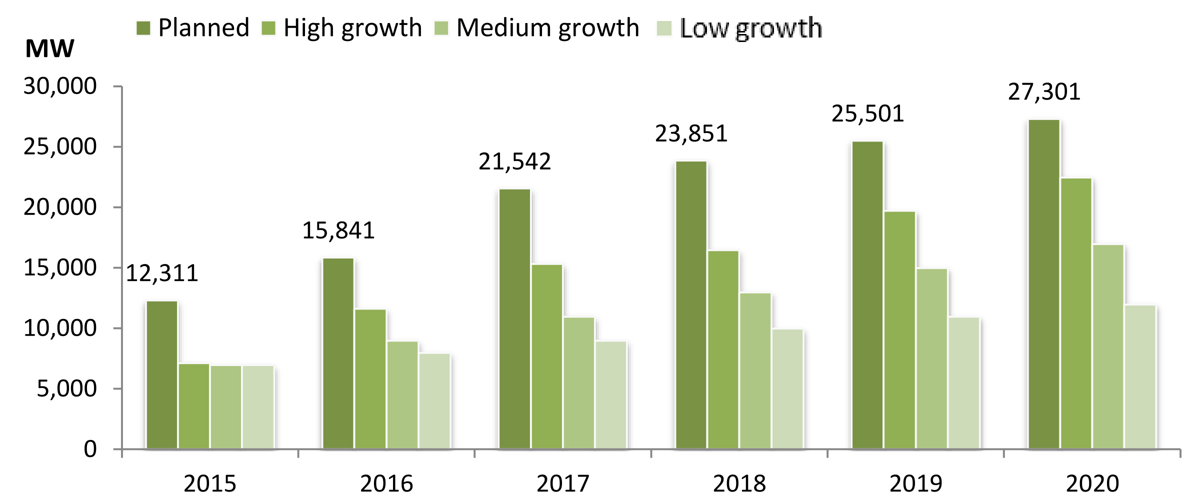
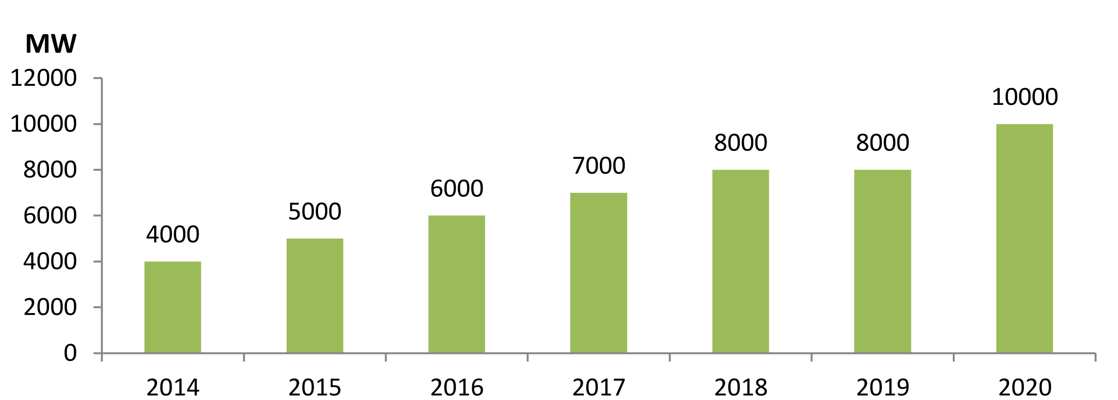


FIGURE 10: ESTIMATE OF ACTUAL GRID SUPPLIED POWER AT PEAK 2014-2020



Source: Interviews with industry experts, team's calculations and estimations

These estimates are in line with World Bank estimates (9 GW by 2019)[48] and Chevron's in-house estimates (11 GW by 2020).[49]

This data highlight the effective gap between effective demand and actual on grid supply of power. Based on multiple discussions with the diverse sector participants, Figure 12 is the team's best found estimate for the true supply forecast of electricity through 2020 (taking into account transmission and gas constraints). Assuming that the effective demand estimate is accurate, that which is not satisfied by improvement and investments to the grid will either go unaddressed or be filled by off grid solutions.

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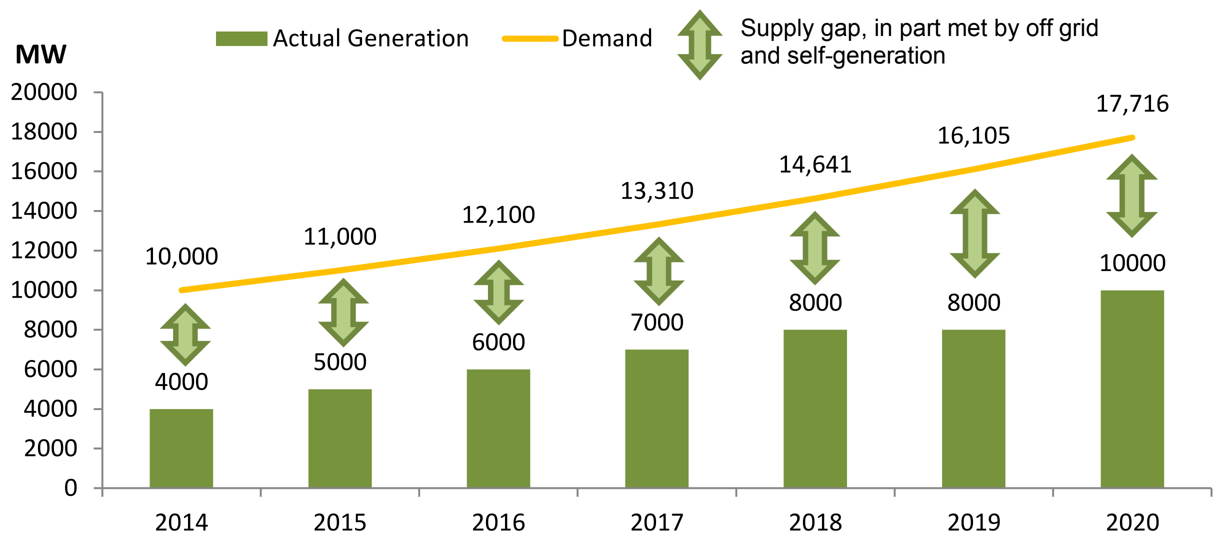
[46] NERC, 2014
[47] Robin Evans, Head of Transmission NIPP
[48] World Bank, 2014
[49] Interview with Nils Magnussen of Chevron

FIGURE 11: ACTUAL GRID GENERATION, PEAK LOAD DEMAND, AND ELECTRICITY SUPPLY GAP IN NIGERIA, 2014-2020 (EXCLUDES PRICE DEMAND RESPONSE)



Source: World Bank, NERC, Chevron, industry insiders, and consultant's calculations

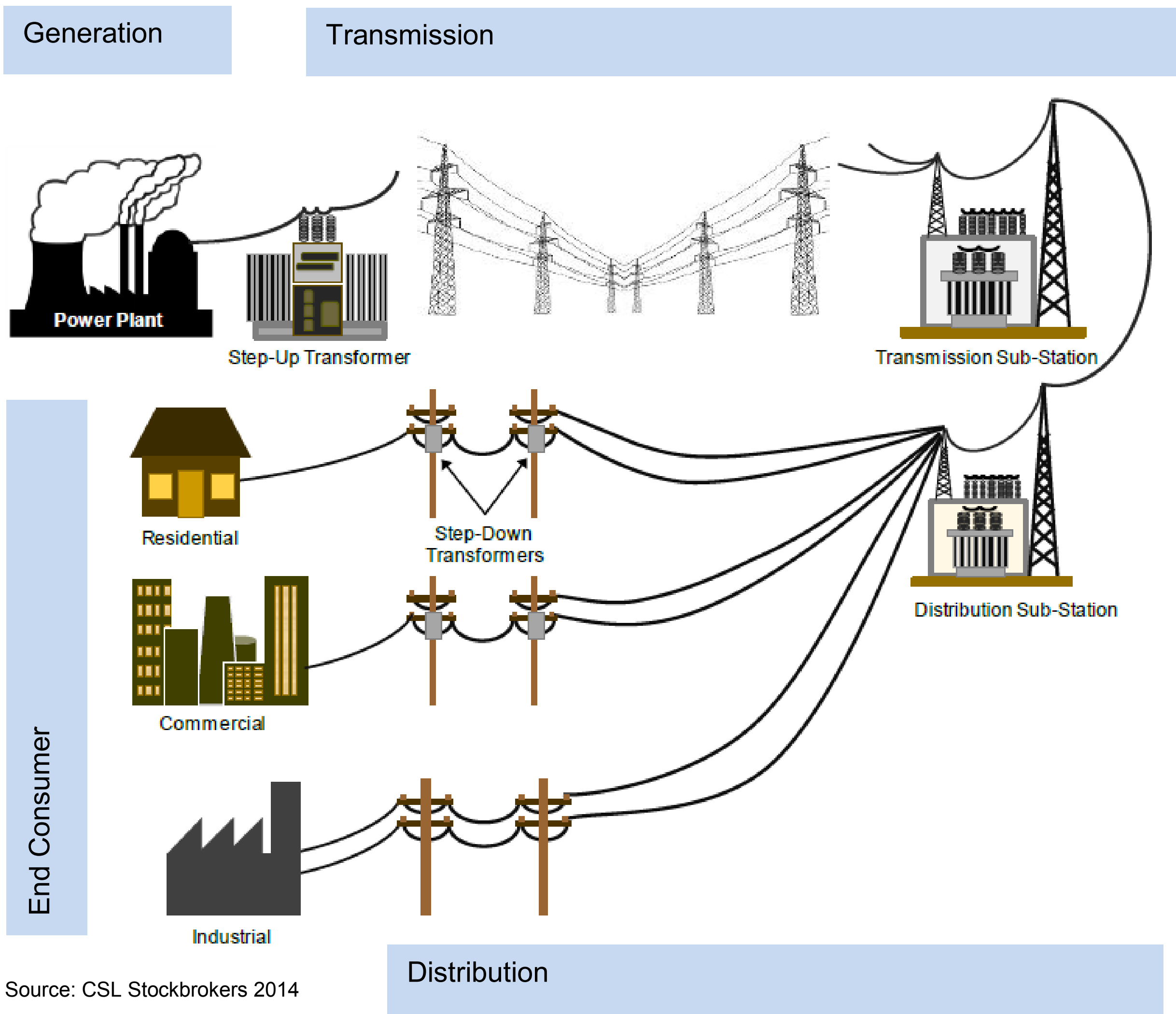
Key implications in the short-term of the outlook for the on grid segment of the value chain:

- While improvements to the grid (and stated intentions by the government) appear to be the most obvious solution the political economy, time and investment sources required render such solutions medium- to long-term pathways. Off grid solutions, despite some frustrations with initial pilots, may be able to supplement part of the supply gap.
- On grid supply will likely continue to be inadequate to meet demand despite the ongoing attempts to reform the sector and more effectively open it to outside private investment.
- The above analysis also holds demand constant relative to supply and price changes; whereas in reality there is a dynamic interaction between consumer behavior and the price paid for electricity, fuel, and/or other energy solutions.
- There is an insufficient amount of reliable evidence on the rural distribution networks necessary to make any inferences on detailed issues pertaining to the rural segment of the on grid network.
- Improvements in energy efficiency, in addition to off grid solutions and improvements to on grid, could yield large benefits. For the grid, it would allow more power to reach more consumers. For off grid consumers, it could, pending the type of generation used, allow more devices and lights to be connected to the power source for a given level of power supply.
- Greater volumes of information are needed to understand the role of small diesel generators that are used to offset the difference between power provided and peak load. These solutions are expensive and inefficient yet are commonly used. Exploring potential ways to aggregate some of this demand and shift to better planned and cost-effective off grid power solutions will require a more detailed cost analysis of these diesel solutions first.

3. On Grid Electricity Value Chain

Building off the information from the supply and demand analysis, the team used a value chain approach to understand the dynamics in both the on grid and off grid segments. Figure 13 highlights the different elements involved in a traditional national grid. These include generation provided by GenCos, transmission provided by a transmission company, and distribution provided by DisCos.

FIGURE 12: BASIC COMPONENTS OF THE NATIONAL GRID SYSTEM



Source: CSL Stockbrokers 2014

GENERATION AND DISTRIBUTION REGULATORY CLASSIFICATIONS

After the unbundling of NEPA energy infrastructure, its assets were transferred to the PHCN, which then subdivided these assets into ten GenCos (known as Successor GenCos), 11 DisCos, and one transmission company, the TCN. Meanwhile, the NDPHC had been charged with implementing the National Integrated Power Projects (NIPP), which included the creation of 10 power plants referred to as NIPP GenCos. The final category of power plant is Independent Power Plant (IPP) which is primarily applied to state run power plants that were not part of NEPA prior to privatization. With privatization, IPPs encompass all power plants that are not Successor GenCos or NIPP GenCos.

All entities involved in the transmission, generation, or distribution of power must apply for a license with NERC, with a few exceptions: generation companies producing less than 1 MW, distribution companies supplying less than 100 kW, international oil companies operating corporate social responsibility activities.

Types of Generation

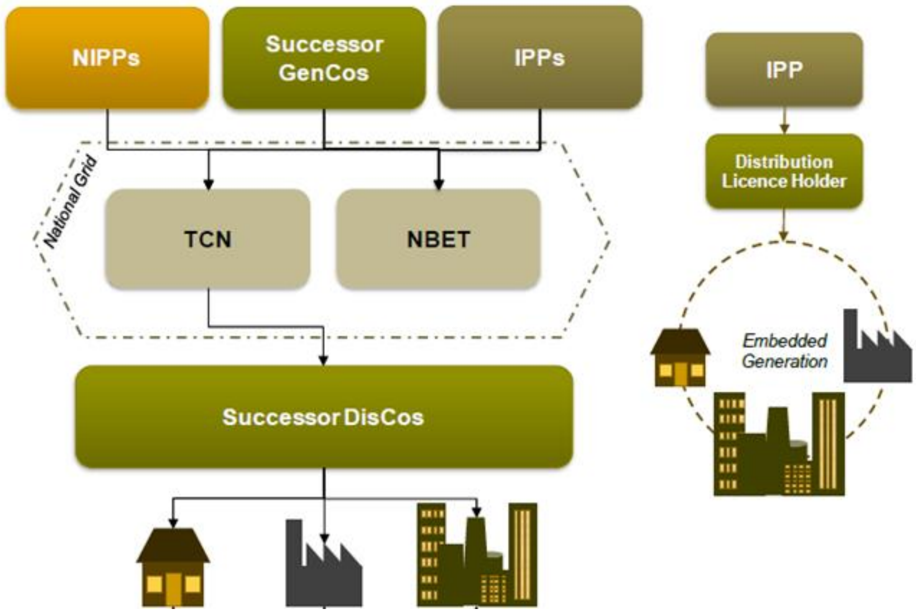
NERC market rules further identify four types of generation:

- **National On Grid Generation:** the standard form of electricity generation, where large (greater than 20 MW) GenCos supply power to TCN which then transmits the power to the DisCos which then on-sell to end consumers.
- **Embedded Generation:** generation of electricity that is directly connected to and evacuated through a distribution system operated by a distribution company connected to the national transmission network. Embedded generation is supposed to complement the power allocation distribution companies currently get from the national grid. The price paid by the distribution company is negotiated between the DisCo and the generator. Embedded generation is sub-divided into small (1-6 MW) and large (6-20 MW). Plants generating more than 20 MW must send their power through the national transmission network.[50]
- **Captive Systems:** generation of electricity exceeding 1 MW for the purpose of consumption by the generator and not sold to a third-party does not require a permit from NERC. Excess production of electricity can be supplied to another off-taker with written consent from NERC if the amount is less than 1 MW. If more than 1 MW is being supplied, then the company producing power must apply for a generation license and would be considered an on grid GenCo.[51]
- **Self-generation:** Though not an official NERC category, it is easier to call it such. This represents any generation that is less than 1 MW. This form of generation is not regulated by NERC.

The first two types of generation can be involved in on-grid value chain. A simplified map of the chain is shown in Figure 13.

[50] NERC, 2012
[51] NERC, 2012

FIGURE 13: SIMPLIFIED VIEW OF THE ON GRID ELECTRICITY VALUE CHAIN



Source: CSL Stockbrokers 2014

Types of Distribution

There are two types of distribution networks recognized by NERC

- **Distribution Company networks:** The networks of the 11 DisCos created for privatization under the original 2005 act.[52] They are necessarily connected to the national grid.
- **Independent Electricity Distribution Networks (IEDNs):** These are networks created by other entities than the aforementioned distribution companies, and are defined as a distribution network not directly connected to a transmission system operated by the System Operator of TCN. Distribution tariffs are charged in accordance with MYTO, though NERC may waive this requirement if the owner of the IEDN presents a compelling case for a different price.[53] There are numerous technical requirements for the IEDN outlined in the NERC 2012 rule regulating them.

NERC will only award an IEDN license if:

- There is no existing distribution system within the geographical area to be served by the proposed independent distribution system;
- Where the infrastructure of an existing distribution licensee is unable to meet the demand of customers in the area. At such a point in time the IEDN operator must:
  - Undertake in writing that the facility of the existing distribution licensee will not be used in its operations
  - There shall not be any parallel overhead lines to existing facility
  - Ensure the safety of equipment, workers and the public
  - The minimum distribution capacity of the IEDN Operator shall be 5,000 kW
  - Show the ability to provide generation capacity for the IEDN.

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[52] FGN, 2005
[53] NERC, 2012

Figure 15 shows how institutional relationships are to operate under TEM. Figure 16 shows how they currently operate in the IRP.

Certain contracts, however, are not bilateral; instead, the GACN aggregates all payments that GenCos are to provide to gas suppliers, and then pays them the DSO price. It is unclear at this time whether this is in spite of the GSA price signed with new IPPs. IPPs pay a price closer to the world market price.[54] The question is, how much does the supplier actually receive? Does it receive the DSO price as per the GSAA or the negotiated price with the GSA? If the latter, then IPP GSAs would bypass the GACN, soon making that institution obsolete. However, if the GACN gets the GSA price from the GenCo but pays the gas supplier the DSO price, then effectively the GACN is obtains additional revenue.

The value chain does not guarantee a fixed amount of power. Rather, it guarantees the DisCo a percentage of the total power in the system.[55] The DisCos choose the amount they allocate to each client type (assuming they have the infrastructure to support such segmentation). TCN gets paid regardless of any performance metric or contract. It receives its share of MYTO regardless of how much it delivers to DisCos.

During the IRP, many of the fundamental issues leading to market inefficiencies that existed in the pre-privatization period remain. Chief among these are the fact that the DisCos can use estimated billing, and that they only pay “what they can” to the MO of the TCN. This in turn creates significant liquidity and payment risk in the system.

In this scenario, the GenCos are private actors that carry the bulk of the risk, since they are obligated to advance gas as per a PPA, to purchase at the GSA price (which, if you are fortunate enough to be a gas powered Successor GenCo, is equal to the DSO price), and then hope for payment from the Market Operator. In the TEM market, it is actually NBET which will carry the brunt of the liability. Table 1 presents the difference in rules between the two periods.

[54] Interview with Azura staff
[55] NERC and CSL Stockbrokers 2014

FIGURE 14: FLOWS OF ELECTRICITY, MONEY, AND CONTRACTS UNDER THE TRANSITIONAL ELECTRICITY MARKET (TEM)

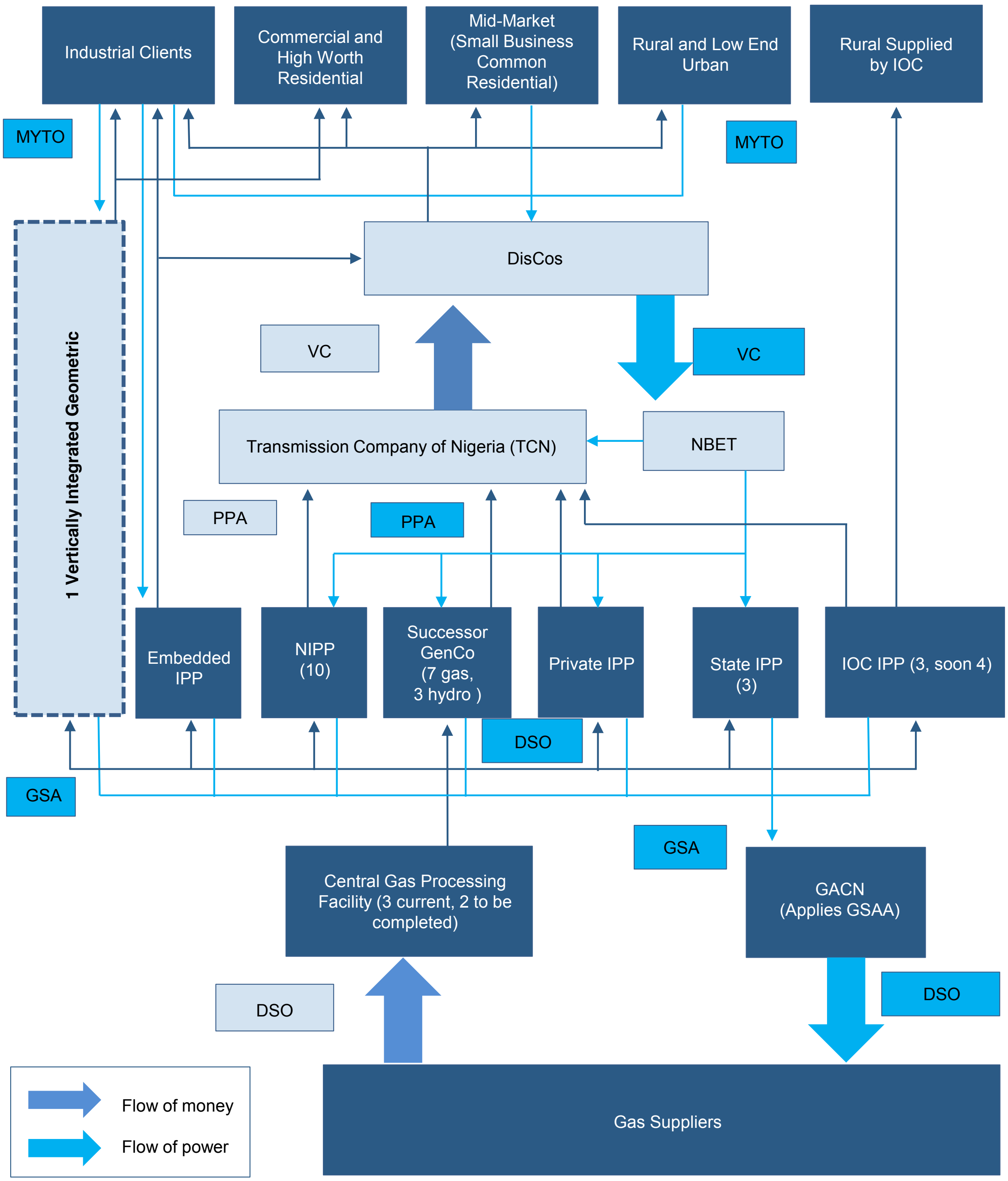


FIGURE 15: FLOWS OF ELECTRICITY, MONEY, AND CONTRACTS UNDER THE INTERIM RULE PERIOD (IRP)

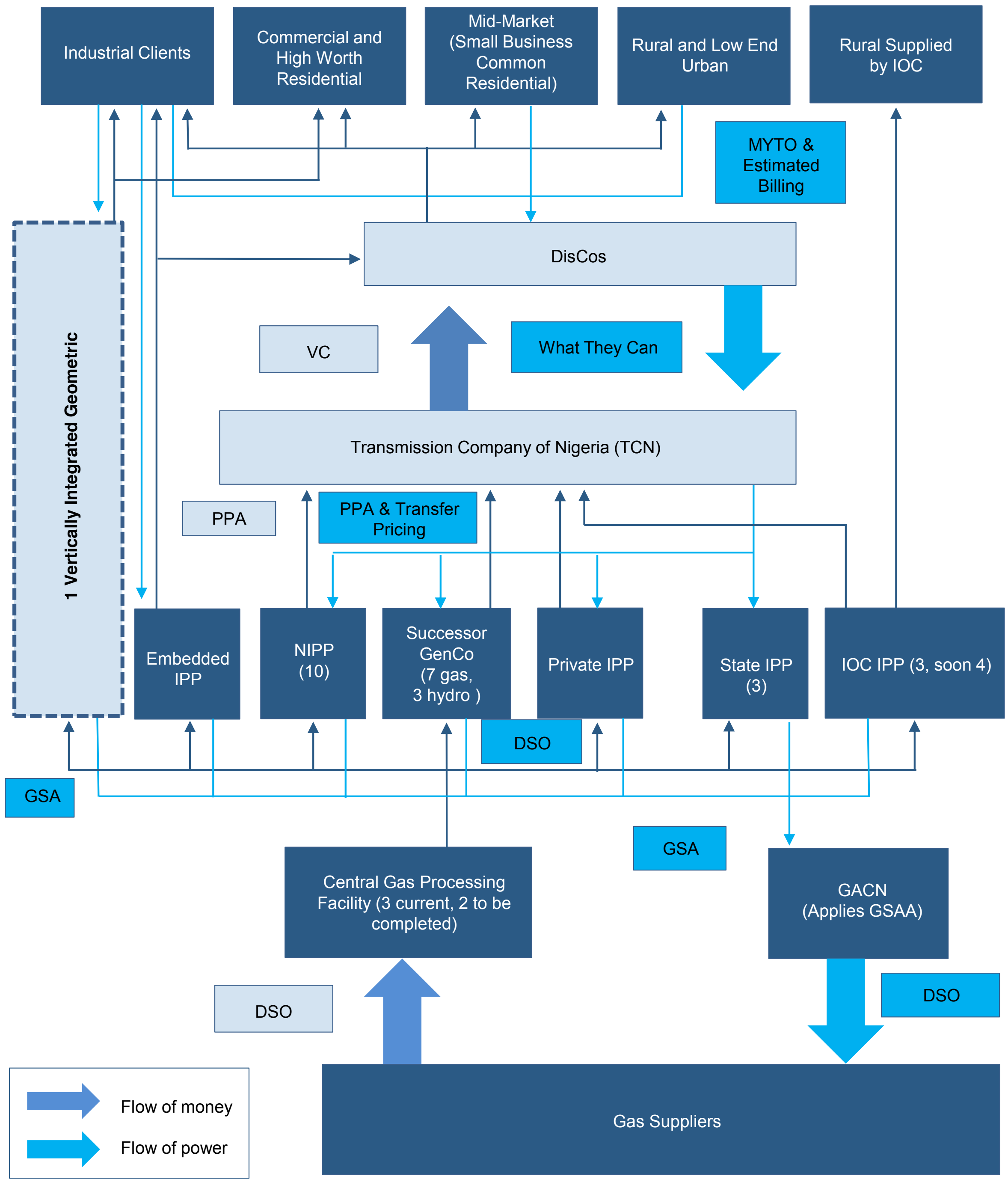


TABLE 1: PAYMENT AND SETTLEMENT SYSTEMS DURING THE IRP AND TEM

Interim Rule Period (IRP)	Transitional Electricity Market (TEM)
Market does not always balance	Market in equilibrium – a debit by a DisCo has a corresponding credit to a GenCo therefore NBET maintains a zero balance.
Shadow Trading • MO receives payments into its market clearing account from DisCos and eligible customers • MO transfers payments to GenCos and service providers Settlement • Per individual settlement calendar • DisCos sell at uniform prices and use estimated billing • IPPs sell at PPA prices; Successor GenCos at various transfer prices Payment • Payment made into escrowed settlement accounts • Based on Minimum Funding Requirement determined by the MO • The Transfer Price is expected to cover the budget for operating costs only	Wholesale Electricity Market Trading • NBET receives and transfers payments between GenCos and Successor DisCos • Existing IPPs sell through PPAs with NBET • New IPPs may contract to sell either to NBET or with the DisCos directly Settlement • Market settlement each month (M) for each DisCo • Monthly Payment (M+1 month) Payment • DisCos submit a Letter of Credit covering three months of payments to be drawn down (plus interest) in the event of non-payment by the DisCo • Incomes in line with MYTO II Revenue Requirement provisions • Per MYTO II, capital costs and return on investments can also be recovered

Source: CSL Stockbrokers 2014

The IRP would not be required if the DisCos were profitable. However, on average they are losing between one and two billion Naira ($6 and 12 million USD) a month.[56] Spread across 11 DisCos, this would result in a cash shortfall within the value chain ranging between 132 and 264 billion Naira ($800 million and $1.6 billion USD) annually.

The DisCos' revenue shortfall and corresponding need for the IRP led the FGN to announce in 2014 a 213 billion Naira ($1.3 billion USD) credit facility from the Central Bank of Nigeria to alleviate the cash crunch within the value chain.[57] NERC is to oversee the financial allocation of this facility and is to be able to extract some commitments from DisCos, notably regarding the faster implementation of metering. It is important to note that this facility will not become available until TEM goes live.

One often cited reason found in the Nigerian press for the facility's necessity is to pay down legacy gas debts. However, according to industry experts, these represented less than 20 percent of the total cash liability spread across the DisCos (14 billion Naira). The remainder of the fund would then be allocated to help address accumulated revenue shortfalls and to ease the transition to sustainability on the basis of cost-reflective tariffs. This act, according to one DisCo CEO, has bought the sector "about 6 months of breathing space," if nothing otherwise changes.

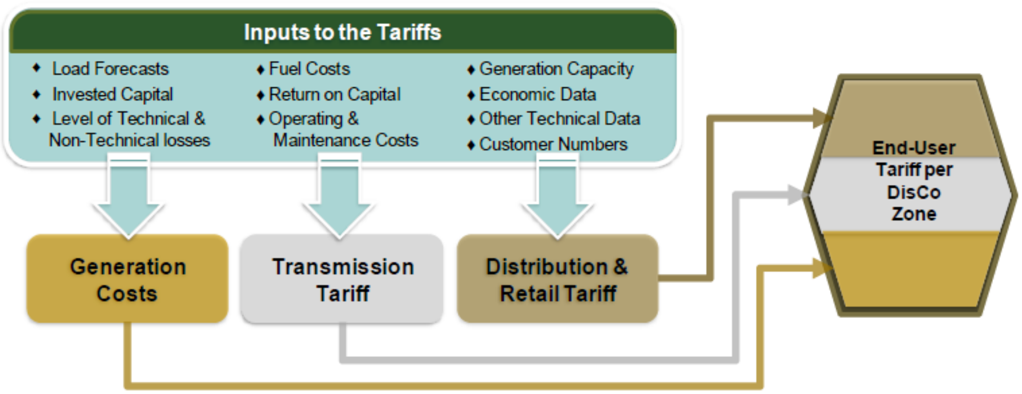
The key question, then, is why are the DisCos, and the sector in general, in such a dire cash position? There are two possible reasons: the MYTO rates are too low, and/or that the DisCos are facing operational constraints.

[56] Interviews with DisCos, NERC 2014, PHED 2014
[57] Central Bank of Nigeria 2014, Reuters Sept 2014

THE MULTI YEAR TARIFF ORDER (MYTO)

The Multi Year Tariff Order (MYTO) was established and formulated in partnership between the World Bank and NERC. It relies on a "building block" model to calculate the costs incurred by every actor in the value chain, then adds a certain amount of profit margin to ascertain a "fair return" to each actor. The logic is to both protect consumers while also ensuring all actors are profitable. This model seems to currently be in use only in Nigeria and Australia.[58] Figure 17 illustrates the MYTO methodology.

FIGURE 16: MULTI-YEAR TARIFF ORDER (MYTO) CALCULATION METHODOLOGY



Source: CSL Stockbrokers, NERC 2014

MYTO prices are to be established for five year periods, however during this time MYTO prices will also be reviewed (a) annually by NERC, but will only be modified according to "varying rates of inflation, cost of inputs of fuel for generation (primarily gas), and exchange rate fluctuation;" and (b) at any time where "industry participants can demonstrate to NERC that industry parameters have changed… to such an extent that a review is required urgently to maintain viability."[59]

One issue with a building block model such as the one employed in Nigeria is that it requires a large number of assumptions when determining tariff inputs. In the Nigerian case, these assumptions were often based on international best practices or other regional assumptions without clarity on the basis for the calculation of the assumptions. In addition to the five year review and exceptional reviews previously discussed, MYTO was designed to be revisited bi-annually in the early years of its application as more information became available.[60] Data constraints were also common.

The original MYTO was launched in 2007, and covered the five year period from 2007 to 2012. MYTO is currently on its second iteration (MYTO II), with tariffs having been revised already once in June 2012.[61] As of October 2014, discussion began to explore an additional update to MYTO II (or MYTO "2.1") that could further increase tariffs.[62]

Partially, this is due to the complaints from two primary actors in the electricity value chain: DisCos and GenCos. DisCos asserted that the tariffs were in general too low, especially for the most common residential inhabitants (R2 in the MYTO jargon, see Table 5 below). A particularly contentious issue, GenCos claimed that the generation tariff that would appear on PPAs was too

[58] Law Business Review, 2012
[59] Federal Republic of Nigeria Official Gazette no 18, Vol 94 April 27th 2007
[60] Phone conversation with Erik Fernstrom
[61] NERC, 2012
[62] NERC, 2014, local newspapers

low, and that this was hindering access to international financing which industry insiders state as the primary reason why NIPP purchase deals have not yet been closed: despite having seven selected buyers for seven selected plants, these investors have been unable to secure financing.

Azura West Africa, the only company that has successfully attracted foreign investors, agrees that this is a problem. According to its Chief Operating Officer, one reason Azura was able to secure a degree of international financing was by negotiating with NERC to receive a higher tariff on its PPA by having an "open book" relationship with NERC; it divulges all its costs in exchange of securing the requisite "cost plus" return the building block model is supposed to return. Azura is hoping not only to improve its business prospects, but also to help NERC understand the true cost of constructing a GenCo in Nigeria. Azura admits that as of October 2014, it was still pushing for a higher tariff.[63]

MYTO PRICES

The following MYTO prices are calculated for generation, transmission, and distribution retail tariff using a constant rate of exchange of 165 naira per US dollar throughout the years shown.

Generation Prices. Although gas prices are a factor in MYTO, according to industry participants any increase in the price of gas is directly passed on by the GenCos to the purchaser. In TEM, this would be NBET for the GenCos. It is assumed that the price would be then passed through to the DisCo and then ultimately the end consumer.

TABLE 2: MYTO II WHOLESALE GENERATION PRICE BY TYPE OF PLANT IN NAIRA/KWH

Tariff N/kWh	2012	2013	2014	2015	2016
Successor gas GenCo	9.56	10.26	12.14	13.17	14.30
New gas GenCo	10.74	11.53	13.52	14.67	15.91
Coal plant	25.11	27.02	29.10	31.56	34.23
Successor large hydro	1.44	1.56	1.69	1.84	1.99
Feed in tariff small hydro	23.56	25.43	27.46	29.64	32.01
Feed in tariff wind	24.54	26.51	28.64	30.94	33.43
Feed in Tariff solar	67.92	73.30	79.12	85.40	92.19

Source: NERC 2012

Azura was able to negotiate a higher price. According to the World Bank PRG documents, the wholesale price Azura' Edo and Exxon's Qua Iboe power plants are to get for their PPA are known: respectively 10.05 cents USD/kWh and 8.64 cents USD/kWh. As can be seen in Table 3, Azura is getting almost 2 cents more per kWh than the MYTO price (or an 11 percent increase), while Exxon is only getting 0.45 cents more than MYTO (3 percent increase). The reason for this discrepancy is not known, although the World Bank documents mentions that Qua Iboe assumes a $2 USD/mmbtu[64] gas price where as Azura expects to pay closer to 3 USD.[65] Since Exxon's Qua Iboe PRG is not finalized, this price might still change.

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[63] Interview with Azura COO
[64] World Bank, 2014
[65] Interview with Azura COO

TABLE 3: MYTO II WHOLESALE GENERATION PRICES IN USD CENTS/KWH VS AZURA AND QUA IBOE TARIFFS

MYTO Tariff in cents/kWh	2012	2013	2014	2015	2016
Successor gas GenCo	5.80	6.22	7.36	7.98	8.66
New gas GenCo	6.51	6.99	8.19	8.89	9.64
Coal plant	15.22	16.38	17.63	19.13	20.75
Successor large hydro	0.87	0.95	1.03	1.11	1.21
Feed in tariff small hydro	14.28	15.41	16.64	17.97	19.40
Feed in tariff wind	14.87	16.07	17.36	18.75	20.26
Feed in tariff solar	41.16	44.42	47.95	51.76	55.87
Azura Required			10.05		
Exxon Mobile Required			8.64		

Source: NERC 2012, World Bank 2014
Exchange rate $1 USD = 165 Naira

Transmission Prices. In contrast, TCN's Transmission Service Provider (TSP) has three revenue considerations to take into account:

- A connection charge for GenCos (a onetime payment to be connected to the system)
- A Transmission Use of System (TUOS) charge paid by DisCos/licensed retailers, and what is commonly referred to as the tariff. This is the heart of the tariff, and is split into a variable energy charge (80 percent of the tariff, linked to the amount of power given) and a capacity charge (20 percent)
- A transmission loss factor is applied to generation to help GenCos cover any costs caused by inadequate transmission (included in GenCo tariff) as a fixed percentage.

From this point, the report focuses on the TUOS or the tariff. According to NERC, the TUOS is structured as shown in Table 4.

TABLE 4: MYTO II APPROVED CHARGES FOR TCN IN NAIRA/KWH AND USD CENTS/KWH

N/kWh	2012	2013	2014	2015	2016
Energy Charge	1,217	1,138	1,120	1,225	1,368
Capacity Charge	304	284	280	3.06	342
Total	1,521	1,422	1,400	1,531	1,710

USD Cents/kWh	2012	2013	2014	2015	2016
Energy Charge	7.38	6.90	6.79	7.42	8.29
Capacity Charge	1.84	1.72	1.70	1.85	2.07
Total	9.22	8.62	8.48	9.28	10.36

Source: NERC 2012
exchange rate $1 USD= 165 Naira

The data in Table 4 on transmission charges are assumed to include the generation prices for the most part. For example for a new gas GenCo in 2015, the transmission company would charge the DisCo 9.28 cents/kWh, and then in turn pay the GenCo 8.89 cents/kWh (as shown in Table 3). Thus, in this example, TCN would retain 0.39 cents/kWh. Based on this interpretation, the approved charges for transmission are assumed to include generation costs that are indicative to some extent of the successor gas and new gas plants' costs, and that other plants such as renewables are assumed to be subsidized since the transmission charges do not reflect the cost of renewables generation as presented in the NERC tables.

Retail Tariffs. Tariffs for the DisCos are adjusted for each region, so the 11 DisCos have slightly different retail tariffs. NERC has decided load allocations for each DisCo. This load allocation was originally intended to be temporary until 3.2 GW of power were consistently supplied,[66] but it is uncertain how long this allocation will last. Table 5 presents an average of the tariff rates that were established June 1, 2014 in Naira per kWh, Table 6 in USD cents per kWh, and Table 7 defines consumer segment classifications. The DisCo revenue is predicated on the difference between the transmission charges and the retail tariff.

The DisCos retail tariff has been the most examined and discussed as it serves as the foundation of the entire value chain (i.e., if the DisCos don't obtain cash flow, no other financial participant in the value chain will not either). Unfortunately, as of late 2014 the DisCos have been losing money on an accounting basis and facing significantly constrained cash liquidity.

TABLE 5: 2014 RETAIL TARIFF BY DISCO AND CONSUMER SEGMENT IN NAIRA/KWH

Customer Class	Abuja	Benin	Eko	Enugu	Ibadan	Ikeja	Jos	Kaduna	Kano	Port H.	Yola	Avg.
Load Allocation	11.5%	9%	11%	9%	13%	15%	5.5%	8%	8%	6.5%	3.5%	100%
R1	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.00
R2	14.7	14.8	15.6	16.4	16.1	13.2	16.8	17.0	16.0	15.1	15.0	15.5
R3	23.8	21.3	23.7	24.6	25.8	23.2	25.8	28.2	25.8	24.8	22.7	24.5
R4	23.8	21.3	23.7	24.6	25.8	23.2	25.8	28.2	25.8	24.8	22.7	24.5
C1	17.4	16.6	15.8	18.1	17.1	17.6	18.7	19.4	17.5	18.3	17.9	17.7
C2	22.1	19.8	22.0	22.9	24.0	21.5	24.0	26.2	24.0	23.1	21.1	22.8
C3	22.1	19.8	22.0	22.9	24.0	21.5	24.0	26.2	24.0	23.1	21.1	22.8
D1	17.8	16.0	17.8	18.5	19.4	17.4	18.7	21.2	19.4	24.8	17.9	19.0
D2	23.1	20.8	23.1	24.0	25.1	22.6	25.1	27.5	25.1	24.2	22.1	23.9
D3	23.1	20.8	23.1	24.0	25.1	22.6	25.1	27.5	25.1	24.2	22.1	23.9
A1	17.1	15.3	17.0	20.3	18.5	16.6	18.5	20.3	18.5	17.8	17.5	18.0
A2	17.1	15.3	17.0	20.3	18.5	16.6	18.5	20.3	18.5	17.8	17.5	18.0
A3	17.1	15.3	17.0	20.3	18.5	16.6	18.5	20.3	18.5	23.8	17.5	18.5
L1	14.1	15.8	13.1	15.6	14.2	12.8	17.9	17.2	14.2	18.3	16.0	15.4

Source: NERC 2014

TABLE 6: 2014 RETAIL TARIFF BY DISCO AND CONSUMER SEGMENT IN USD CENTS/KWH

	Abuja	Benin	Eko	Enugu	Ibadan	Ikeja	Jos	Kaduna	Kano	Port H.	Yola	Avg.
Load Allocation	11.5%	9%	11%	9%	13%	15%	5.5%	8%	8%	6.5%	3.5%	
R1	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
R2	8.9	9.0	9.5	10.0	9.8	8.0	10.2	10.3	9.7	9.15	9.1	9.4

[66] NERC, 2012

	Abuja	Benin	Eko	Enugu	Ibadan	Ikeja	Jos	Kaduna	Kano	Port H.	Yola	Avg.
Load Allocation	11.5%	9%	11%	9%	13%	15%	5.5%	8%	8%	6.5%	3.5%	
R3	14.4	12.9	14.4	14.9	15.6	14.0	15.6	17.1	15.6	15.1	13.8	14.9
R4	14.4	12.9	14.4	14.9	15.6	14.0	15.6	17.1	15.6	15.1	13.8	14.9
C1	10.5	10.1	9.6	11.0	10.4	10.7	11.4	11.7	10.6	11.1	10.8	10.7
C2	13.4	12.0	13.4	13.9	14.5	13.1	14.5	15.9	14.5	14.0	12.8	13.8
C3	13.4	12.0	13.4	13.9	14.5	13.1	14.5	15.9	14.5	14.0	12.8	13.8
D1	10.8	9.7	10.8	11.2	11.7	10.5	11.4	12.8	11.7	15.1	10.8	11.5
D2	14.0	12.6	14.0	14.5	15.2	13.7	15.2	16.7	15.2	14.7	13.4	14.5
D3	14.0	12.6	14.0	14.5	15.2	13.7	15.2	16.7	15.2	14.7	13.4	14.5
A1	10.3	9.3	10.3	12.3	11.2	10.1	11.2	12.3	11.2	10.8	10.6	10.9
A2	10.3	9.3	10.3	12.3	11.2	10.1	11.2	12.3	11.2	10.8	10.6	10.9
A3	10.3	9.3	10.3	12.3	11.2	10.1	11.2	12.3	11.2	14.4	10.6	11.2
L1	8.5	9.6	7.9	9.4	8.6	7.7	10.8	10.4	8.6	11.1	9.7	9.3

Source: NERC 2014
Exchange rate $1 USD = 165 Naira

TABLE 7: NERC CONSUMER SEGMENTATION

Residential	
R1	Consumption is below 50 kwh per month, typically one fan, radio, 2-3 light bulbs
R2	Consumption is above 50 kilowatt hrs per month. Majority of households fall under this category
R3	Large residences e.g. government house, small estates, have dedicated transformer and maximum demand (MD) meters
R4	Large estates, also with dedicated transformers and maximum demand meters
Commercial	
C1	Small businesses e.g. small barbing and hair dressing salons
C2	Hotels, also with dedicated transformers and maximum demand meters
C3	Large supermarkets or hypermarkets with dedicated transformers and MD meters
Industrial	
D1	Small industries e.g. welders, pure water packagers etc.
D2	Larger scale industries, e.g. metal fabrication companies with dedicated transformers and MD meters
D3	Oil companies, large construction companies with dedicated transformers and MD meters
Special	
A1	Schools, mosques and churches
A2	Medium sized army barracks with dedicated transformers and maximum demand (MD) meters
A3	Large barracks, large agricultural processing companies with dedicated transformers and maximum demand (MD) meters
L1	Street lights

Source: NERC, 2014

R1 and R2 segments are cross subsidized by other segments. According to NERC's original estimates, the cost of servicing these customers ranges between 20 and 24 Naira/kWh. If one looks at each sector using a non-weighted average, then servicing a residential home yields a potential 17.14 N/kWh, a special client 18.13 N/kWh, a commercial entity 21.08 N/kWh, and an industrial client 22.25 N/kWh. This is not fully accurate, however, because weighted averages should be used, particularly because residential clients R2 represent the majority of clients. However, even in this non-weighted average, it quickly becomes clear that there are certain clients that a loss making DisCo would want to prioritize: industrial enterprises, followed by commercial and wealthy residential.

Based on a review of the tariffs, the most recent DisCo tariff is not particularly low when compared to international norms (with the exception of the R1 and R2 residence). For comparison, the EDF price per kWh in France is approximately 17.8 cents/kWh.[67] Therefore, the causes of the DisCos' financial woes are likely found elsewhere, such as within DisCo operations and the challenge of obtaining payments from its customers.

METERED AND UN-METERED ELECTRICITY OFF-TAKERS

Tariffs can only be effectively applied if metering is used. Unfortunately at this time a large proportion of Nigerian energy customers are still unmetered (exact numbers are unknown, but likely to be near 50 percent). NERC has issued an official methodology for calculating estimated billing using the "weighted average cluster load."[68] This method requires knowing the "averages of the proportions of the consumptions for the various classes of customers in the urban and rural areas," from which a set proportion is allotted to each individual based on the total amount of power sent from distribution substation to a distribution transformer. In other words, a price is derived based on the historical amount of power a specific area receives.

NERC is seeking to impose more metering by the DisCos through a variety of schemes, including the Credited Advance Payment for Metering Implementation (CAPMI). In essence the consumer pays the original cost for the meter and its installation (40,000-50,000 Naira for a residential meter). This amount is deducted from the consumer's future monthly energy bill, with the consumer in other words financing the DisCos installation of meters. Because the customer is financing the installation, the original sum is subject to a 12 percent interest charge, incentivizing him to purchase the meter. In urban areas, all meters are required to be "smart" meters with prepayment functionality, and all demands for meters should be fulfilled within 45 days of their request. Although CAPMI has been in place since May 2013, its execution and roll out have been slow. Based on consumer interviews, they seem uncertain or unaware of how CAPMI is supposed to work. Others state that the 45 days rule is often not followed, and that the DisCos are slow at rolling out meters.

DISTRIBUTION COMPANY (DISCO) OPERATIONS

Although there are 11 different DisCos in Nigeria, only three DisCos operate in the Niger Delta; the Port Harcourt Electricity Distribution (PHED) and Benin Electricity Distribution Company (BEDC) the two primary DisCos for the Delta, which cover seven of the nine NDPI target states. The last two states (Abia and Imo) are two of the five states covered by the Enugu Electricity Distribution Company (EEDC).

DisCos are responsible for the distribution network within their geographic zones. However, as was already mentioned, several other stakeholders including NREA, the NDDC, IOCs, and state ministries of power also play a role in electrification and distribution including by providing communities with transformers. According to the DisCos and GIZ, however, these transformers are often placed in communities by state officials without consultation with the DisCos. The result is

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[67] EDF website, 2014
[68] NERC 2012

that the transformers that are present often do not function well the DisCos' existing distribution network.

PHED services four states (Rivers, Cross Rivers, Bayelsa, and Akwa Ibom). It further subdivides these states into fifteen business units. The exact distribution grid mapping is not known for the DisCo. According to its load allotment, PHED receives 6.5% of the total country-wide generation.

Simple Performance and financial analysis. In September 2014 PHED received 150,312 Megawatt Hours (MWh) of power from TCN. It billed its clients for 121,812 MWh of electrical energy, having lost the rest due to technical issues in distribution. These losses represent about 20 percent of power linked to faults in the 33 kV distribution networks (which to some extent is inevitable). Nevertheless, this is an initial loss incurred versus generation.

Table 8 demonstrates PHED's financials for the month of September 2014 in both USD and Naira. The cost of inputs paid to the TCN MO represents 86 percent of total costs, with the remaining 14 percent accounted for by the DisCo's operating and staff costs. The table indicates that only 52 percent of the total amount billed to consumers was actually collected. In other words, 48 percent of bill amounts are currently left unpaid by consumers. Were all customers to pay their bills, on the other hand, PHED would make a profit with revenue exceeding cost ($14.4 million billed, $12.9 million total cost).

TABLE 8: PHED SEPTEMBER FINANCIAL RESULTS IN USD AND NAIRA FOR THE MONTH OF SEPTEMBER 2014

	Amount Billed To Clients	Cash Collected	Staff Costs + Operating Costs	Market Operator Costs (Input Pmt.)	Total Costs	Profit
Naira	2,372,623,000	1,238,579,000	299,143,000	1,836,041,000	2,135,184,000	- 896,605,000
USD	$14,379,500	$7,506,500	$1,813,000	$11,127,500	$12,940,500	- $5,434,000

Source: PHED, 2014
Exchange rate $1 USD = 165 Naira

Because 150 million kWh were sent through the distribution network, of which 122 million kWh made it to customers, average revenue per kWh can be calculated as follows: *Amount collected/kWh = 1,238,579,154/121,812,819= 10.17 N or 6.2 cents USD/kWh, or the apparent tariff based on the revenue collected versus the electrical energy provided.*

Similarly, cost of inputs can be calculated as: MO costs/total amount of energy received = 1,836,041,000/150,314,051= 12.21 Naira or 7.4 cents USD/kWh in payment to the MO (which is less than the amount given to the MO under MYTO II).

Staff + operating costs / total amount of energy received = 299,142,675 / 150,314,051 = 1.99 Naira or 1.2 cents USD per kWh of energy received.

What If scenario. What would happen if the 20 percent technical losses were eliminated but bill collection remained the same? PHED would have lost 729,878,664 Naira that month ($4.4 million USD). Therefore, although reducing the technical losses would be helpful, the key would be to reduce unfulfilled bill payment—i.e., get more consumers to pay.

If we continue to assume 20 percent technical losses, then collection rate would have to increase from the current 52 percent to 90 percent for PHED to make a small 176,545 Naira ($1069 USD) profit. In fact, based on the current assessments, profitability becomes material only starting 93 percent collection rate, where PHED would have earned 71 million Naira ($432,000 USD).

This seems to provide support for the point that the problem is not the tariff itself, but rather an issue found at the level of the DisCo. The consumer/DisCo commercial relationship is particularly problematic; consumers are either unable or unwilling to pay their bills to DisCos, and/or DisCos do not have the capacity to collect effectively.

PHED provided extensive details on the financials and performance of their 15 business units. This is shown in Table 9, and provides some insights on both the consumer relationship and the type of consumers currently being serviced by DisCos.

Table 9 demonstrates that the PHED business unit (which corresponds to specific geographic areas) that receives the most electricity is Trans-Amadi, Port Harcourt's industrial area. This Port Harcourt district received 13 percent of the entire electrical energy allocation across four states; and also accounted for 20 percent of all cash collected by PHED in September 2014.

The next three largest business units in terms of electrical energy received (and for two out of three, in terms of cash received) represent major urban centers: Calabar and its surrounding area (Cross Rivers State capital), Uyo and its surrounding area (Akwa Ibom State Capital), and Yenagoa (Bayelsa State capital). These four business units together receive 47 percent of all electricity. Still Trans-Amadi stands out, since it is by far the most profitable unit (20 percent of collected payments for 13 percent of power), and has one of the highest collection rates.

This highlights a trend predicted during the analysis of the tariff structure: high worth clients are the most attractive electricity off-takers for DisCos, especially in the circumstances where the DisCos are losing money. Industries such as those located within Trans-Amadi are more likely to pay on time for power, since it is a requisite for their business' financial viability. They are also subject to a higher tariff rate. Similarly, high tariff residential clients (MYTO R3 and R4 customers) and commercial clients (MYTO C2 and C3) are more prominent in urban areas than in peri-urban or rural ones.

TABLE 9: PERFORMANCE AND FINANCIALS BY PHED DISTRICTS IN SEPTEMBER 2014

District	Description	Estimated Population	Power Received (kWh) (w/o ATC), from Largest To Smallest	% Of Total Power Received (w/o ATC)	Power Per Person (kWh/ Person)	Amount Billed (N)	% Of Total Amount Billed	Colle ction %	Payment Posted	% Of Total Payment Received
Trans Amadi	Industrial area of Port Harcourt	N/A (mainly manufactur-ing)	19,721,407	13.12%		310,098,750	13.07%	78%	241,877,025	19.53%
Calabar	Capital of Cross Rivers	350,000	18,705,120	12.44%	53.44	222,154,121	9.36%	63%	139,957,096	11.30%
Uyo	Capital of Akwa Ibom	600,000	16,480,497	10.96%	27.47	276,115,145	11.64%	49%	135,296,421	10.92%
Yenagoa	Capital of Bayelsa	400,000	15,515,722	10.32%	38.79	211,438,382	8.91%	34%	71,889,050	5.80%
Rumuola	Port Harcourt suburb		12,048,028	8.02%		225,706,647	9.51%	50%	112,853,324	9.11%
Ahoada	2 Local Gov't Areas (LGAs)	411,000	11,705,973	7.79%	28.48	158,409,876	6.68%	29%	45,938,864	3.71%
Borokiri	Port Harcourt neighborhood		10,596,819	7.05%		168,900,705	7.12%	61%	96,630,024	7.80%
Eket	City/Town	400,000	10,371,910	6.90%	25.93	168,245,285	7.09%	28%	47,108,680	3.80%
Diobu	Port Harcourt dense residential		9,712,790	6.46%		160,459,748	6.76%	50%	80,229,874	6.48%
Onne	Port	N/A (port)	5,809,512	3.86%		81,360,513	3.43%	36%	29,289,785	2.36%
Oyigbo	Local Gov't Area (LGA)	170,000	5,426,974	3.61%	31.92	104,114,153	4.39%	78%	81,209,039	6.56%
Ikot Ekpene	City	280,000	2,962,145	1.97%	10.58	60,630,313	2.56%	38%	23,039,519	1.86%
Ikom	LGA	180,000	1,515,126	1.01%	8.42	28,654,567	1.21%	80%	22,923,654	1.85%
Ogoja	LGA	172,000	1,453,010	0.97%	8.45	27,426,467	1.16%	72%	19,747,056	1.59%
Total			150,312,049			2,372,622,543			1,238,579,154	

Source: PHED, 2014

Aggregate Technical and Commercial Losses (ATC). ATC is a measure of performance for a DisCo, because it allows a comparison of how much energy was "sent" to clients versus how much a client was billed. The reason for the discrepancy can be technical (the client receives less than was sent because of distribution network performance issues) or commercial (there is a billing error and client is charged less). Table 11 shows the ATC losses per business unit for PHED. It highlights an important trend which is also supported by an analysis of customer complaints: the most profitable clients are not necessarily serviced effectively.

For example, Trans-Amadi has the highest amount of ATC losses in kWh, followed by Yenagoa and Uyo. The reason for these losses is not known, but indicate that high grossing areas may still provide more revenue. Similarly, of the 1,069 recorded complaints PHED received in the month of September 2014, 158 (14 percent) were from Trans Amadi clients and 193 (18 percent) were from Calabar, the two top grossing business units. This indicates that the clients are also more demanding and are still unsatisfied with the PHED service. However, as was shown in the previous What If scenario, fixing these losses will not have a major impact on total profitability, unless they are accompanied by a corresponding increase in collection rates.

TABLE 10: ATC LOSSES BY PHED BUSINESS UNIT IN SEPTEMBER 2014 IN KWH

District	Description	Power received (kWh)	Amount Billed (KWh)	Aggregate technical & commercial (ATC) losses	ATC as % of energy received
Trans Amadi	Industrial area of Port Harcourt	19,721,407	14,349,464	5,371,943	27%
Calabar	Capital of Cross Rivers	18,705,120	17,213,981	1,491,139	8%
Uyo	Capital of Akwa Ibom	16,480,497	14,033,617	2,446,880	15%
Yenagoa	Capital of Bayelsa	15,515,722	11,828,098	3,687,624	24%
Rumuola	Port Harcourt Suburb	12,048,028	9,863,911	2,184,117	18%
Ahoada	2 LGAs	11,705,973	8,826,210	2,879,763	25%
Borokiri	Port Harcourt Neighborhood	10,596,819	7,472,698	3,124,121	29%
Eket	City/Town	10,371,910	8,617,433	1,754,477	17%
Diobu	Port Harcourt Neighborhood	9,712,790	7,803,403	1,909,387	20%
Rumuodomaya	Port Harcourt area	8,289,018	7,364,082	924,936	11%
Onne	Port	5,809,512	4,146,123	1,663,389	29%
Oyigbo	LGA	5,426,974	4,764,654	662,320	12%
Ikot-ekpene	City	2,962,145	2,948,835	13,310	0%
Ikom	LGA	1,515,126	1,325,879	189,247	12%
Ogoja	LGA	1,453,010	1,254,451	198,559	14%
Total		150,314,051	121,812,839	28,501,212	19%

Source: PHED 2014

Conclusions for DisCo and implications for the value chain. In terms of simple revenue and expense figures (pricing), distribution companies should be profit-making institutions. However, these DisCos are loss making institutions, primarily because of poor collection ratios, hovering around 50 percent. Since the DisCos are the cash and revenue entry point for the entire value chain, all DisCo-level shortfalls are felt throughout the value chain, at least until NBET becomes functional. At that point, in theory, NBET can help make up the shortfall. However, according to industry insiders, even NBET does not have enough capital to support the current aggregate shortfall in revenue across all 11 DisCos.

Within this context, it makes sense to prioritize the highest paying (industrial, middle to large commercial and high end residential clients) in order to maximize potential revenue. Since these clients are more dependent on grid power for their own profitability (as self-generation can cost twice as much as the grid power, as will be seen in Section 4), they are also more likely to pay their bills on time.

Yet even within this context, high value customers still suffer ATC losses and post high numbers of complaints. It is therefore logical to expect, in the near future, for DisCos to focus any near term investments and improvements on this select category of individuals. This is assuming that NERC allows them to do this.

Ideally, the DisCos would improve their collection efficacy. This can be partly done through metering but would require CAPEX from the DisCos, which are currently do not have their own cash or adequate access to external finance to do so.

ON GRID ELECTRICITY CONSUMERS

Overall, information on Niger Delta electricity customer/off-taker segmentation is not widely available. Several reports, including a customer satisfaction survey done by SDN on behalf of PHED, are currently being drafted, but have not yet been released. Still, some anecdotal evidence was compiled, primarily through interviews of value chain actors, for this report. A survey of four peri urban locations in Rivers and Bayelsa state (two in each state) completed by SDN provides some basic information regarding Niger Delta consumers.

EVIDENCE FROM INTERVIEWS

For this report, several sites were visited around Port Harcourt to discuss the availability of power. These included a hospital, a small business center, an SME that produces plastic pipes and tubes, and a hotel in Bori. Many of those interviewed were not were not familiar with PHED as their distribution company and instead most frequently referred to the now defunct NEPA when talking about the on grid power. Complaints included the continued use of estimated billing, the regular lack of power, and the request to pay a fixed connection fee. Estimated billing was a practice allowed under NEPA. According to consumers, estimated billing was based on size of building, not the NERC formula.

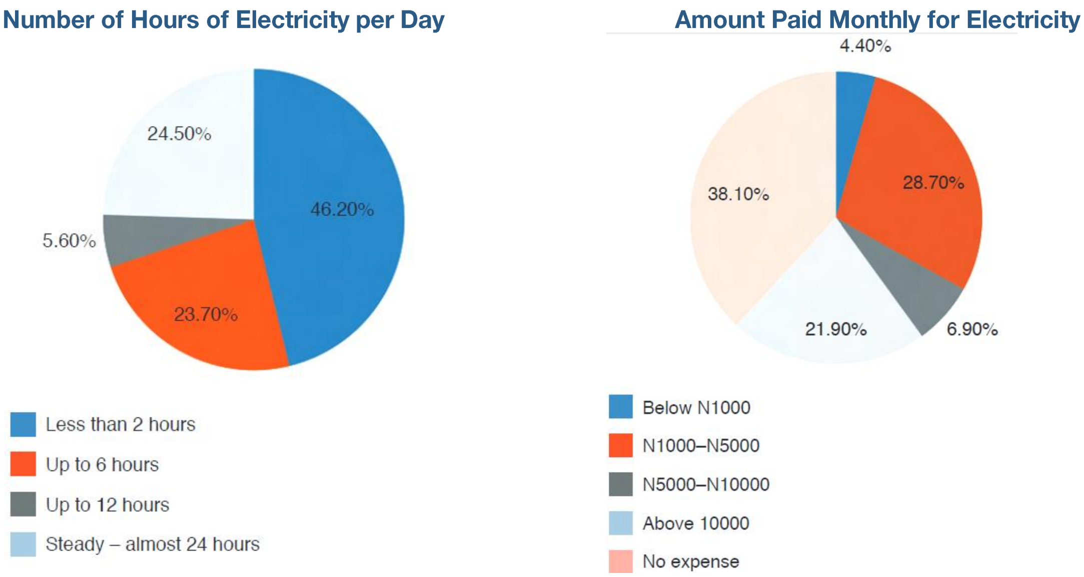
Consumers also expressed concern that some of the PHED bill collectors were the same as pre-privatization, and they suspect them of cheating them out of money. They also were not supportive of the connection charge—some stated they received less than one hour of power per week at times. However, they stated that they would not necessarily trust a “NEPA” meter.

The primary reason stated for this sentiment was the consumers’ experience with petrol pump meters at gas stations. It is common in the Niger Delta for petrol stations to have faulty meters. This is so widespread that one often sees individuals fill up jerry cans at petrol pumps to make sure they are receiving the correct amount of petrol. It seemed, in general, that consumer awareness of how the power system was supposed to work was quite low. Some knew about the CAPMI project but did not seem to understand how it worked. Others seemed to think that having a pay as you go meter would exempt them from the connection charge.

EVIDENCE FROM SDN RESEARCH

The Stakeholder Democracy Network NGO (SDN) has conducted a survey of four communities in two states (Bayelsa and Rivers). Of 160 households interviewed, 92.5 percent of the individuals were connected to a power distribution network. Although 46.9 percent only state they were connected to the national grid, the paper warns about reading too much into these numbers since many individuals did not know the origin of their power.

FIGURE 17: KEY FINDINGS FROM SDN REPORT FOR FOUR COMMUNITIES IN THE NIGER DELTA



Source SDN

Although significant insights were gained through SDN and this report's interviews, it is clear that more research is needed to understand the Niger Delta energy end consumers' knowledge, needs, ability to pay, and supply expectations. However even at this time, it seems clear that the end consumer is generally dissatisfied with the service, does not understand how the service works, and does not properly understand communications from the DisCo.

ON GRID VALUE CHAIN MAP AND DISCUSSION

As has been noted throughout this section, the understanding of the value chain is far from complete. Information regarding the end consumer is still quite light, as are some operating cost data for actors within the chain. Still, there is sufficient information to draw a preliminary value chain map under current conditions. This section first highlights some on the grid CAPEX expenditures for different actors, notably different types of GenCos and the TCN.

CAPITAL EXPENDITURES IN THE VALUE CHAIN

Table 11 provides illustrative estimates of the capital expenditure per kW (EPC not included) calculated by the World Bank and UNIDO as required to build power plants in Nigeria to the below output specifications.

TABLE 11: CAPEX (NO EPC) BY TYPE OF GENERATION IN USD/KW

Type of Generation	$/kw
MYTO2 assumptions for open cycle new gas plant (250 MW)	1,433
Azura-Edo open cycle gas turbine plant (459 MW)	1,771
Qua Iboe/Exxon combined cycle gas plant (533 MW), excluding cost of transmission line	1,876
Small Hydro	2,000
UNIDO-supported rice husk biomass plant (5MW)	2,920

Source: World Bank 2014, UNIDO 2014

The assumed CAPEX in MYTO is significantly lower than the actual CAPEX envisioned by new Greenfield IPPs. This again helps explain why these two IPPs are requesting a higher tariff from NERC, and further highlights some of the erroneous assumptions that have so far underlined the MYTO system.

TABLE 12: ESTIMATE OF POWER ALLOCATION BY CUSTOMER SEGMENT BASED ON PHED REVENUE

	Average Tariff N/kWh	% power allocation	Revenue in N/kWh
D2+D3+R2+R3	24.51	18%	537,413,795
C2+C3	23.07	15%	421,533,260
D1+C1+A1+A2+A3	20.50	32%	798,936,172
R2+L1	16.67	29%	588,879,711
R1	2.42	6%	17,718,228.22
Total		100%	2,364,481,166.36

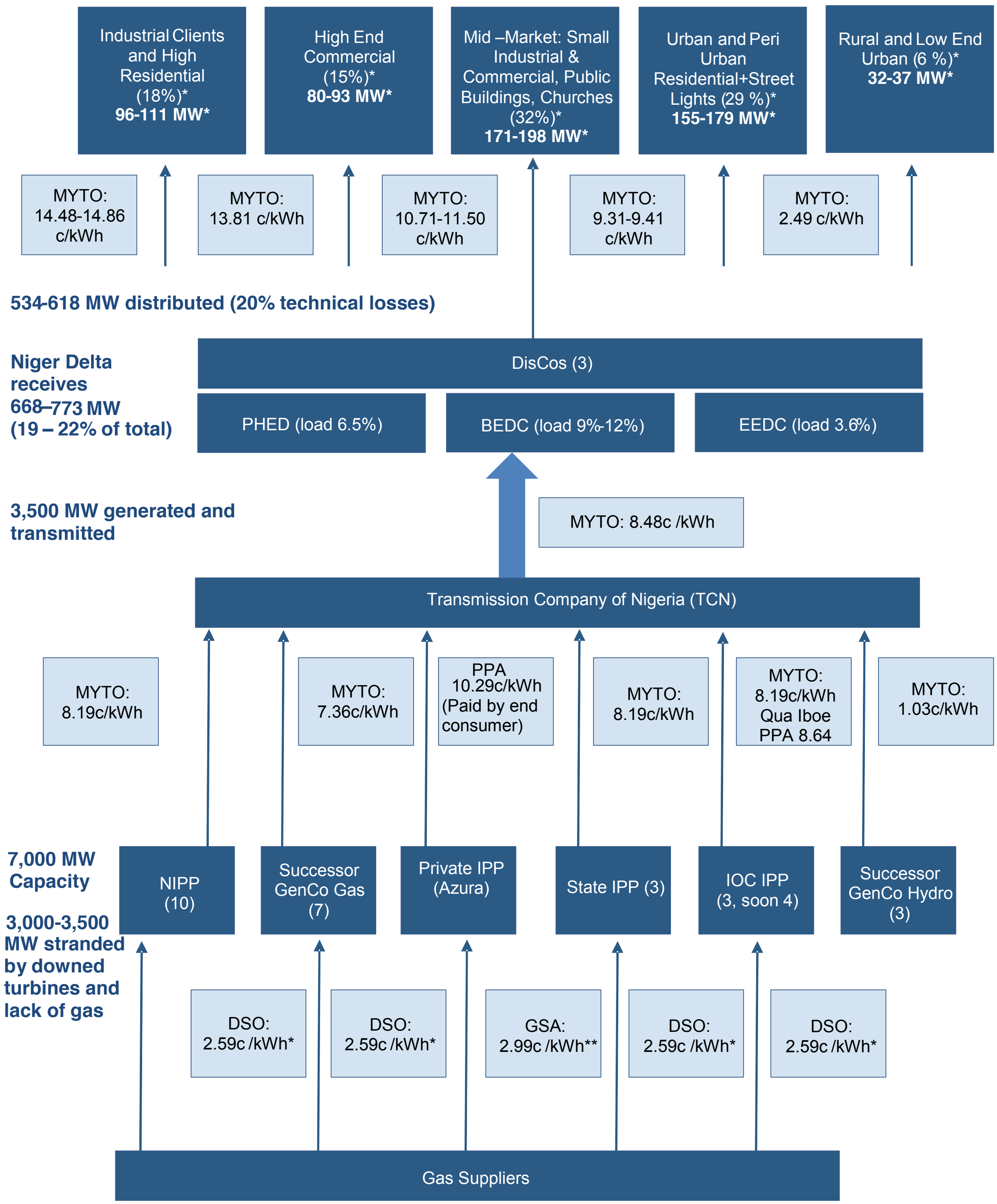
Source: PHED 2014 and calculated estimates

Value Chain Map Assumptions

Some assumptions have to be made for the purpose of consumer segmentation. Four segments have been made based on the most current MYTO prices. Also, based on PHED, a simple model was used to estimate percentage of power allocated to each segment, as can be seen in Table 12. It is important to note that the percentages are estimates based on the PHED example and basic knowledge of the country.

- Industrial and high worth clients: these are heavy industrial (D2, D3) and high end residential (R3 and R4) clients. Since the area of Trans-Amadi is essentially D2 and D3 clients and it alone receives 13 percent of PHED's power allocation, it is safe to assume that this segment receives 18 percent of the total allocation of power across the four states covered by PHED.
- High end Commercial clients: C2 and C3 clients, most likely located in urban areas. Power allocation this is estimated at 15 percent.
- Mid-market: This is primarily the small industries such as welders (D1), commercial business such as bars or barbers (C1), and all special "A" customers (schools, churches, military barracks, government buildings). Power allocation is estimated 32 percent, making this the largest segment.
- Residential urban, peri-urban, and street lights: these are R2 and L1 connections, and is estimated at 29 percent.
- Rural and low end urban: These will be mainly R1 connections, using less than 50 kW. Note that it is unlikely that most urban or peri urban individuals are legally connected on an R1 line. Power allocation is estimated at 6 percent.

FIGURE 18: NIGER DELTA ON GRID VALUE CHAIN MAP (MYTO II TARIFFS)



** 2.59c/kWh derived from $2.50 gas + $0.80 pipeline transit tariff = $3.30 per mmbtu, heat rate 7860 btu/kWh*
***Azura IPP GSA of 2.99c/kWh $3.00 gas + $0.80 transit = $3.80 per mmbtu, heat rate 7860 btu/kWh*

ON GRID ELECTRICITY VALUE CHAIN FINDINGS

The value chain analysis of the on grid electricity segment in the sector highlights several important points that should be kept in mind when assessing opportunities for intervention:

- DisCos face serious cash shortfalls in terms of collection (an estimated 50 percent payment rate) that greatly weakens the commercial viability of future private sector investment. Recent FGN bail-outs underscores this aspect (213 billion Naira credit facility).
- Poor quality and consistency of power supplied through the on grid network drives, in part, poor payment and collection. Consumers do not feel fully obligated to pay for power that they either do not consume or are not able to leverage with any consistency to improve productivity, business operations or life style. This is made even worse given the extra estimated cost of operating and running individual/household and business generators on an ad-hoc basis.
- The grid is greatly insufficient to meet current needs. According to the AfDB, of the 41 percent of the Nigerian population that has access to grid electricity, only 30 percent of that number state that their power needs are currently met.[69] Under-investment, poor maintenance, and insufficient generation, transmission and distribution contribute to this gap.
- There is no clear understanding of why consumers are not paying the DisCos leading to the 50% average non-payment rate.
- The complexities of the political economy of the sector as well as the high costs required for investment make it difficult to enter and provide solutions. This is in part technical, part cost (cost to invest and make an impact is quite high) and part institutional. FGN's role in the sector is unclear and inconsistent up and down the value chain and public sector agencies are weak in capacity to push through and implement much-needed reforms.

[69] AfDB 2014

4. Off Grid Electricity Value Chain

This section addresses the estimated 6 GW of Nigerian off the grid electricity generation. The sources of off grid generation vary greatly, from small gas plants to diesel generators and solar micro-grids. Self-generation is particularly important particularly at peak load times when load shedding occurs on grid. Given the paucity of on grid electrical power relative to demand, often it is the same electricity off-takers who exist in the on grid and off grid consumption spaces. This is particularly true for consumers that require stable power (even if the consumer is technically on grid). DisCos have yet to establish brown out or black out schedules within the value chain, which means that power can disappear at any moment—particularly troubling for industrial and commercial clients; the very ones that DisCos already provide with the bulk of their on grid power.

As with the previous sections, this off grid presentation will begin with a brief overview of the value chain and a discussion of known self-generation, captive generation, and micro grid models. The next section will highlight several different known models from various IOCs. After which, the report will present some information on a substitute for all the previously described models: small solar powered appliances. The section will conclude with a current off the grid value chain map.

OVERVIEW

Off grid generation currently provides, by most estimates, the majority of power in Nigeria, although that should change by the middle of 2015 (see Section 2). However, even then, on grid generation will be unable to meet effective demand (Graph 8, Section 2). Therefore it is appropriate that stakeholders take a closer look at off grid generation; particularly both the FGN and the international donor community, which is looking at renewable energy as a way to bridge the demand gap. DFID, USAID, the AfDB, and GIZ all have programs currently on-going or just starting involving renewable off grid energy.

As was mentioned in Section 3, Nigeria recognizes multiple forms of generation, including embedded and captive generation. Embedded corresponds to a small GenCo (< 20 MW) directly connected to a distribution system, whereas captive generation is a power plant that services only one or a specific set of clients. Self-generation is a subgroup of captive generation. This section discusses in more detail what these mean within the Nigerian context, with special focus paid to the Niger Delta States.

SELF-GENERATION

Self-generation in this context refers to generating power for one's own use, whether domestic or commercial. In Nigeria, this is primarily achieved via diesel and petrol generators. Though some solar self-generation does exist, it is currently negligible. Indeed, the World Bank estimates in its Assessing Low Carbon Demand for Nigeria paper that 50 percent of all current electricity (or approximately 5 GW) is provided by diesel and petrol generators.

It is important that for NERC, self-generation is unregulated and is limited to all generation providing less than 1 MW. Beyond the 1 MW threshold, self-generation becomes either captive generation or embedded generation (if servicing a DisCo), and must be registered with NERC.[70]

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[70] NERC 2008

Cost of Inputs

The primary advantage of self-generation is that it is reliable and controllable, which is important when working in a location where on grid power supply is often unreliable. It is particularly important to industrial and commercial businesses that require power for their economic activity. It is also quite expensive, however, with unit costs increasing as the size of the generator decreases. Petrol generators are generally smaller both in size and in power, and are more for domestic/small business use. Diesel generators can provide a larger load than petrol generators, and for large users are more efficient. However diesel is significantly more expensive in Nigeria than petrol. Indeed:

- Diesel costs 150-200 Naira per liter ($0.90 USD to $1.21 USD per liter)
- Petrol is in theory subsidized and capped at 97 Naira ($0.58 USD) per liter. However one recent survey found that, in May 2014, 78 percent of Nigerian consumers paid more,[71] between 100 and 130 Naira ($0.60 and $0.70 USD) per liter.[72]

In the case of solar self-generation or micro hydro self-generation, the cost of input is basically nil as it comes from sun or rivers. However, the upfront capital costs are materially higher.

The Most Common Generators: Petrol and Diesel

According to wholesalers interviewed in Port Harcourt, the most common type of generators sold to households and small businesses are Honda models with a capacity ranging between 2.5 to 6 kva, and Sumec models ranging from 2.3 to 6 kva. Honda is seen as a best value (with sales price ranging from 60 thousand to 300 thousand Naira ($363 USD to $1,212 USD)), while Sumec is the lower price alternative (models cost between 35 thousand and 120 thousand Naira ($212 USD and $727 USD). Rural clients tend to purchase generators with as smaller load (2.3 to 3.5 kva), whereas urban dwellers prefer 3.5 and above models. This is due primarily to the urban consumer's load consumption profile: urban dwellers tend to own higher end electronics (notably air conditioners and refrigerators) which consume more power than the light bulb and television set up in many rural dwellings.

Families traditionally purchase their own small generators. More recently, Port Harcourt vendors claim that customers have expressed interest in also purchasing inverters with a battery pack attached to charge while the grid is distributing electricity to them. These devices are already common in Lagos (30 percent of the households own one, according to Schneider Electric), but they are only slowly appearing in other regions. Inverters are particularly attractive to the consumer, as they help decrease both fuel consumption and noise pollution relative to a diesel generator.

Companies, on the other hand, often rely on larger diesel generators, which can often power entire factories. Companies express financial concerns regarding the input costs of diesel fuel, along with the costs associated with generator maintenance. One business interviewed for this report stated that 10 percent of its total operating costs were linked to diesel and generator maintenance; hindering its ability to be price competitive with Chinese imports.[73] In addition to diesel, certain individuals use Low Pour Fuel Oil (LPFO).[74]

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[71] Vanguard, May 2014
[72] Daily Trust, March 2014
[73] Interview with Plant Manager of Kolesil Investments Nigeria
[74] PTFP 2010

Cost per kWh of Self-Generation

Both CAPEX and operating and maintenance costs will depend on a variety of factors, including types of usage, proper upkeep (which is rare in Nigeria), and efficiency of the motor. Below are some different figures provided by a variety of sources on the subject. Most of these seem derived from "best estimate" and back of the envelope calculations. Table 13 provides this breakdown.

TABLE 13: ESTIMATED COST OF DIESEL AND PETROL GENERATION IN NAIRA AND USD PER KWH

Source	Diesel Naira/kWh	Petrol Naira/kWh	Diesel USD/kWh	Petrol USD/kWh
PTFP	60	50-70	0.36	0.3-0.4
World Bank	41.25	69.3	0.25	0.42
Derived from interviews with SMEs	51.15	80	0.31	0.48

Source: PTFP 2010, World Bank 2014, interviews

Note that these numbers can be applied to the same consumer segments identified in the on grid market. Indeed, Industrial and commercial clients are likely to have diesel generators, while middle income to rural segments are more likely to have petrol generators. Based on this knowledge, we can compare the premium paid for self-generation versus on grid power.

TABLE 14: AVERAGE MYTO RETAIL TARIFFS COMPARED TO COST OF SELF-GENERATION

Segment	Average On Grid Tariff In Cents USD/Kwh	Average Estimated Off Grid Generation Cost In Cents USD/ Kwh	Off Grid Premium
Industrial +High end residential	14.67	30.05 (diesel)	15.33
High end Commercial	13.81	30.05 (diesel)	16.24
Mid-Market	9.03	40.05 (petrol)	31.02
Urban and peri urban Residential	9.36	40.05 (petrol)	30.69
Low end urban and rural	2.42	40.05 (petrol)	37.63

Source: NERC, 2014 and own calculations

As demonstrated in these tables, there is a material premium on self-generation. Despite diesel being more expensive than petrol, it is actually the lower end consumer with the smaller generator that pays the highest premium. This is partly because the two lower segments are cross-subsidized on the grid. This segment could be particularly attracted to inverters, since these can generally help decrease fuel costs, and therefore decrease the general cost of self-generation. Therefore, although self-generation via diesel and petrol is the most common form of power found within Nigeria, it is also the priciest in terms of continued operating cost (in this case, CAPEX was not included). This might make other systems, such as captive generation or micro-grids, more attractive.

CAPTIVE GENERATION

Captive generation refers to a power plant that was created specifically to service a company or a community. Generally, there is no distribution fee associated, since the generation facility is just another fixed asset to the owner. In Nigeria, this involves any facility providing more than 1 MW of power for the generators own use. The generating facility can sell surplus power to an off taker without a permit if it provides less than 1 MW to the off taker in question. Otherwise, it must apply for an embedded generation permit or a standard grid GenCo permit.[75]

There are several known examples of captive generation in Nigeria, though the list is far from exhaustive. These include a small hydro plant project started by UNIDO in Taraba for a tea factory, a 5 MW biomass plant also done by UNIDO for a rice cluster in Ebonyi State, and multiple IOC plants in the Niger Delta.

Captive Generation versus Embedded Generation

It is easy to get this dynamic confused in the Nigerian context. However, there is a fundamental difference. In embedded generation, the end user pays for the power generation and a distribution license holder a tariff.[76] In captive generation the end user is also in theory the "owner" so a tariff would not make sense.

Tariffs, Cost, and CAPEX of Captive Generation

Tariffs between an embedded institution and a DisCo/licensed distribution holder are negotiated apart from MYTO, and can be set at a higher or lower rate. Data varies greatly based on the type of plant and whether the distribution network is extensive or not. At this time the costs are not fully understood or known.

MICRO-GRIDS

A micro-grid is a network of embedded generation, except for those considered by Nigerian regulators to produce less power than 1 MW. Since they do not meet this threshold, they are unregulated. In the Niger Delta, one company has produced a solar micro-grid with the support of the United Nations: Green Village Electricity (GVE).

Green Village Electricity (GVE) Model

GVE provides solar power to rural communities through producing and managing solar generation and installing necessary infrastructure. GVE also built the distribution network and provided the meters. It has a Site Manager to manage the infrastructure.

The pilot site involved installing 6 kW of solar generation and distribution in a rural community. A consumption profile was created based on the fact that most consumers were farmers who would be absent during most of the day. GVE calculated an expected daily consumption of about 4 hours a day (primarily in the evenings). Eventually 60 households were connected, with an expected use of 250 watts per household. Note that since villagers had low consumption thresholds, at the request of villagers, households were generally grouped into units of 3. In other words though 60 households were connected, only 20 meters were installed.

At the pilot site, each household was attributed a maximum draw amount, which can be increased through payment. To not exceed the draw amount, surge protectors were installed so that power would automatically stop should the draw amount exceed the agreed maximum. So if a household had signed up for fan + lights + television drawdown, hooking up a fridge would trigger the circuit breaker. This was done to "keep people honest" as well as to allow them to understand the power limits of the system.

The current load profile on the entire 6 kW micro grid is: 20 TVs, 20-28 fans, 60 cell phones, and 240 LEDs. The LEDs have made a big difference in terms of load management and

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[75] NERC 2008
[76] NERC 2012

consumption. The result for GVE is fewer customers but more that consume a heavier load than expected. Their original business plan expected them to have more clients paying about $15 USD a month in total energy charge. The reality is only 60 clients who pay $18 dollars a month in capacity charge.

People who were connected to the GVE system had to put forward a 7000 Naira deposit (which GVE calculated as 3 months of expected consumption). This was the only fixed charge. Variable charge was set at 127 Naira / kWh. It should be noted that this is 30x the R1 price in MYTO and 10x the R2 price. According to GVE, people still found this cheaper than paying for generation through generators or by purchasing substitutes such as candles or kerosene.

Aware of the progress of rural electrification and access to generators, GVE has created a model where the initial investment is recouped within three years of operation.

THE SUNGAS MODEL

The EU is supporting the development of a gas micro-grid pilot project in Rivers State known as Sungas. The project is a combination of both an IPP (generation less than 1 MW) and an IEDN. As of late 2014, the team could not verify with certainty reliable data estimates on the status of the project nor critical cost information related to its pricing scheme.

SMALL SOLAR

There is a relatively diverse offering of small solar lamps, chargers, and home panels available in Nigeria. Price points vary, but these items can also help in the current environment. In fact, they might be more beneficial to certain communities and individuals. Given the common brown outs and black outs, many individuals still have kerosene lamps and candles on hand.

In fact, according to the PTFP, it costs 80 Naira to produce one kWh of light via candles and kerosene.[77] How this number was calculated or derived is not explained in the document. If this is accurate, however, then it makes candles and kerosene generation as expensive as some of the lower end generators. Obviously the generators provide much more value in terms of actual efficacy.

As was the case in the on grid market, very little is known about the consumer segments in the off grid market. The result are different messages based on with whom one interacts.

CONSUMER INTEREST IN SMALL SOLAR PRODUCTS

According to Schneider Electric, a key European provider of solar products in Nigeria, direct sales of small solar products to consumers are practically non-existent and have been that way for at least the past five years. On the other hand, sales to NGOs, state governments, and the FGN are quite high. So the question becomes whether the average Nigerian consumer in the Niger Delta is simply not interested in these products, or is the marketing mix employed not well established.

SDN tested a pilot where it created a resale model for solar lights. A “village entrepreneur” was identified and trained on how to sell five different solar lights from three different makers (two Sunking lamps, two wakawaka, and one Schneider). The project managed to sell over 344 such units at a profit over a period of four months. The breakdown of the sales can be seen in Table 15.

[77] PTFP 2010

TABLE 15: SALES OF SOLAR LAMPS BY SDN OVER A FOUR MONTH PERIOD

Product	Quantity Sold	Set Price (N)	Average Price (N)	% Variance on Price
Sunking Pro	262	5,500	5,340	3%
Sunking Small	16	2,500	2,378	5%
Super Wakawaka	25	9,000	8,500	6%
Schneider	16	13,500	11,750	13%
Waka	25	3,000	3,031	-1%
Total	**344**			

Source SDN 2014

The most popular product was, by a large margin, the Sunking Pro—although the precise reason for the interest in the product is unclear. It could be because it is a good quality portable item, or because of the price point, or because it also charges phones. This is important to understand so as to better understand consumer preferences, since this study provides some fairly strong anecdotal evidence that Rivers State consumers are ready to purchase these items.

Given that SDN was targeting a rural market, consumers were unable to purchase the lights with one lump sum. Therefore, the village entrepreneur provided some financing, allowing the purchaser to put down a 40 percent down payment and to pay back the remaining 60 percent over a two month period.

Current Challenges for the Small Solar Value Chain

The National Agency for Science and Infrastructure (NASENI) opened a solar power manufacturing plant to much fanfare in 2011. However the plant does not appear to be particularly active. In fact most individuals working in the solar sector stated they purchased foreign built solar panels.

Solar panels can be purchased via distributors of large name brands (such as Schneider or GE) as well as through smaller shops that carry lower quality Chinese equipment. The poor quality of these Chinese brands, as well as the poor quality of installation, are seen by some actors in the solar value chain as a key reason these products have not taken off in the Nigerian market. Consumers are too accustomed to seeing shoddy equipment that has been poorly installed and inevitably fails to deliver on its promise of power.

In addition to the presence of poor quality products and a lack of capable installers, solar products face many hurdles with Nigerian Customs. Solar products are supposed to be exempt from import duties. However, this is often not the case according to market participants. Certain solar sector small and medium-sized enterprises have cited that is sometimes more practical to import solar equipment through neighboring Benin's duty free port in Cotonou than to transport the solar equipment overland to Niger and then back through the northern Nigerian border to arrive in Lagos or Abuja rather than coming through the Lagos port itself.

Small Solar Conclusions

On paper, small solar items should have good market potential in a country where power supply is insufficient, brown outs and black outs are common, and sunshine is available. However, due to the limitations of electricity storage, relying on small solar during the rainy season and during the evening and night is often not effective.

Small solar can be sold to all individuals, whether they are connected to the grid or not. However, direct sales of these products to consumers have been poor. Given SDN's small but informative study, the issue seems that the product marketing mix (including the product financing mechanism and trustworthiness of retailers) is not properly developed. Additional supply side issues include quality of products, ease of purchase, and import tariffs are also present.

THE BONNY ISLAND UTILITY COMPANY (BUC)

Bonny Island has a Liquefied Natural Gas terminal to facilitate the export of gas from Nigeria to other countries. The terminal was set up by multiple IOCs, including Shell, and power was provided from the terminal via a dedicated turbine as early as 2000. In 2010, a 4-year project to revamp the distribution network and to set up a local distribution company, the BuC, was completed. For the first time, local inhabitants were asked to pay a tariff for power, in order to ensure that the distribution company could properly maintain the local network.

In 2014, two turbines provide 22 MW of power to the BuC, who in turn sells it to the 12,000 inhabitants of Bonny Island. The BuC tariff is still very low compared to MYTO, at about 2.5 naira/kWh.[78] The power is generally provided on a pre-payment system. The network is in relatively good working order, and only a select few inhabitants have generators, primarily hotels which must at times go above their power allotment.

CURRENT OFF GRID VALUE CHAIN MAP

The value chain map below displays some micro-grid and generator elements of the value chain. The small solar was not included, primarily because the small solar items are essentially one time investments, while the other form of generation require constant inputs. There is the notable exception of GVE, but its establishment as a vertically integrated micro-grid gives it ongoing costs and revenues.

The map also doesn't clearly show the substitutes for power, notably candles and kerosene lamps. The PTFP claims that people pay 80 naira per kWh by burning these two (48 c USD/kWh). That would make it the second most expensive form of generation, after the GVE micro-grid (see Table 16). However, when looking at cost per kWh, it is important to remember that this does not indicate monthly expenditures for a Nigerian household. Producing a kWh worth of power via candles is expensive, buying candles is not. A better understanding of this consumption and ability to pay is vital if one wishes to pursue investments in the power sector, and will be further explored in subsequent work.

TABLE 16: COMPARING POWER COSTS AMONG MICRO-GRIDS, MYTO, SELF-GENERATION, AND TRADITIONAL LIGHTING

	BuC	R1 MYTO (lowest tariff for all market segments)	AVG R4 MYTO (highest tariff for all market segments)	Diesel Generator	Petrol generator	Candles, kerosene	GVE
Naira/kWh	2.42	4.00	24.52	50.3	66.8	80	127
c USD/kWh	1.47	2.42	14.86	30.48	40.48	48.48	76.97

OFF GRID ELECTRICITY VALUE CHAIN FINDINGS

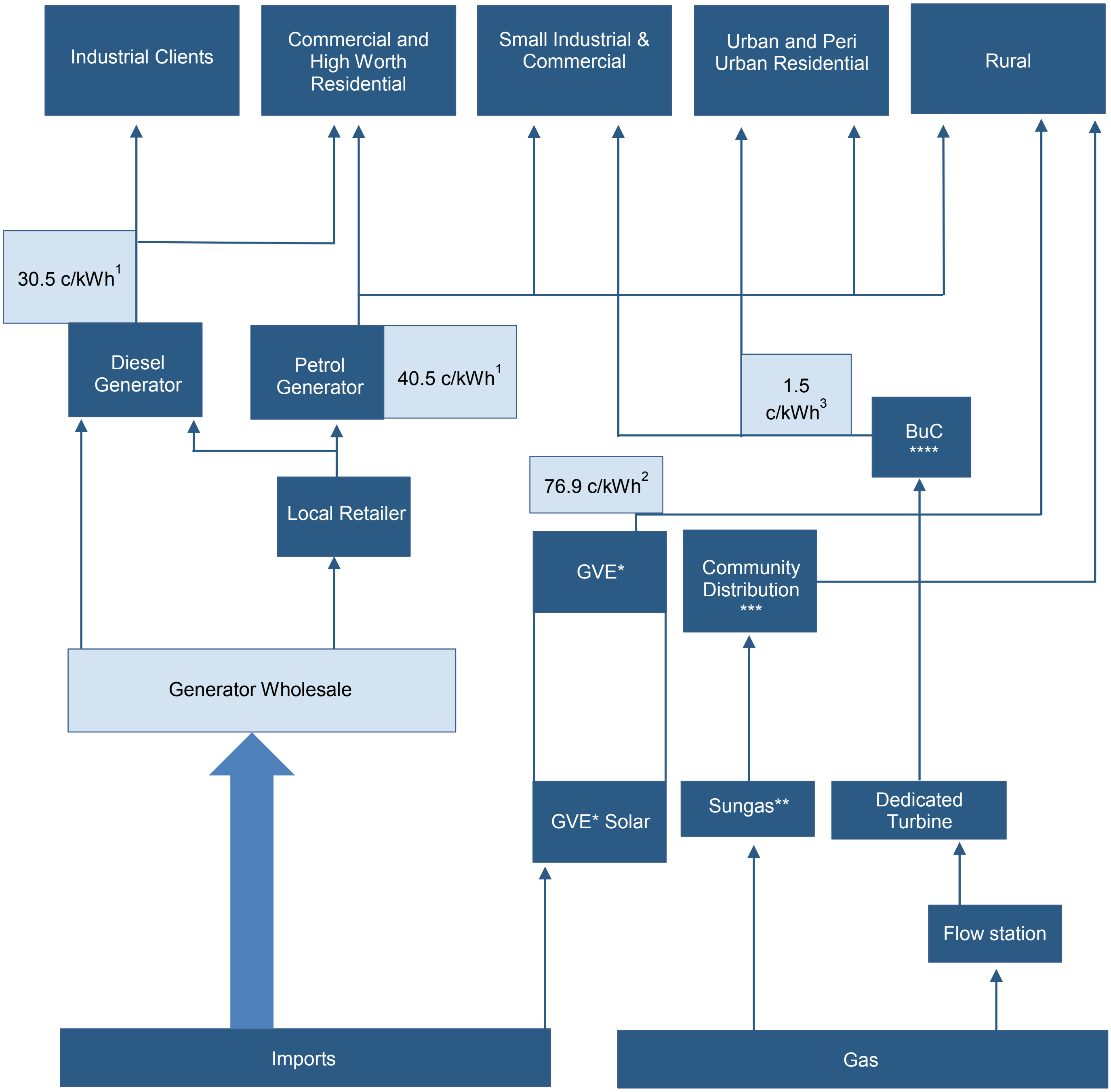
The off grid segment in Nigeria is critical to the functioning of the economy. Many estimates put aggregate off grid generation as greater than the actual on grid power distributed through the

[78] Based on receipts from Bonny Island inhabitants

system (4 GW versus 6 GW). However, great inefficiencies exist that drive cost up and innovative solutions for alternative off grid solutions have yet to be shown to be scalable.

- Self-generation via diesel and petrol generators account for the bulk of current off-grid energy production. This generation is much more expensive than national grid power, costing twice to three times as much per kWh depending on the market segment. However, it is reliable and provides some stability to the end consumer, which is particularly important to industries since sudden power outage could not only stop production, but ruin a current production, resulting in losses both in terms of inactivity and wasted inputs.
- Alternative forms of off grid generation have the potential to introduce efficiencies and scalability to the off grid segment. However, not enough data was analyzed in the scoping phase to render opinions on the commercial viability or scalability of these solutions.
- The institutional and legal regulatory framework around the off grid segment is unclear and roles, responsibilities and rules are in many places still undefined. This is true at both the national level as well as the state-level in the Niger Delta.
- There are three known micro-grid projects active in the Niger Delta: A solar micro-grid supplied by GVE (unregulated), a gas micro-grid supported by the EU that is about to begin operations (Sungas, which is both an IPP and an IEDN), and an existing gas micro-grid supported by Shell on Bonny Island (an IEDN, which has probably been given a MYTO exemption). All three would benefit from greater analysis to better understand costs and constraints.

FIGURE 19: ILLUSTRATIVE NIGER DELTA OFF GRID ELECTRICITY VALUE CHAIN MAP



* GVE (Green Village Electricity) is not subject to regular sector regulations given generation < 1MW and distribution < 100kW.

** The Sungas pilot project is now getting underway with a stated <1 MW generational capacity. There is to date insufficient data to determine specific prices and to confirm exact industry arrangements (i.e. regulations).

*** Proposed Licensed Distribution holder as part of Sungas project. Distribution expected to be >100 kW.

**** Licensed Distribution holder. Not able to confirm extent of NERC regulations application to date.

[1] Based on data gathered from interviews with select SMEs. See NERC 2014 and World Bank 2014.

[2] Based on interview with Green Village Electricity CEO.

[3] Based on data gathered from field interview with Bonny Utility Company and a sample invoice.

5. Niger Delta Electricity Scoping Study Conclusions

Moving through the various segments of the electricity value chain in the Niger Delta has helped map the overarching dynamics and challenges in achieving reform and encouraging deeper investment. Overall it underscores the difficulty in affecting change in the on grid segment given the high costs of entry, the difficulties related to political economy, and the financial risks that can only be overcome with strong government regulation, metering, rule enforcement and collections.

The off grid carries its own risks and uncertainties, albeit at different proportions. While the off grid currently supplies more electricity than actual on grid it is done in ad hoc, non-integrated and unsynchronized ways. The non-diesel generator solutions that have been either piloted or implemented have either been not commercially sustainable or have not been around long enough to draw forth conclusions on their effectiveness.

Near unanimity exists in the belief that electricity provision in the Niger Delta is insufficient to meet effective demand and that significant economic losses arise from this reality. What is less certain is how best to address the challenges, how long such changes will take, the legal and regulatory environment required, and which market participants will play what role to make it all happen.

In this context, positioning the best role for NDPI and PIND as active participants in the power sector requires careful consideration and selection. NDPI's potential role must tie directly into its core objective to stimulate pro-poor broad-based economic growth in the Niger Delta through market-driven solutions using commercially viable and sustainable business models. While the electricity value chain requires extensive support, both financial and technical, most of the issues would not be suitable for NDPI direct support given the long-term requirement to draw on large-scale private resources for investment in the sector and the need for extensive long-term capacity support and institutional reform provided by development partners.

Potential Engagement Areas for NDPI/PIND Next Steps

Below we set out conclusions and recommendations for areas of potential follow-on activity for NDPI and PIND in the context of the Niger Delta electricity value chain. We have divided these recommendations according to five potential points of entrance into the value chain and then provided commentary on various dynamics that might affect the attractiveness of pilot investment interventions to improve electricity access for the target population or group of electricity users. The first segment, areas of existing economic activity that do not have access to the national grid nor are they likely to in the foreseeable future, may be particularly attractive for electricity pilot investment. The second segment, areas of existing economic activity that have national grid access but are significantly underserved, also offers some promise for innovative business models that are commercially viable in this context. The final three segments, on grid customers with good electricity access, electricity off-takers in the proximity to IOC operations, and isolated communities currently without any direct access to electricity, offer limited probable opportunity for pilot investments for the reasons laid out below.

Segment 1: Areas of economic activity that lack power and will remain isolated from the electricity grid for the foreseeable future (as long as 20-25 years). Such geographic clusters would provide potentially attractive and commercially viable business models to improve electricity access. They would display a strong pattern of economic activity, growth, and electricity demand, with greater definition as follows:

- These businesses and residential off-takers currently rely on self-generation to meet their electricity needs.
- Geographic clusters defined in this manner appear to be attractive and the least complex for PIND to target due to (i) the absence of an active, dedicated on grid distribution company; there is no current grid competition and no existing grid infrastructure; (ii) the presence of an electricity off-taker base that is accustomed to paying high electricity prices (through self-generation) and have predicated their business models on that reality; (iii) an adequate level of economic activities in the cluster that grouped to achieve economies of scale from an electricity investment; and (iv) the potential that the geographic area would become a pole for growth—augmenting the productivity of existing businesses and enabling them to expand, inspiring other businesses to relocate or start up due to reliable electricity, and improving economic opportunity for the area's informal micro-enterprises and entrepreneurs.
- In this context, potentially attractive and commercially viable business models could be developed if predicated on the following preliminary parameters:
  - An extended time horizon (such that the commercial enterprise would not be displaced by the grid prior to its investment recovery and a reasonable return).
  - A predictable peak load profile with estimated growth forecast.
  - Substantial and sustainable average daily load.
  - Electricity tariffs that are affordable and appropriate for the cluster's economic activity.
  - Appropriate mix of electricity off-takers (predominantly high value off-takers balanced against low-value customers, such as residential). This may mean supplying some electricity to low-value customers at cross-subsidized rates to avoid jeopardizing this particular business model by seeking to preclude illegal connections and the associated loss of revenue and lowering system reliability.

Segment 2: **Areas of economic activity that are connected to the national grid but who are under-served** (frequent outages and/or load shedding). Some off-takers may be economically indifferent to electricity loss or not interested in alternatives; while other off-takers suffer significant economic loss and willing to consider alternatives (must identify customer class magnitude, profile, ability to pay, and related considerations). A commercially viable business model could be developed if appropriate parameters suggest that it would provide affordable electricity for off-takers (relative to their own economic contexts), yet which would also entail investment recovery and a reasonable return from the investing entity. Such a model may require a significant capacity charge relative to unit charges.

Any such business model cannot compete in the same space as on grid suppliers. Such existing suppliers already have the advantage of economy of scale, existing infrastructure, an ability to improve the reliability and quality of power to existing off-takers, and established relationships with regulators and other government agencies; together leading to significant barriers to entry for any new electricity suppliers.

Segment 3: Three cluster groups fall into this segment that are not likely to be attractive targets for pilot electricity investment activities. They are **on grid customers with good electricity access, electricity off-takers in the proximity to IOC operations, and isolated communities currently without any direct access to electricity**. In differing ways, each group presents a number of barriers to commercial entry, technical and other risk factors, and/or significant regulatory complexities.

- **Existing on-grid customers:** receive relatively reliable power (greater than 50% availability); connected to the existing TCN system via existing distribution on feeds from the existing substations in the Niger Delta; periodic outages resulting in a lack of electricity; most off-takers have back-up self-generation units; others may be indifferent to temporary outages.
  - These off-takers are currently connected to an inexpensive source of electricity (relative to off grid or self-generation); or they will be soon.
  - High-value customers who receive interruptible power, for the most part, already have backup generation capacity and have built the need for it into their business models.
  - It is unlikely that replacement of the status quo would lend itself to a commercially viable business model due to the higher unit costs relative to on grid power.
  - Given these off-takers are already on the grid and viewed by the DisCos as current customers, they have the ability to lobby individually or collectively for more reliable and cleaner power as tariffs are rationalized. In addition, many international donors (e.g. USAID, DFID) and multiple multilateral institutions (World Bank, African Development Bank) are active in the on grid space; providing tens of millions of dollars of technical assistance, and hundreds of millions in financial guarantees and co-financing to augment the grid and improve its efficacy at the systemic level.
- **Electricity off-takers in the proximity of major IOC operations:** limited market scope (usually limited to local communities in the proximity of the IOC operations); constrained expansion; uncertain longevity. The commercial viability of investments in these locations are heavily impacted by expectations of the potential benefit streams from IOCs to the communities surrounding their operations.
- **Isolated, geographically-dispersed micro-enterprises/others without power:** This group comprises individuals, communities, and microenterprises who are not connected to the grid nor self-generate electricity. The reasons this segment is most likely not attractive to NDPI as its primary focus include:
  - These are amongst the least economically included segments. While they require external assistance to gain access, these are unlikely to generate substantial aggregate demand that would be commercially viable for a private investor. Scaling-up by leveraging external funding would therefore be difficult for NDPI.
  - Electricity users in this segment are often sparsely distributed geographically, and nearly always have small loads and limited and inconsistent usage. Such demand uncertainty and variability in load magnitude limits the commercial viability of a business model seeking to service this demand.
  - Given the diversity of individuals, micro-enterprises, and communities in this off-taker segment, their relatively low income, and their presence in the informal economy, willingness to pay and ability to pay are limited in general and unknown in specificity. Together, this decreases commercial viability for new electricity investment in this space.
  - International donor agencies and NGOs are active in this space due to social development goals such as educational outcomes (e.g. by providing light sources to students), and health outcomes (e.g. by replacing wood- or charcoal fires with clean energy). The provision of this aid would complicate a business model seeking commercial sustainability and viability.

As clusters of economic activity are identified geographically, the DAI team recommends the following areas of research and analysis to advance NDPI's decision-making process for future activities:

1. **Cluster Selection:** initial analysis on potential clusters and working to select specific clusters for studying according to key criteria.
2. **Political Economy Analysis (PEA):** establishing a reliable understanding of the political-economy related to the power sector in the Niger Delta with a focus on mapping the stakeholders involved in the provision, transmission, distribution and consumption of electricity in the proximity of our selected clusters.
3. **Cluster Mapping:** completing a cluster-specific GIS mapping overlay (augmenting with existing open source GIS map data) to visually display the proximity of focus clusters relative to existing and planned on grid systems.
4. **Cluster Power Demand Analysis:** carrying-out surveys within each sector to understand the access, provision, cost, consumption and demand for electricity; and to get a clearer view of the business activity in each cluster (e.g. firm size, growth, sector, female-owned/managed businesses).
5. **Additional supporting sector analyses:** this component will include a brief study of three areas: (a) financing mechanisms and existing local financing options for model off-grid investments; (b) review of the existing regulatory and institutional environment for the Niger Delta and with details specific to each cluster; and (c) overview of possible technological solutions that may be applicable for these clusters (solar, gas, diesel, etc.). Case studies would examine existing off grid electricity projects in the Niger Delta.

Annex 1: Interview List

Institution	Name	Title	Date
NERC	Ibrahim Abba	Commissioner, Gov't & Consumer Affairs	10/16/2014
NERC	Yusuf Adussalam	Renewable Energy/R&D division	10/16/2014
CREED Energy	Hannah Kabir	Chief Executive Officer	10/16/2014
USAID	Peter Argo	Senior Power Sector Advisor	10/17/2014
USAID	Imeh Okon	Project Manager, Energy & Climate Change	10/17/2014
Winrock	Segun Adaju	REEP Chief of Party	10/17/2014
NIAF	John Gower	NIAF senior energy policy TA	10/18/2014
NDPHC	Evan Robins	head of transmission NIPP projects	10/19/2014
World Bank	Erik Fernstrom	Lead Energy Specialist	10/20/2014
Port Harcourt Electricity Distribution	Jon Abbas	Chief Executive Officer	10/20/2014
European Union	Marta Abrantes	Programme Manager, Economic Governance and Trade Cooperation	10/21/2014
Kolesil Investment Nigeria	Chima Nwokene	Plant Manager	10/22/2014
Green Village	Ifeayeni Orajaka	Chief Executive Officer	10/23/2014
Benin Disco	Yemi Omoyelu		10/24/2014
GE	Naveed Manazir	Project Development Leader	10/24/2014
GE	Chinonyem Obaji	Commercial Development Lead	10/24/2014
Schneider Electric	Anne Ezeh	Field Marketing Manager	10/28/2014
Schneider Electric	Ifeanyi Odoh	Business Development Executive	10/28/2014
Azura Edo Power	Nonye Obibuaku	Chief Financial Officer	10/28/2014
Consultant/PTFP member	Ayodeji Sotinrin	Consultant/advisor	10/29/2014
UNIDO	Chuma Ezedinma	NPO Agri-business& entrepreneurship	10/29/2014
UNIDO	Alhaji Mustapha	Energy Expert	10/29/2014
UNIDO	Azubike Emechebe	National Project Manager Biomass	10/29/2014
Federal Ministry of Power	Ifeoma Malo	Special Assistant on Energy Policy	10/30/2014
GIZ	Luis-Carlos Miro	Advisor on rural electrification	10/31/2014
Azura Edo Power	Edu Okeke	Chief Operating Officer	11/1/2014
Chevron	Nils Magnussen	Economist, Global Gas	11/6/2014
SDN-visited communities With questionaires			
Hotel in Bori			10/22/2014
Public Hospital in Bori			10/22/2014
School in Bori			10/22/2014
Bonny Island inhabitants			10/27/2014
Bonny Island Utility Co.			10/28/2014
Erema community			10/30/2014
Port Harcourt generator vendors			10/31/2014
Oporoma community			11/1/2014
Umudioga community			11/3/2014

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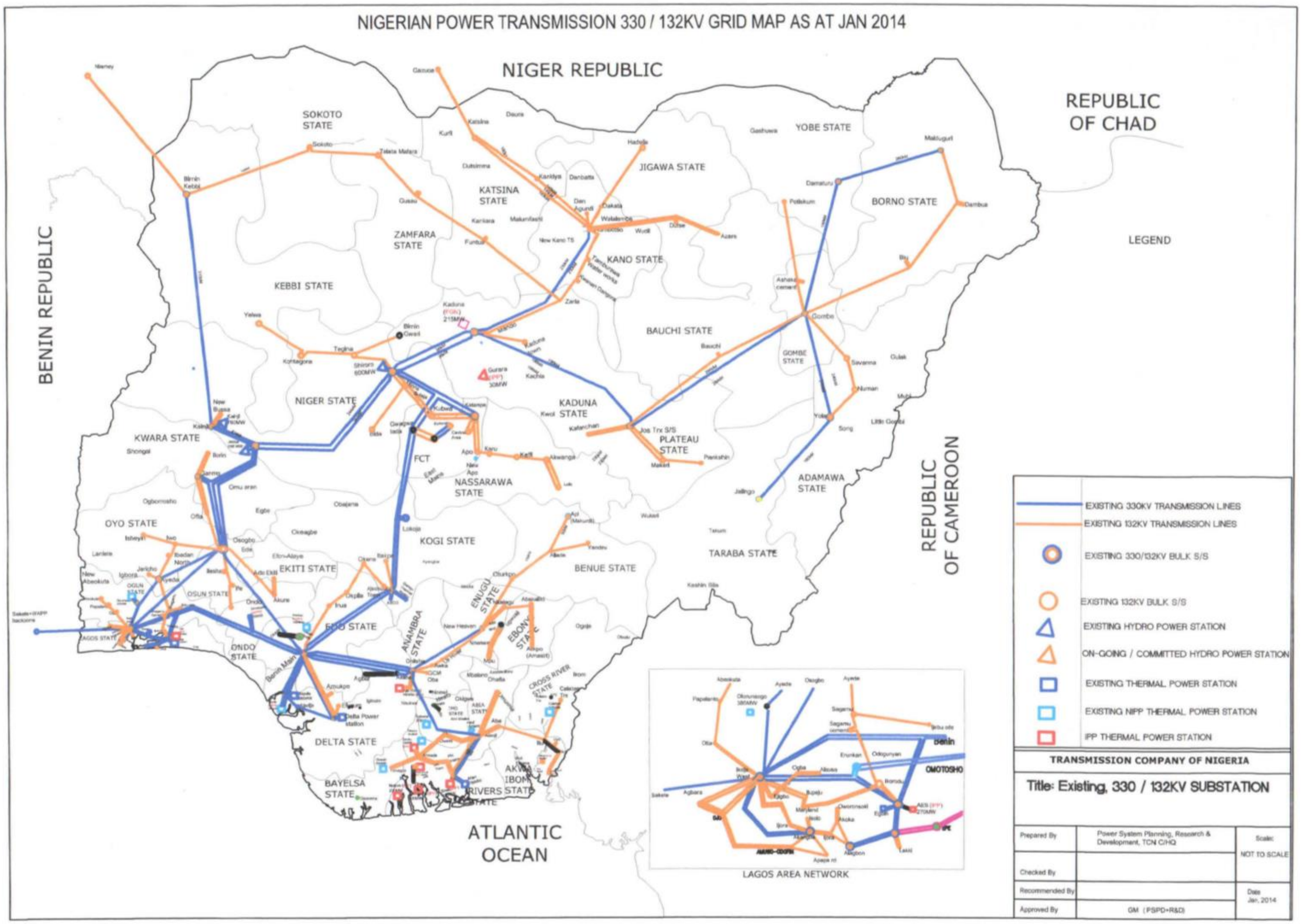
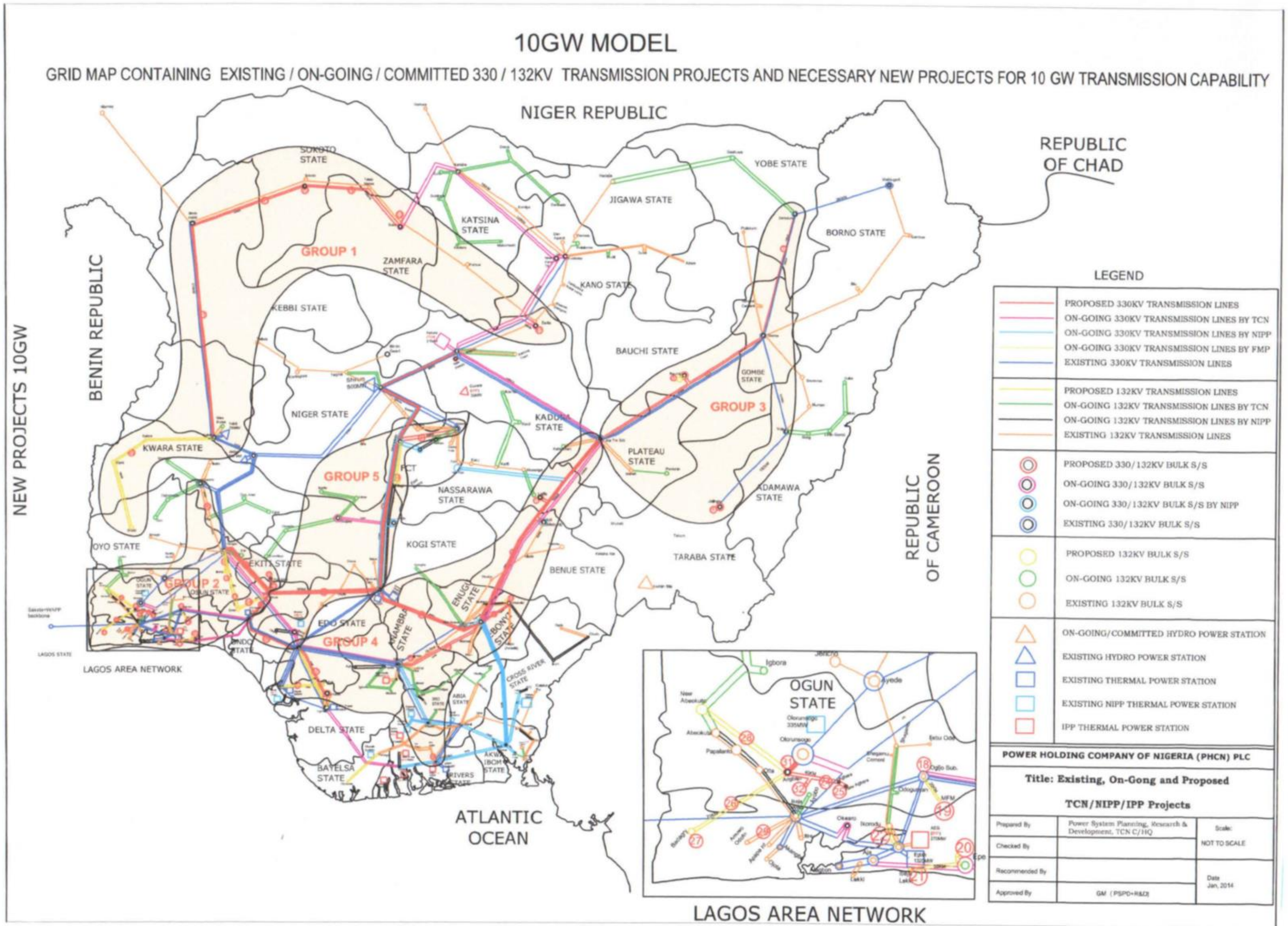
- Nigeria to Triple Natural Gas Output for Power Supply, Daniel Magnowski, Bloomberg, September 16th 2014

MAPS OF NIGERIA ELECTRICAL GRID

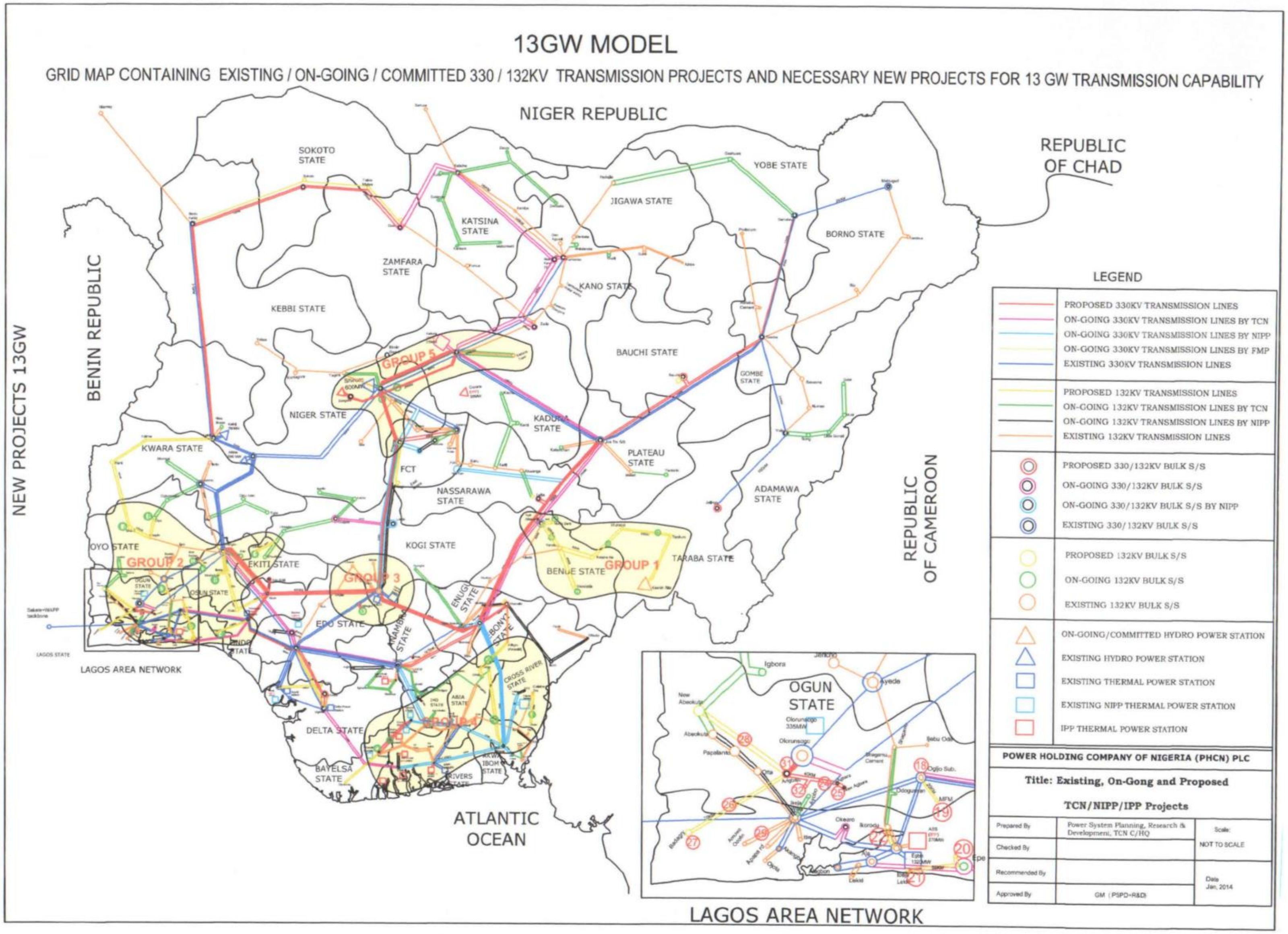
MAP 1: NIGERIAN NATIONAL GRID AS OF JANUARY 2014



MAP 2: NIGERIAN NATIONAL GRID – 10GW TRANSMISSION CAPABILITY



MAP 3: NIGERIAN NATIONAL GRID – 13GW TRANSMISSION CAPABILITY



MAP 4: NIGERIAN NATIONAL GRID – 16GW TRANSMISSION CAPABILITY