RAPID ASSESSMENT OF THE NIGERIAN GAS SECTOR

POWER AFRICA TRANSACTIONS AND REFORMS PROGRAM (PATRP)

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1. PROJECT OVERVIEW / SUMMARY

Program Name:	USAID / Power Africa Transactions and Reforms Program "PATRP"
Activity Start Date And End Date:	18 July 2016 – 01 October 2016
Name of Prime Implementing Partner:	Tetra Tech ES, Inc.
[Contract/Agreement] Number:	AID-623-C-14-00003
Name of Subcontractors/Sub-awardees:	Gas Strategies Group Ltd
Major Counterpart Organizations	
Geographic Coverage (cities and or countries)	London (UK), Lagos (Nigeria), and Abuja (Nigeria)
Reporting Period:	18 July 2016 – 14 August 2016

2. ACRONYMS AND ABBREVIATIONS

Acronyms / Abbreviations	
AfDB	African Development Bank
BPE	Bureau Of Public Enterprises
C1, C2	Commercial power sector tariff bands
CBN	Central Bank of Nigeria
CCGT	Combined Cycle Gas Turbine
CNG	Compressed Natural Gas
DISCO	Distribution Company
DPR	Department of Petroleum Resources
DSO	Domestic Supply Obligation
EI	Existing Infrastructure
ELPS	Escravos–Lagos Pipeline System
FC	Fundamental Challenges
FII	Future Investment in Infrastructure
FGN	Federal Government of Nigeria
GACN	Gas Aggregation Company Nigeria Limited
GSAA	Gas Sales and Aggregation Agreement
GSA	Gas Sales Agreement
GENCO	Power Generation Company
GMP	Gas Master Plan
InIn	Infrastructure Investors
IOC	International Oil Company
IPP	Independent Power Producer

JV	Joint Venture (specifically between oil companies and NNPC)
LNG	Liquefied Natural Gas
LOC	Local Oil Company
LC	Letter of Credit
MD	Maximum Demand power sector tariff band
MoF	Ministry of Finance
MoPWH	Ministry of Power, Works and Housing
MoPR	Ministry of Petroleum Resources
MO	Market Operator
MYTO	Multi Year Tariff Order
NBET	Nigerian Bulk Electricity Trading PLC
NDPHC	Niger Delta Power Holding Company Limited
NERC	Nigerian Electricity Regulatory Commission
NEPA	National Electric Power Authority
NGC	Nigerian Gas Company Limited
NGPTC	Nigerian Gas Pipeline and Transportation Company
NIBOR	Nigerian Interbank Offer Rate
NIPP	National Integrated Power Projects
NLNG	Nigeria LNG Limited
NNPC	The Nigerian National Petroleum Corporation
OB3	Obiafu/Obrikom/Oben Pipeline
OCGT	Open Cycle Gas Turbine
PA	Power Africa
PATRP	Power Africa Transactions and Reforms Program
PHCN	Power Holding Company of Nigeria
PPA	Power Purchase Agreement
PSC	Production Sharing Contract

R1, R2	Residential power sector tariff bands
TPA	Third Party Access
SNG	Synthetic Natural Gas
SO	System Operator
STA	State Government
TCN	Transmission Company of Nigeria
WB	World Bank

3. EXECUTIVE SUMMARY

In 2013, President Obama launched the Power Africa initiative, with the objective of stimulating economic growth within sub-Saharan Africa. Power Africa aims to increase the availability of and access to electricity.

Gas Strategies was engaged by Tetra Tech ES, Inc. to support USAID's Power Africa Transactions and Reforms Program. Gas Strategies has been commissioned to perform a Rapid Assessment to identify interventions and activities that can be implemented over a 12-month period and which will:

- result in additional power and electricity delivery from existing gas-fired assets
- create an enabling environment for future gas-fired power generation
- facilitate transactions for future gas-fired power generation

to ultimately increase electricity availability and access in Nigeria.

In August 2016, Gas Strategies undertook a program of engagement with about 30 relevant stakeholders in Nigeria, active across the breadth of the gas-to-power value chain. Stakeholders included private sector entities in the gas and power sectors; state organizations and regulatory bodies; and professionals in the financial and legal sectors focused on gas-to-power in Nigeria. All stakeholders gave their time freely and discussed the issues openly. There is a great deal of interest in the whole of Nigeria concerning the electric power situation. The stakeholder meetings were supplemented by an in-briefing and out-briefing with USAID in Abuja.

The findings of the Rapid Assessment and the recommendations regarding the interventions and activities to facilitate additional gas-fired power generation, have been structured into three categories:

- Opportunities and interventions for Existing Infrastructure (EI)
- Issues and interventions to address Fundamental Challenges (FC)
- Opportunities and interventions for Future Investment in Infrastructure (FII)

These recommendations combine both the input received during the program of engagement with stakeholders as well as drawing upon the Gas Strategies team's existing knowledge and understanding of the Nigerian gas sector. Gas Strategies has particularly drawn upon its existing experience in the gas elements of the supply chain.

An observation from the feedback provided by stakeholders is that aside from the gas supply sabotage and lack of payments by the gas upstream sector (either by revenue not being received for gas sales, or the lack of NNPC JV funding) the gas elements of the gas-to-power chain are more commercially and technically robust than the mid and downstream ends of the power chain.

By comparison, the gas supply upstream infrastructure has less commercial and technical issues than the downstream power sector. For example, the upstream infrastructure has largely been built by IOCs,

in most cases it is well maintained (particularly given that is it a counterpart to oil production), and is funded by IOCs. Commercially upstream structures work if there is revenue flowing up the chain. The same, however, cannot be said for the downstream transmission and distribution elements of the power chain.

Therefore, when discussing potential solutions to the issues in the gas-to-power chain, stakeholders focused more on the power transmission and distribution end of the power chain, than on the gas supply chain.

Gas Strategies' investigations covered the whole value chain from gas supply through to the DISCOs and electricity tariffs. Gas Strategies understands that Power Africa is already undertaking a series of interventions regarding power transmission and DISCOs (it should be noted that the interventions being undertaken by Power Africa regarding power transmission and DISCOs should not be considered as exhaustive), and therefore Gas Strategies was advised to focus this report more on gas supply through to power generation. This report therefore does that and reports on transmission and DISCOs only in short form. In Gas Strategies' opinion, fundamental reform of the DISCOs is a key part of the solution to an improved gas-to-power value chain. The reforms Gas Strategies suggests would involve FGN and its agencies, as well as the DISCOs themselves, and without which the revenues that underpin the whole gas-to-power chain will not be sufficiently achieved. Gas Strategies' full commentary on this part of the value chain can be made available to USAID if required.

Existing Infrastructure

From the current base of between 11 and 12 GW of generation capacity, of which there is ~3.5 GW of operational capacity (as at August 2016, in March 2017 the figure is closer to 4.5 GW), the "quick wins" that can be achieved within a 12-month timeframe are limited to the utilization of current infrastructure – it is not possible to develop additional infrastructure to support higher levels of gas-fired power generation within a 12-month period.

The priority areas for Power Africa to increase operational generation capacity from ~3.5 GW towards ~5 GW focus around:

- Increasing the availability of gas entering the gas-to-power chain by:
    - reducing/resolving the gas supply sabotage
    - restoring gas supplies cut off to existing GENCOs due to lack of payment to gas suppliers
    - optimization of available gas supply to the most efficient power generators
- Concluding the drawdown of the CBN loan facility that was originally established to settle outstanding debts owed to gas suppliers, but was suspended when IOCs failed to meet CPs related to the facility
- Addressing power transmission evacuation constraints, to maximize the delivery of MWh to the DISCOs

Fundamental Challenges

However, to make a lasting and sustainable impact on the volume of gas-fired generation in Nigeria, the fundamental challenges that represent the real constraints to the development of the gas-to-power sector need to be addressed. These fundamental challenges can be considered to include: the lack of a commercially sound and viable value chain; the lack of a technically robust chain; the ongoing sabotage to gas supply infrastructure; weak regulation; lack of revenue collection from DISCOs; national policy that is fit-for-purpose; and historical or legacy issues resulting from the previous poor management and performance of the gas-to-power chain .

Once addressed, Nigeria will have a platform for both operation of the existing gas-fired power fleet, as well as an environment in which investor confidence increases, resulting in more gas supply, power generation and associated infrastructure investment.

The opportunities for Power Africa to facilitate a resolution of the fundamental challenges fall into the following categories:

- Commercially sound and viable value chain
  - Undertake contract review along the upstream gas to power distribution value chain, including the GSA, Gas Transportation Agreement and PPA to understand potential issues that are (apparently) an impediment for now and for future
- Technically robust chain
  - Support the TCN management capacity to implement necessary projects to increase capacity of power transmission network
- Solution to sabotage
  - Largely a FGN issue, however some investment in, for example, infrastructure and skills development in the Niger Delta could be facilitated by Power Africa
- Strong regulation across the technical and commercial chains
  - Promote establishment of an independent gas and power regulator with appropriate powers (Gas Strategies advocates that the single regulator be NERC)
  - Review legislation and recommend legislation changes if required to give NERC appropriate powers
- Fit-for-purpose DISCOs (Power Africa is currently supporting a number of DISCOs in this regard)
  - Investment in DISCOs (necessitating public monies and dilution of current owners to suit)
  - Increase management capability and capacity
  - Technical assistance to the DISCOs
  - Support implementation of metering, revenue collection (including from FGN and State agencies) and cost-reflective tariff
- Policy
  - Develop an Energy Policy (gas and power) to replace out of date Gas Master Plan
  - Undertake a national demand study to establish where power demand is and will be in the future
- Legacy issue
  - Facilitate the ‘drawing of a line’ under previous poor management and performance of the gas-to-power chain to allow the future to start without the hang-over of legacy issues

Future Infrastructure Investment

By improvement in the performance of the commercial and physical chain on a sustainable basis, it is possible to achieve ~10 GW without the need for any further investment in power generation facilities, however this would require investment in the power transmission grid.

Investors will be prepared to release finances as long as commercial viability and confidence is there, regulatory stability believed, and the sabotage situation resolved. The potential opportunities for further Power Africa interventions regarding new infrastructure focus primarily on enhancing the ability of potential projects to reach financial close through interventions including:

- Provision of early development capital to enable projects to achieve a greater level of maturity, reduce risk and increase attractiveness to project financiers
- Provision of capable and internationally recognized transaction advisory support which brings credibility to financing process

Conclusions

In conclusion, there are interventions that can be made to achieve additional gas-fired power generation at least as high as ~5 GW in a 12-month timeframe. However, to have reliable and continual power generation in the medium to longer-term the fundamental challenges in the sector need to be addressed. If these challenges remain unattended to, generation will reduce and new investment in the sector will not be forthcoming.

A key point emphasized by the stakeholders was that they would like feedback on the findings of this process in reciprocity of having given their time and knowledge for interviews, and more importantly because they are part of the solutions going forward for Power Africa.

4. INTRODUCTION

4.1 RAPID ASSESSMENT PROCESS

In 2013, President Obama launched the Power Africa initiative, with the objective of stimulating economic growth within Sub-Saharan Africa. Power Africa aims to increase the availability of and access to electricity.

Gas Strategies was engaged by Tetra Tech ES, Inc. to support USAID's PATRP. Gas Strategies was commissioned to perform a Rapid Assessment to identify interventions and activities that can be implemented over a 12-month period and which will:

- result in additional power and electricity delivery from existing gas-fired assets
- create an enabling environment for future gas-fired power generation
- facilitate transactions for future gas-fired power generation

to ultimately increase electricity availability and access in Nigeria.

After initial desktop research and analysis, Gas Strategies undertook a three-week program of engagement with ~30 relevant stakeholders in Nigeria, active across the breadth of the gas-to-power value chain. Stakeholders included private sector entities in the gas and power sectors; state organizations and regulatory bodies; and professionals in the financial and legal sectors focused on gas-to-power in Nigeria.

The stakeholder engagement took place across three weeks; in Lagos (w/c 25 July 2016) and two weeks in Abuja (w/c 1 August 2016). An 'In-Briefing' meeting took place with USAID and the PATRP team on 2 August, and an 'Out-Briefing' on 11 August 2016.

4.2 STRUCTURE OF THIS DOCUMENT

This document sets out the key findings of the Rapid Assessment process.

Section 5 provides a series of concepts for the future evolution of the gas-to-power sector in Nigeria, and some of the key constraints that may limit the growth of the sector.

Building on these concepts, the findings of the Rapid Assessment and the recommendations regarding the interventions and activities to facilitate additional gas-fired power generation have been structured into three categories:

- Opportunities and Interventions for Existing Infrastructure (EI)
- Issues and Interventions to Address Fundamental Challenges (FC)
- Opportunities and Interventions for Future Investment in Infrastructure (FII)

These categories are set out in Sections 6, 7 and 8 and link closely to the potential evolution concepts described in Section 5.

Following feedback during the Out-Briefing with USAID, and to aid the accessibility of the information, the findings have been structured in the form of three tables, with an accompanying narrative for each table.

On the right hand side of each of the tables, are four columns headed A to D. These columns indicate the possible opportunities for Power Africa involvement, broken into the following categories:

A. Power Africa investment, with/without other agencies, including loan guarantees

B. Other direct Power Africa involvement/intervention e.g. expert assistance, active direct roles, workshops

C. Power Africa Influence by lobbying, persuading other parties

D. None for whatever reason

The cost implication for Power Africa of these activities decreases from A through to D.

Recommendations of the priority interventions for Power Africa have been identified in the following tables and these are identified by the grey shading in the relevant rows. These recommendations are also compiled and set out as a separate table in the Findings and Conclusions section.

5. DEVELOPMENT CONCEPTS

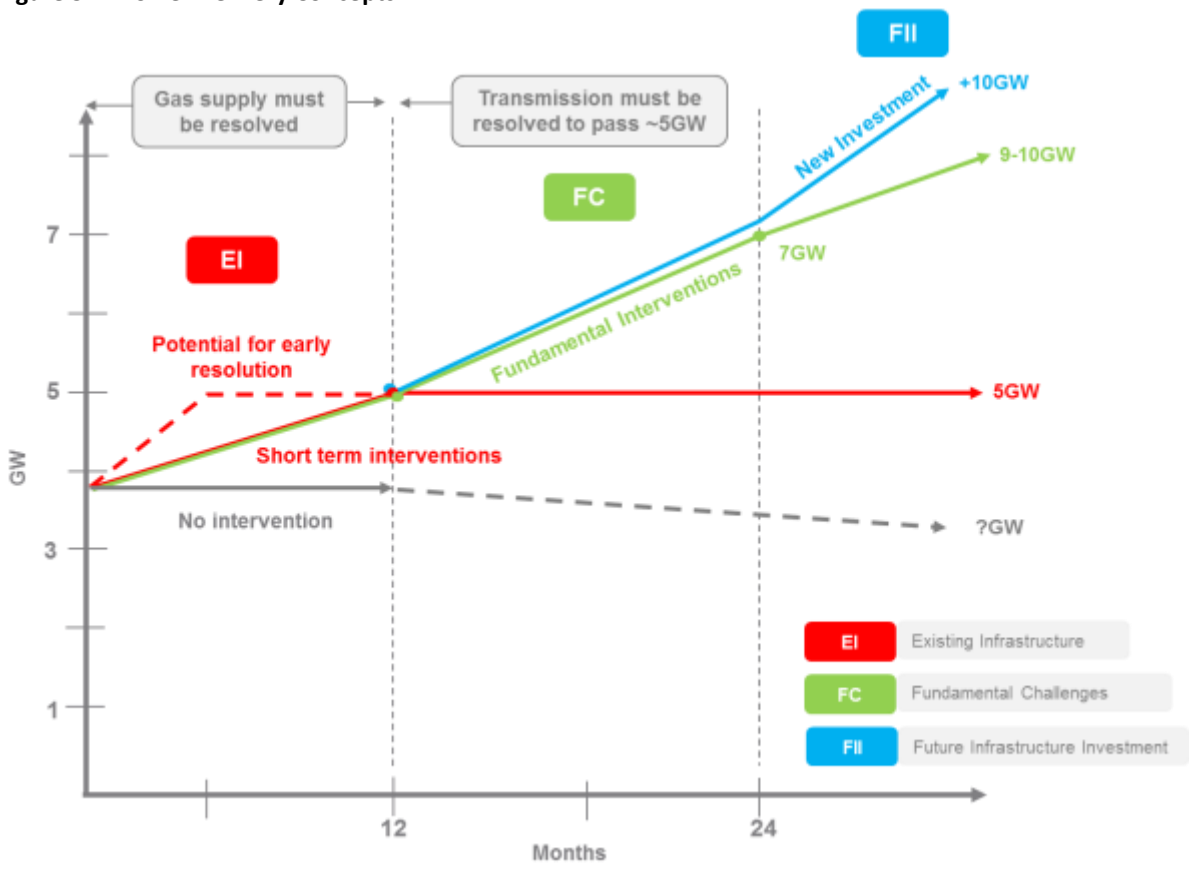
The purpose of the Rapid Assessment was to concentrate on the realistic interventions and activities that can be implemented over a 12-month period. However, in order to achieve this purpose, the current issues and constraints within the gas-to-power sector in Nigeria need to be identified; without understanding the issues, one cannot understand what needs to be addressed.

The major challenges in the gas-to-power chain that were raised by stakeholders were as follows:

- the commercial value chain is broken
- the chain is technically deficient
- regulation is weak (non-existent in the case of gas)
- confidence in commercial, contractual and operational performance is zero
- gas supply sabotage, which increased over 2016
- free entitlement concept amongst power users
- Transmission Company of Nigeria and DISCOs are weak and not fit for purpose

With these challenges representing the current reality, the chart below sets out a number of concepts for the future delivered power generation in Nigeria:

Figure 5-1: Power Delivery Concepts



If the current challenges in the gas-to-power sector are not addressed, the likely result is that power supply will reduce further through a combination of a lack of maintenance in the existing power generation and transmission infrastructure, reduction of gas supply through continued upstream sabotage and potential shut-offs in both gas and power through a lack of revenue flow up the chain. This concept is represented by the grey line in Figure 5-1.

From the current base of ~3.5 GW of operational generation capacity (as at August 2016, in March 2017 the figure is closer to 4.5 GW), the "quick wins" that can be achieved within a 12-month timeframe are limited to the utilization of current infrastructure (across the whole value chain) – it is not possible to develop additional infrastructure to support higher levels of gas-fired power generation within a 12-month period.

Opportunities to increase capacity towards ~5 GW, represented by the red line in Figure 5-1, focus around reducing/resolving the gas supply sabotage, restoring payments for shut-off gas and directing gas supply to the most efficient power generators.

These findings form the basis of the first set of potential opportunities and interventions, set out in **Section 6 Existing Infrastructure (EI)**.

However, without addressing fundamental challenges and establishing more sustainable solutions, some interventions could be considered as only 'sticking-plasters'. For example, embedded power and 'work-

around' gas and power supply solutions do not resolve fundamental gas and power performance challenges.

To make a lasting and sustainable impact on the volume of gas-fired generation in Nigeria, the fundamental challenges need to be addressed. These fundamental challenges can be considered to include: the lack of a commercially sound and viable value chain; the lack of a technically robust chain; the ongoing sabotage to gas supply infrastructure; weak regulation; lack of revenue collection from DISCOs; national policy that is fit-for-purpose; and historical or legacy issues resulting from the previous poor management and performance of the gas-to-power chain .

Once addressed, Nigeria will have a platform for both operation of the existing gas-fired power fleet, as well as an environment in which investor confidence increases, resulting in more gas supply, power generation and associated infrastructure investment.

Recognizing the importance of having the gas-to-power industry established on firm foundations, **Section 7 Fundamental Challenges**, sets out the potential interventions that can be implemented to address these issues.

Above ~5 GW, wheeling capacity of the power transmission grid becomes the significant bottleneck[1] – even if more than 5 GW of power generation is available the grid cannot sustainably wheel that quantity of electricity. To achieve ~10 GW assumes significant investment in the power transmission grid, additional gas supply and east to west gas connection through the OB3 and ELPS2 (+ compression) pipelines. However, achieving ~10 GW, does not require any additional investment in new power generation. This is shown by the green line in Figure 5-1.

Post 10 GW, additional new power generation will be required – the blue line on Figure 5-1. As long as commercial viability and confidence is there, regulatory stability believed, and the sabotage situation resolved, feedback from investors is that they will be prepared to invest. The opportunities for interventions regarding new infrastructure are set out **in Section 8 Future Infrastructure Investment**, however, as stated above, without initially addressing the fundamental challenges new investment is unlikely to come forward.

To conclude; there are interventions that can be made to achieve additional gas-fired power generation in a 12-month timeframe. However, further increase in generation in the medium to longer-term will only be achieved by addressing the fundamental challenges in the sector, and if these challenges remain unattended to generation will reduce and new investment in the sector will not be forthcoming.

[1] TCN is currently progressing 22 "critical projects" that are intended to increase the level of transmission in the grid to somewhere between 5 GW and 7 GW.

6. EXISTING INFRASTRUCTURE (EI)

Any opportunity for increased power generation and evacuation in a 12-month period must be based upon improved utilization of existing gas and power infrastructure or fast tracking existing projects. A 12-month timeline is insufficient to implement any new infrastructure that is not already in an advanced stage of implementation. The Rapid Assessment identified a number of opportunities and interventions to increase utilization of existing infrastructure (see Table 6-2). The narrative below should be read in conjunction with this table.

6.1 GAS SUPPLY EI 1 TO 5

Deliberate sabotage and vandalism of the oil and gas pipelines and facilities in the Niger Delta Region is an unfortunate regular occurrence. This sabotage and vandalism is primarily a political issue and caused mostly by long standing grievances amongst a proportion of the population of the Niger Delta Region. Despite a significant proportion of hydrocarbon production in Nigeria being from the Niger Delta Region, the local population considers that too little of the revenue received from the sale of the hydrocarbons is invested back into the Region. Out of frustration militant groups, such as the Niger Delta Avengers, have resorted to deliberate sabotage of pipelines to draw attention to their cause.

The draft Petroleum Industry Bill includes proposals seeking to resolve the sabotage and vandalism by increasing investment in the Niger Delta Region through the introduction of a Host Community Fund. However, the draft Petroleum Industry Bill has not been passed into legislation and the broader content of the draft Bill remains a contentious issue.

In the past the level of sabotage was reduced by the FGN issuing security contracts to protect the oil and gas pipelines and facilities, with associated payments for the provision of those services being made to the parties linked to the sabotage and vandalism. However, the current Administration cancelled these contracts, leading to the recommencement of the sabotage and vandalism.

It was reported in local media that in August security contract payments were reinstated in the Niger Delta Region, however this can only be considered as a "sticking plaster" solution to the problem and it is a longer term fundamental issue that the Government has to resolve (this challenge is described further in Section 7.7).

That said, if Power Africa has the appetite to intervene in this matter, **there are practical actions that could be undertaken to follow through on previous Government promises for investment in the Region that have not been delivered. For example: providing skills training to improve the capability and capacity of the local population; investing in the development of infrastructure, such as, off-grid generation to utilize flared gas, schooling, and hospital services.** Such interventions do not directly improve gas-to-power, however they may lead to reduction of sabotage, thereby reducing gas supply stoppages (in order to better understand the expected level of success would require interaction with Delta communities). Unless addressed the deliberate disruption in oil and gas supply could remain the hydrocarbon sector's Achilles heel for years to come.

Whilst the sabotage and vandalism is having a significant impact on gas supply and subsequent impact on power generation, there are opportunities to generate additional power from existing generation facilities.

Both the Rivers IPP and Gbarain NIPP have had gas supplies suspended by Shell for non-payment of gas supply invoices. It is understood that both these power stations would be able to evacuate power if the gas supply was restored. Both power stations have direct gas connections rather than connection from the NGC domestic gas network. It is not known what the current level of debt is however, if these payment issues are resolved, over 200 MW of additional power could be restored. **During the Rapid Assessment the opportunity for reinstating gas supply to these two power stations was identified; it could also be possible there may be other power stations in a similar position and investigating this possibility further could be a beneficial intervention.**

An additional source of gas supply that has been proposed for some time, is to divert wet gas from the Bonga deep offshore field to Escravos in the West, rather than, as is the current practice, wet gas from Bonga being transported via a sub-sea pipeline to Bonny in the East of Nigeria, where NLNG extracts the NGLs and liquefies the dry gas for export via LNG.

Under the proposed plan, a third party company, Giga Gas, plans to take delivery of the wet gas at Escravos and process it to extract the liquids and supply up to an additional 120 MMscfd (approx. 400 MW) of dry gas into ELPS. **Market feedback indicates that this project is advanced and would provide an opportunity for additional gas supply with a minimum lead time.**

Additionally, there are other existing gas production sites, Odidi and Forcados, that have the potential to increase gas production capacity, but as yet the increases have not occurred. It is not known what upgrades are required or what are the barriers to completing the work.

In late 2014 CBN put in place a loan facility to settle all outstanding debts from the power sector owed to gas suppliers. The loan was to be repaid via an increase in the electricity tariff and the IOCs also agreed to supply additional quantities of gas to the domestic gas market.

Unfortunately, when NERC did not increase the electricity tariff in March 2015 and the IOCs failed to increase gas production, the loan facility was suspended. A major issue for the IOCs has been the non-payment of gas supplied and, particularly when coupled to not receiving NNPC's share of the upstream JV costs, it is not unreasonable that the IOCs have been cautious about undertaking further investment in the sector. The loan facility was seen as one of the major steps to activation of the transitional market in the electricity sector and with the suspension of the loan facility the sector has once again stalled. **There is the opportunity for an intervention to encourage settlement of issues that allow CBN to reactivate the loan facility. Payment of debt to the gas suppliers would be of great benefit to the sector.**

6.2 GAS TRANSMISSION EI 6 & 7

The Nigerian domestic gas transmission network is inherently fragile in its design with only one main trunk line in the West and a separate, much smaller, network in the East. The gas network is adequate to support power generation up to the confirmed electricity evacuation capacity of 5,075 MW, however it lacks resilience and inter-connectivity.

Figure 6-1: Map of Gas Infrastructure in Nigeria

This problem is being partly addressed through the construction of ELPS 2, a duplication of ELPS 1. This expansion will double the capacity of ELPS to 2,200 MMscfd and completion has been delayed from the expected date of Q4 2016. However, the capacity can only be fully realized if two compressor stations are also constructed. Without the compressor stations the capacity in free flow conditions will be 1,500 MMscfd, which is 200 MMscfd below the current demand level (this assumes no sabotage or vandalism). An estimate of the current demand level is shown in Table 6-1 below:

Table 6-1: ELPS Gas Demand (2016)

Sector	MMscfd
Privatised power stations	610
NDPHC power stations	565
IPP	65
Industry	335
West African Gas Pipeline	125
Total	1,700

This estimate does not include Azura 115 MMscfd (start date 2018). The estimate is built up through a combination of the following:

- Power station figures are a combination of actual values from GSAAs; data from NDPHC publication and estimates based on power generation capacity (some commentators have suggested that the power stations are understating their gas requirements and the maximum value is closer to 1,500 MMscfd as compared to 1,240 MMscfd[2] above)
- Industry is the highest throughput figure to date
- WAGP contracted quantity

A further project, which is currently under construction, is the OB3 pipeline. This will connect the West and East gas networks and is critical because a large proportion of the under-developed gas reserves are in the East however the majority of the gas demand is in the West. OB3 is programmed for completion in July 2017.

Historically in Nigeria, infrastructure projects have a reputation for being delivered late, primarily as a result of poor project management. **An intervention to provide project management assistance with these projects would assist with their timely completion, leading to greater resilience in the gas network.**

Currently all gas to power stations on the domestic gas network is supplied via NGC. With willing seller-willing buyer transactions and any activation of the GSAAs will reduce NGC's de facto monopoly. The new GSAAs will replace the existing 'legacy' gas contracts that are in place with NGC and are linked to DSOs. Willing seller-willing buyer agreements – much to be encouraged – will also be in place for gas not supplied under DSO.

The new Gas Sales and Transportation Agreements have been signed but await activation. One of the main issues preventing their activation is the lack of appropriate levels of financial security in place from gas buyers.

Whilst NGC continues to be the sole supplier there is a concern regarding its approach to allocating the available gas. The allocation appears to be based on gas network operational considerations rather than the optimization of gas based on the most effective use of gas into the power sector. Some power stations are more efficient than others and some will be in locations optimal for the evacuation of more power. If gas were allocated to power generation plants in a way that optimized efficiency and evacuation, power generation and evacuation would increase for the same volume of gas supplied. There would be more MWh of generation for the same level of MMBtus of gas**. There is opportunity to implement this technical intervention to better facilitate power dispatch. This intervention would need to be driven within NGC, as the party responsible for gas allocation of gas.**

6.3 POWER GENERATION EI 8 TO 10

AES owns a floating barge mounted power station moored on the Lagos Lagoon next to Egbin power station, which came into service in 2001. Initially the barge was operated commercially under a tolling agreement with the Lagos State Government, prior to this agreement subsequently being passed to PHCN's control.

[2] Summation of Privatized and NDPHC power stations and IPPs

The 270 MW power station operated until the privatization in the power sector after which it could no longer generate power due to two gas supply challenges. Firstly, as a result of being operated under a tolling arrangement it was PHCNs responsibility to supply gas to AES. With privatization of the power sector and PHCN being disbanded, the AES barge no longer had a commercial counterparty to supply it with gas, and therefore could not operate. Secondly, the gas supply to the barge is via a spur line off the pipeline that supplies gas to the Egbin power station. There is no metering point along the spur line to the AES barge, the only metering point being for gas flowing through the pipeline to both Egbin and the AES barge. This means gas flow to AES cannot be measured. This situation was less important in the nationalized system prior to privatization of the power sector, however in a privatized system each plant needs to accurately know what volume of gas it is consuming. Therefore, the AES barge is sitting idle due to contractual and metering reasons. **The solution to the gas supply problem should be fairly easy to resolve and with the execution of a PPA it could be back in operation. Technical assistance could also address the metering issue and bring this power barge back into service.**

There are two CCGT power stations in Nigeria; Olorunsogo and Alaoji. A CCGT power station uses the waste heat from the gas turbines to generate steam to drive a steam turbine and is typically 50% efficient compared to 30% efficiency for OCGT. It is understood that these two CCGT power stations are running mostly open cycle. This is a lost opportunity to increase plant efficiency and thereby generate more electricity from the same volume of gas**. A swift intervention could establish what is preventing the steam turbines from being brought fully into service and what action could be instigated to bring them into service.**

One power station operator suggested during the Rapid Assessment process that with the current shortfall in gas supply, with the plant therefore not being able to generate due to lack of gas, it was an ideal time to complete maintenance on power stations. However, cash constraints are restricting the ability to undertake these works. This problem is linked to power stations only receiving part of their revenues from NBET due to the value chain deficiencies in power. **An intervention to address this issue would enable power stations to dispatch more power when additional gas supply would be available. This intervention will be complex to facilitate because it is primarily a loan facility rather than physical support**.

6.4 POWER TRANSMISSION EI 11

TCN confirmed that it has identified 150 projects to increase the capacity of the power transmission grid. Of these 150 projects, 22 are critical projects, which can be delivered by year end and should increase evacuation capacity to 6,000 – 7,000 MW. TCN described these projects as being "fully funded but with some CPs outstanding." TCN has a poor track record in delivering projects which is in part due to poor management and in part due to practical unforeseen construction issues. **Technical/project management assistance on delivery of these critical projects and future projects would improve the overall power evacuation capability in the system. It would also improve power evacuation in the East where there is available gas supply to generate more power but is currently limited by evacuation capability**. It is understood that this is already an area of focus of Power Africa interventions.

The tables below are structured in line with the gas-to-power chain, starting with gas supply through to evacuation of power. On the right hand side of the table, are four columns headed A to D. These columns indicate the possible opportunities for Power Africa involvement, broken into the following categories:

A. Power Africa investment, with/without other agencies, including loan guarantees

B. Other direct Power Africa involvement/intervention e.g. expert assistance, active direct roles, workshops

C. Power Africa Influence by lobbying, persuading other parties

D. None for whatever reason

Table 6-2: Opportunities and Interventions for Existing Infrastructure (EI)

No	Opportunity regarding Existing Assets	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges / Comments	Opportunities for PA Involvement			
							A	B	C	D
EI 1 - GAS SUPPLY	Reduce / resolve sabotage of oil and gas facilities and pipelines	Assist Government in resolution of Niger Delta community issues	Investment in Niger Delta and local communities e.g. procurement of services, provision of training programs, investment in infrastructure	FGN STA PA	Uncertain, however would expect some progress in less in 12 months	This is primarily a Government / political issue		✓	✓	
EI 2 - GAS SUPPLY	Reinstate gas supplies cut off to GENCOs through lack of payment to gas suppliers – e.g. Rivers IPP and Gbarain	Pay existing debts to gas suppliers and agree process for future gas supply / payment	Facilitate debt plan and future payment solution e.g. loan facility to the GENCOs This intervention has the opportunity of bringing immediate results, however needs to be sustainable Confirm if any other GENCOs are in a similar position	PA CBN	Less than 12 months	Requires the underlying gas-to-power commercial chain to be addressed for the intervention to be viable and sustainable		✓	✓	
EI 3 - GAS SUPPLY	Supply of Bonga gas to the domestic market	Requires new commercial arrangement between Bonga PSC and Giga Gas, and the development of new pipeline and processing infrastructure	Facilitate securitization of the transaction Understand the status of this existing project	PA WB?	Conclusion of agreements and infrastructure greater than 24 months	Credibility of Giga Gas? Commercial treatment of liquids extracted from wet gas stream? Ownership of dry gas? (from IOC with DSO)	✓	✓	✓	

No	Opportunity regarding Existing Assets	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges / Comments	Opportunities for PA Involvement			
							A	B	C	D
EI 4 - GAS SUPPLY	Supply of additional gas from Odidi and Forcados (existing gas production facilities suppling gas into ELPS) to the domestic market	Requires secure commercial viability and likely settlement of past JV arrears	Facilitate securitization of the transaction Lobbying of Government re JV arrears	FGN NNPC PA DPR	Conclusion of agreements and infrastructure upgrades, if required, greater than 24 months	Enforcement of the DSO would assist in resolution of this issue		✓	✓	
EI 5 - GAS SUPPLY	Conclusion of CBN loan facility (the loan facility was originally established to settle outstanding debts owed to gas suppliers, but was suspended when IOCs failed to meet CPs related to the facility)	IOCs need to meet their CP commitments for release of funds, e.g. supply of DSO gas	Facilitation of monitoring of IOCs and assistance in funds disbursement	CBN PA DPR	12 – 18 months	IOCs have not shown willingness to progress upstream projects as originally agreed			✓	
EI 6 - GAS TRANSMISSION	Completion of NGPTC pipeline projects, ELPS2 and OB3 Completion of gas compressor stations on ELPS	Improve project management and implementation within NGPTC	Implementation assistance to NGPTC	NGPTC PA	Less than 12 months Greater than 24 months	Community issues and practical construction issues, e.g. wet season, may limit opportunity to accelerate these projects		✓		

No	Opportunity regarding Existing Assets	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges / Comments	Opportunities for PA Involvement			
							A	B	C	D
EI 7 - GAS TRANSMISSION	Optimization of available daily gas supply to the most efficient power generators	NGPTC to schedule gas to the most efficient GENCOs to maximize MWh from available MMBtus	Technical assistance to NGPTC to implement	NGPTC PA GENCOs	Less than 12 months	Requires co-operation of less efficient power plants to not take gas and not dispatch. Government owned NIPPs are in many cases the most efficient, resulting in private sector plants not running (although still receive capacity payments)		✓	✓	
EI 8 - POWER GEN	Bring AES Power Barge back into operation (AES tolling agreement with PHCN came to an end and has not been renewed partly due to complications of a shared gas supply with Egbin power station)	Agree GSA and PPA	Facilitate securitization of the transaction	PA AES NBET Egbin	Less than 12 months	Commercial agreement with Egbin; resolution of issues around gas connection/metering required for use of gas pipeline to supply power barge		✓	✓	
EI 9 - POWER GEN	Fully bring into service steam turbines at Olorunsogo and Alaoji, to move from OCGT to CCGT	Provide financial and or technical as required	Provide technical assistance to unblock issues	PA Ologun Alaoji	Potentially less than 12 months.	Cause could be significant technical problem that cannot be addressed in short term		✓	✓	

No	Opportunity regarding Existing Assets	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges / Comments	Opportunities for PA Involvement			
							A	B	C	D
EI 10 - POWER GEN	Clear back log of investment of rehabilitation and maintenance of successor GENCOs	Undertake necessary works	Financial assistance to enable maintenance work to take place	PA GENCOs NIPP	Some opportunities within 12 months, i.e. Egbin	With current gas supply limitations, this is a timely period in which to take plant offline to carry out works. Will only yield results when reliable gas supply is restored	✓	✓	✓	
EI 11 -POWER Tx	Address power transmission evacuation constraints (particularly in SE Nigeria)	Complete TCN 22 priority projects (out of a potential 150 projects). WB / AfDB funded – CPs outstanding	Technical / project management assistance to TCN to implement priority projects	PA TCN	Within 12 months, some by year end	Long history of poor management of projects Compounded by conclusion of MHI contract	✓	✓	✓	

7. FUNDAMENTAL CHALLENGES

Addressing the fundamental challenges and constraints in the chain is the key to unlocking a sustainable future for the gas-to-power chain.

This section sets out those fundamental challenges, initially highlighting those issues that are a historical hang-over from poor management and performance in the chain in the past ('Legacy' Issues), suggesting ways to draw a line under those issues and moving on to address the current issues (with the issues described under six different headings).

The narrative below should be read in conjunction with Table 7-1. Each row in the table has a reference starting FC (for Fundamental Challenges) and a number corresponding to the row number. Similarly to Table 6-2, the issues are broadly described along the value chain.

In addition, the left hand column also includes an abbreviation linking the fundamental issue to one of the following opportunities for resolution:

Com – Commercially sound and viable value chain
Tech – Technically robust chain
Supply – Solution to sabotage
Reg – Strong regulation across the technical and commercial chains
DISCO – Fit-for-purpose DISCOs
Pol – Policy (i.e. national demand study, national energy policy)
Leg – Legacy issue

7.1 LEGACY ISSUES

In seeking to address the fundamental challenges that have held back the development of the gas-to-power chain in Nigeria, it should be recognized that many of these issues are historical long-term issues. Some stakeholders commented to Gas Strategies that for at least thirty years there has not been a commercially viable value chain in operation in Nigeria with gas suppliers not being paid for most of this time. While oil prices were high and while there were no significant alternative outlets for the gas the oil and gas producing companies tolerated the situation – after all if the gas was used by the State it eliminated some flaring (particularly relevant pre-1999 before NLNG was operational and used the associated and previously flared gas for the production of LNG).

The gas-to-power technical and value chain was previously in the hands of two Government agencies NGC (now NGPTC) for the gas and NEPA (and its successor PHCN) for the electricity (now broken up into component parts and partially privatized). At least in the early years the gas-to-power chain more or less worked technically, allowing gas to be evacuated. Any deliberate sabotage was confined to oil pipelines mostly.

Both NGC and NEPA/PHCN were under-maintained and under-invested (FC 6). NEPA did not concern itself with metering nor with illegal connections. Its actions, or rather lack thereof, encouraged a culture of free electricity entitlement. This culture has extended to Government and its agencies many of which have not paid their electricity bills for some time. At the time of the break-up of PHCN and its partial privatization, no component part of the chain was technically fit-for-purpose. There was, and still is, a severe back-log of under-investment. This is estimated by stakeholders as being several US$ billion.

The situation with gas upstream supply is not dissimilar. NNPC, which has a 55-60% interest, in the upstream oil/gas JVs, has failed to contribute in full its share of the cash calls to cover its portion of the costs. It is understood arrears to IOCs total around US$ 7 billion (FC 4).

NGC owes the IOCs a significant amount for past debts relating to unpaid supplies of gas. It is doubtful that the IOCs are particularly concerned about the historic owings where the price of gas per MMBtu was very small. The IOCs' major concern is the significant upstream JV NNPC arrears, and with it a concern that any new JV investment will just attract more non-payment and arrears – a significant deterrent to further investment.

A further concern – and this applies to all participants in the commercial value chain which are not protected by guarantees – is that there is no confidence that any future revenue stream to repay new investment will flow notwithstanding that there may be contractual obligations.

Recently, the deliberate sabotage of pipelines has migrated to gas pipelines and it is seriously affecting gas supply and therefore electricity generation.

7.1.1 Debts

In order to develop a sustainable commercial gas-to-power chain, legacy debts (whether capital or revenue) (FC 27) need to be settled. This can be achieved through payment of the outstanding debt in full, payment plans backed by guarantees or part payment to an agreed value (where the party owed takes a 'haircut'), or in combination. The objective of this is that on a defined date when a viable commercial value chain will be in place, there will be no legacy debt that is not accounted for and for

which settlement in one way or another has not been guaranteed. Legacy debts should not be a burden on the consumer going forward.

7.2 HISTORIC UNDER-INVESTMENT AND UNDER-MAINTENANCE

Whether or not the goal is to privatize elements in the chain, the infrastructure has to be brought up to standard at Government expense and not at the expense of the electricity customer going forward (FC 6). If an element is to be privatized then it will likely be better for the (fully qualified and appropriately capitalized) purchaser to undertake such work with capital provided by the Government or otherwise guaranteed to the purchaser in order for it to bring the enterprise up to standard. This can be achieved by direct capital injection or reduction in purchase price, but it should not be by way of increased fee for service, which would then be a burden on the electricity customer going forward.

7.3 AGREEMENTS ON QUANTA OF CAPITAL AND REVENUE DEBT

This will not be an easy task as, among other things, there is probably poor record keeping, and there will be many different views on what is and what is not owed. For the endeavor to establish quanta that will be accepted by all, it will be fundamental to demonstrate, by whatever means, that the debts will be paid. Without that, there would be no confidence that any initiative of this sort would bear any tangible fruit, and so co-operation would likely be minimal.

7.4 MOVING ON FROM THE LEGACY

Settlement of the legacy debt (even if over time) through a firm, believable, Government funded or otherwise guaranteed plan will make the current commercial gas-to-power chain sustainable and drive investment in infrastructure. Making the current infrastructure fit-for-purpose will make it capable of delivering a substantial improvement in MWh to the bars; for a total power capacity estimated in the range 5,000 – 7,000MW, depending on the view of different stakeholders. At the higher levels of this range, gas supply infrastructure will be a limiting factor; as will TCN if it cannot achieve such higher level of transmission.

Post-legacy, there are many fundamental challenges to address. These are described below:

7.5 COMMERCIALLY SOUND AND VIABLE VALUE CHAIN – FC 2, 4, 8, 15 & 25

Gas pricing is not a fundamental challenge, at least not for now. From the perspective of an existing gas supplier, there are greater fundamental issues to resolve now in order for there to be a viable commercial value chain. These are principally: NNPC funding of IOCs (arrears and for the future); sabotage; realistic gas supply and purchase arrangements between buyers and sellers; DSO; flaring reduction/elimination; future payment for supplies. Without these fundamental issues being addressed, there will be no investment in gas supply, almost no matter what the price is that is on offer.

What constitutes a reasonable gas price is dependent on the starting position. For established production where associated gas is currently being flared, all that is required is compression and maybe processing before the gas can enter the transmission network. There is also provision within the

legislation for NGC (and now presumed to be with NGPTC) to pick up the gas for free at the flare. So, by that argument, and under sound gas evacuation and payment conditions all that is needed is a price to cover and minimal operating costs and a return on the compression/processing investment. If flaring and DSO penalties would be taken into account, then the hurdle price needed reduces.

For new oil/gas production, the situation is not that different. Justification of investment is usually based on the oil production alone with no account taken of the associated gas, save that – should it be flared – the costs of flaring penalty (and DSO if relevant) need to be taken into account.

The demand for gas in Nigeria is not such that there is need to develop yet pure non-associated gas fields. When that will be the case, the economics may look rather different. However, that speaks to a time when the gas evacuation issues have been solved and the value chain is commercially viable. On a willing seller/willing buyer principle, the price will be what the price will be based upon the market conditions at the time of the agreement.

Conditions today are that, together with gas shut in for sabotage and non-payment reasons, there is enough unharnessed associated gas to fuel a further few thousand MW (to determine how much would need more detailed investigation) without resorting to non-associated gas production.

The policy of which gas should be developed, the attitude to flaring and DSO and penalties should be a subject of the proposed National Energy Policy and Plan suggested in the last section of this report.

Revenue generation is source of gas-to-power chain commercial viability – FC 25:

The sole source of revenue for the value chain is revenue from electricity sales. Revenue is currently paid for c.35-40% of electricity supplied. No value chain can work properly at such levels. **Power Africa is aware of the need for greater revenue collection by DISCOs and is already undertaking interventions to address this issue.**

Additional issues to revenue generation include: gas supply and transportation fees being paid in Naira but indexed to US$; current account funding for successor GENCOs; sound future basis for gas supply payments; and the viability of commercial contracts through the value chain.

Gas supply and transportation costs – FC 2:

It is usual in any country for goods and services to be priced in the local currency. In Nigeria gas suppliers want the gas supply price to be indexed to US$. The same is true for the gas pipeline transportation tariff through the NGPTC pipelines. A postage stamp tariff paid in Naira but calculated in US$ and then converted to Naira using the CBN exchange rate for the month during which the services were provided. This US$ 'indexation' works its way through to the tariff to the electricity consumer – most of whom have absolutely no exposure on their income to US$ values and yet are exposed in their electricity tariff to US$. This is neither fair nor sustainable.

The arguments for US$ indexation are that the oil and gas industry in Nigeria (as elsewhere) works in US$. This is acceptable for exports of a global commodity such as oil and LNG. Partially through a failure to sufficiently develop Nigeria based industries, much of the capital good of oil and gas production facilities and transmission infrastructure is imported, therefore in 'hard-currency' forex (usually US$) not

in Naira. However, once spent and converted to Naira, the linkage to forex should evaporate, except for maintenance and replacement capital costs where these are still forex denominated. Also, where there are loans that are forex based funding the capital expenditure, the repayment over the tenure will be forex based. Loan tenure is usually a lot less than the economic lifetime of the asset. [US$ is used as a proxy for all forex expenditure whatever its denomination.] Many of the gas infrastructure assets have no outstanding forex based payments. Many are fully depreciated, including much of the NGPTC pipeline infrastructure (the obvious exceptions being ELPS2 and OB3 which are currently under construction). **Operating costs of the gas supply and transmission infrastructure are largely based in Naira. Therefore, there is a strong argument for reducing substantially, if not eliminating, the US$ basis for escalation provisions in the gas supply and NGPTC transportation tariffs, and instead using some Naira basis.** This would be very welcome for the electricity consumers, providing some stability in the price of electricity and over an issue over which they have no control or ability to mitigate. **To achieve this will require consultation with stakeholders and an analysis of the cost structure so as to establish a fair escalation basis that affords some measure of forex protection to private promoters of infrastructure.** For public sector investments, where likely these are made from current account and existing forex reserves, there is no need for forex based escalation at all. No doubt it will be a difficult sell, however the rewards will assist in preserving commercial viability of the gas-to-power value chain, and assist in future confidence in its viability – essential for future investment in the chain and also for industries served by electricity.

Gas Supply payment – sound future basis – FC 4:

NNPC has a 55-60% interest in the upstream oil/gas JVs. Any future upstream development project that requires funding is supposed to have NNPC pay its appropriate share of costs. It is unrealistic to expect the IOCs (or LOCs) to carry – however temporarily – this interest. **It is essential to any future development of gas supply projects that there is a sound future basis under which NNPC will be able to pay its share of the capital projects and operating budget** (approved on a year by year basis) and as called for through the cash call procedure. This is not an issue for now as there is sufficient gas supply (with sabotage removed) to supply a substantial increase in MW beyond that of today, but its resolution will allow new gas supply projects to be delivered as and when they are required in the medium term.

Current account funding for successor GENCOs – FC 8:

All funding for the GENCOs is from revenues collected through the electricity tariff. Successor GENCOs are not protected by guarantees, unlike the new IPPs. GENCOs' ability to fund their day-to-day expenditure, undertake routine and turn-around maintenance is based on the revenues flowing upstream from the DISCOs. There will be an interim period while the DISCOs are being made fit-for-purpose to achieve their performance targets when these generating assets will not receive their full quota of revenue based on a per asset MW threshold. This revenue should be paid to the GENCOs according to the threshold, with the Government covering the difference between the required performance standard of the DISCOs and this threshold. DISCOs would have to pay GENCOs according to their performance obligations whether achieved or not.

For any of this to work, the sabotage of pipelines needs to be resolved so that the GENCOs are not unable to produce electricity due to gas supply outage. In the interim, while the sabotage situation is

being addressed and, if Government is serious about establishing a viable commercial chain, there should be some level of underpinning by Government to the extent that a certain level of gas supply cannot be realized owing to sabotage.

Commercial contracts through the value chain – FC 15:

Stakeholders along the gas-to-power chain expressed opinions to Gas Strategies that there are issues surrounding the contracts along the chain and their appropriateness. **At the least there should be a review of all contracts within the gas-to-power chain to ensure that they are fit-for-purpose.** The work should include making recommendations.

7.6 TECHNICALLY ROBUST CHAIN – FC 9, 10 & 11

A chain is only as strong as its weakest link. Technically, the weakest links in this chain are TCN and its power transmission grid. However, the transmission grid is not being stretched to capacity at the moment as the lack of gas supply because of sabotage is not exposing the shortcomings in transmission.

The Fundamental Challenges for TCN are covered in FC 9, 10 and 11. Power Africa is already supporting TCN with an embedded advisor.

TCN has identified 22 critical projects (out of a longer list of 150 projects) which have the objective of delivering a power system capable of providing 5,000 – 7,000 MW sustainably (the specific number varies between different stakeholders). TCN described these critical projects as being "fully funded by the World Bank", however it was not clear where the funding was coming from. Now that the management contract with MHI has expired, TCN is in need of project management capabilities. **Technical losses through the system are high – some report it as being as high as 40%. Clearly this is an area for examination with a view to loss reduction, and links to the 22 critical and the other 128 projects on TCN's agenda.**

Gas transportation infrastructure is relatively sound – save for sabotage – and with the addition of OB3, the West-East connection, and ELPS2, there will be capacity for several more thousand MW of generation capacity.

Based on reports from stakeholders, DISCO distribution networks are also in need of refurbishment and upgrade. That should be a subject of the thorough look at DISCOs although distribution technicalities are perhaps the least of their problems.

7.7 SOLUTIONS TO SABOTAGE – FC 3

Sabotage is the "Elephant in the Room" as far as the gas-to-power technical and value chains are concerned. The current focus of sabotage activities is oil and gas pipelines. There may be some commercial value in sabotaging oil pipelines if this is leading to illegal bunkering, however generally that activity is the removal of a portion of oil from the flow leaving the remainder intact. After all, there can be no oil evacuation, legal or illegal, from a pipeline shut-in because of a pipeline break.

Sabotage where pipelines are taken out causing total shut-in, is therefore not for reasons of economic gain. The drivers of the perpetrators behind the sabotage and potential interventions are described in Section 6.1. **It is recognized that the root cause of the sabotage needs to be addressed. Sabotage is essentially a Federal and State Governments' issue, however there may well be interventions to do with community support, training, gas based micropower etc. with which Power Africa might wish and be able to become associated.** Such interventions would show results over the medium term, however they would and could be started soon, assuming Federal and States Governments' support.

7.8 STRONG REGULATION ACROSS THE PHYSICAL AND COMMERCIAL CHAINS – FC 5, 7, 12, 13 & 16

No Gas Regulator, DSO and Flaring Obligations, Weak NERC: There is no gas regulator, or at least none worthy of the name when it comes to 'post hydrocarbon production point' regulation. The Department of Petroleum Resources has this responsibility, however it does not take any action with respect to the DSO or gas flaring issues.

NERC is an independent regulatory agency which was inaugurated on 31 October 2005 as provided in the Electric Power Sector Reform Act 2005. NERC is responsible for:

- Monitoring and regulation of the electricity industry;
- Issuance of licenses to market participants; and
- Ensuring compliance with market rules and operating guidelines

Therefore, aside from the setting of electricity tariffs – which are in theory cost-reflective and therefore include gas supply and gas transmission costs – NERC's remit extends only to generation, transmission, distribution and trading of electricity. There is therefore a gap in the regulation in the gas-to-power value chain between where the remit of DPR stops at the production platform and where NERC starts with the GENCOs.

Were gas evacuation to the gas transmission network totally fungible, then DPR could impose DSO and flaring regulations and penalties independently of downstream considerations. However, this is not the case in Nigeria. There are many reasons why evacuation may not be possible e.g. sabotage, gas grid issues; and there are many reasons why new gas supply projects do not happen e.g. legacy issues, sabotage, NNPC investment performance, broken commercial gas-to-power chain. In these circumstances it would be difficult for a regulator which does not have oversight of the whole chain to be effective. Therefore, while in most countries with developed and well-functioning gas evacuation it would be satisfactory (and normal) for the gas regulator to be a different entity from the electricity regulator, in Nigeria it would make sense for a single body, i.e. NERC, to have oversight and regulatory responsibility of the value chain from post hydrocarbon production point through to the electricity consumer. **One of its responsibilities would then be to ensure that DSO and gas flaring obligations are progressively achieved where there is/will be satisfactory evacuation possibility, and to be tough in the enforcement of penalties where they are not.**

NERC is in theory independent, established by Act from the National Assembly rather than by secondary legislation. Its commissioners are appointed by the President subject to confirmation by the Senate. Its revenues are from a 1.5% fee from market revenues, and license fees. Penalties accrue to the Government not NERC. Currently, its revenues are not sufficient for its operation and Government provides a subvention. In due course, NERC intends to fully fund its activities without subvention. Interference in its independence during the administration of the last President has compromised NERC's reputation (the most significant example being the FGN preventing NERC increasing the R2 electricity tariff in March 2015**). It is essential that NERC's independence be maintained such that it may be respected as being without fear of favor in the performance of its duties.** The general public and industry rely upon its ability to set fair and affordable tariffs. One of NERC's goals is to provide "safe, adequate, reliable and affordable services".

NERC's major failure is in its regulation of the DISCOs. An excuse is the overlap of responsibilities with the BPE, which has a 40% stake in each of the DISCOs. Seemingly BPE has not shouldered any of the responsibilities normal for a shareholder.

GACN, established in 2010, supposedly has roles with respect to Demand Management, Aggregate Pricing and Escrow account management and Network Administration. However, none of these are effectively in operation. Its demand management extends to vetting of potential buyers and if approved admitting them to the demand pool. Aggregate pricing goes against the general market principle of willing seller, willing buyer. It is no accident that no IOCs have activated their GSAAs. Seller and buyer can do their own due diligence on each other, establish a price on a willing seller, willing buyer principle, and between them establish their own securitization and other obligations. **It was the view of many stakeholders that GACN should be disbanded.**

One role that would be useful for NERC to perform in its new role as gas-to-power chain regulator would be to ensure that the contracts established by seller and buyer contain the necessary general provisions to make them acceptable as partners on the gas transmission network. NGPTC currently operates the gas transportation infrastructure. In due time, it may be that, as with TCN, NGPTC gets shorn of this responsibility and is just responsible for maintaining and investing in the network. At that stage a system operator would be required.

In addition, there could be the opportunity for reassessment of the power tariff structure. For example:

- The R1 (Residential power sector tariff bands) lifeline tariff is non-existent in some DISCOs and covers very few people in others
- Many C1 (Commercial power sector tariff bands) customers (e.g. market traders) only use a minimal amount of electricity and solely for light (i.e. not for processing). Aligning the R1 and C1 tariffs could provide some stimulus to the smallest commercial entities that help fuel the Nigerian economy
- R2 (Residential power sector tariff bands) forms the bulk of the customer base in most DISCOs. In some DISCOs, R2 is split into single phase and three phase customers – the only way to split if unmetered. Many R2 customers could afford a higher tariff. Once metering is installed, the

better split within R2 would be on the basis of consumption. Having a higher R2 tariff in part would boost the nominal (and collected) revenue for passing up the chain.

Full enumeration and metering will assist in better tariff design, an increase in nominal and actual revenues and therefore a stronger commercial chain, and will contribute to the achievement of one of NERC's goals, that of uninterrupted electricity: 'Constant and reliable power supply is critical to the growth of the Nigerian economy'.

DISCOs (theoretically) are obliged to pay a fixed charge in their PPAs albeit, through no fault of their own, they are not receiving the full volume of MWh against which the fixed charge is set. MYTO 2.1 set fixed charges for customer tariffs, however in December 2015 fixed charges were abolished in exchange for an increase in commodity tariff. This might work well if the load on which the tariff is based (believed to be 3,200 MW but subject to confirmation) is actually being delivered, but it is not. There is therefore an in/out imbalance in the DISCO, as well as there being an unfairness to DISCOs in the PPAs which do not apparently provide any security to DISCOs for NBET's failure to deliver the required bulk power to the DISCOs.

7.9 FIT-FOR-PURPOSE DISCOS – FC 18 – 25 INCLUSIVE

As observed in Section 7.5 above, unless there would be a policy of subsidy (not recommended) the only source of revenue in the gas-to-power chain is that coming from electricity consumers through the tariff system (FC 25). Disregarding for a moment the sabotage, the DISCOs' failure to perform on a number of fronts is the major cause of the commercial failure of the gas-to-power value chain. Any plan for reform and success has to make the assumption that the sabotage issue will be resolved at least in major part.

There are fundamental and quick fixes for the DISCOs that will generate revenue improvement, the key to commercial improvement and performance up the value chain. Consistent observations by stakeholders in the gas-to-power chain and newspaper reports have highlighted that the DISCO privatization process was not well structured; the baseline for DISCO performance measurement is not appropriate; and there is much wrong with DISCOs' financial, managerial and technical capacities, governance and audit. BPE and NERC have both failed in their monitoring and audit responsibilities. It is likely that influence between new owners and Government has played a role in privatization shortcomings and maybe has since.

The various issues within the DISCOs were cited frequently by those engaged with during the Rapid Assessment process. The issues raised fell into the following categories:

- Privatization process was flawed and the baseline for establishing future performance was inaccurate and therefore DISCO performance has not met the obligations in its license
- Management, governance and transparency are weak and audit performance is poor
- Technical capacity is weak
- Financial capacity is weak

Gas Strategies' investigations covered the whole value chain from gas supply through to the DISCOs and electricity tariffs. Gas Strategies understands that Power Africa is already undertaking a series of interventions regarding power transmission and DISCOs, and therefore Gas Strategies was advised to focus this report more on gas supply through to power generation. This report therefore does that and reports on transmission and DISCOs only in short form.

In Gas Strategies' opinion, fundamental reform of the DISCOs is a key part of the solution to an improved gas-to-power value chain. The reforms Gas Strategies suggests would involve FGN and its agencies as well as the DISCOs themselves and without which the revenues than underpin the whole gas-to-power chain will not be sufficiently achieved. Gas Strategies' full commentary on this part of the value chain can be made available if required.

7.10 POLICY – FC 14 & 28:

There is little understanding of where electricity demand is, nor where it will grow over time. An understanding is essential in order to plan transmission and distribution networks for the future. A National Demand Study could achieve this.

The Gas Master Plan is now out of date. Without embracing power – 85% generated from gas and to which 70% of domestic gas supply goes – the GMP now has little value. A National Energy Policy and Plan should take its place. As currently there is not an Energy Ministry, a National Energy Policy and Plan would also usefully draw together the Ministries of Power and Petroleum Resources. The National Energy Policy and Plan would have the hope of ensuring that the gas supply, gas transportation, generation, power transmission and distribution developments would be in sync with each other, and will meet the demand levels and distribution of the National Demand Study.

Between the two, an assessment of the necessary investment could be achieved. Policy and plans for privatization including privatization of the infrastructure could be set. Policies / plans for flares out and DSO may be reviewed / reset in tune with the National Energy Policy and Plan.

Table 7-1: Issues and Interventions to Address Fundamental Challenges (FC)

No	Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 1 **Com**	Commercial Value Chain broken/defunct	Improve revenue collection; better financial rigor through chain	Many interventions required – see those issues marked 'Com'	_____	From 6 months onwards		__	__	__	__

No	Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 2 **Com**	Gas Supply and transportation– price escalation is $ based	Modify escalation provisions more in line with $/Naira cost reality	Undertake analysis for existing (depreciated) and new infrastructure Consultations with stakeholders	NERC IOCs NGPTC NNPC LOCs (PA)	From 6-9 months onwards	Engagement of IOCs regarding substantial $ JV arrears Belief of some that gas has to be $ related Potentially different for new and existing assets		✓	✓	

No	Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 3 **Supply**	Gas Supply – sabotage	Principally a Federal and State issue as FGN funding does not reach the grass roots, it being syphoned off along the way.	Community support and investment. PA could be involved in interventions relating to community development and support, training, micro-power	FGN (PA)	From 3 months onwards	Broken relationship between Niger Delta and Government; sense of free entitlement without effort Without a solution to this at least in major part, the rewards of other interventions will not be reaped	✓	✓	✓	
FC 4 **Leg**	Gas Supply payment and upstream JV funding. Needs to be resolved for a sustainable future basis	Payment of bills for Gas Supply (to IOCs and NNPC); NNPC to pay arrears for JV funding. Will require Government to underwrite payments as NNPC does not keep the earnings it generates through oil and gas sales. NNPC exists on basis of budget appropriation for capital and operating expenditure	Catalyze funding mechanism for future and develop robust payment plan for past	IOCs NNPC (FGN) (PA)	From 6 months	Likely into next year; baseline accounts need to be finalized; parties will have different views on what is owed Without confidence in the future payment stream, little to no development in gas supply will result		✓	✓	

No	Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 5 **Reg**	Failure to implement DSO and gas flaring penalties	Inadequate regulatory powers or use of powers. Excuses for non-compliance are not allowable but reasons (e.g. sabotage) are Strong argument for a single regulator overseeing from gas supply to electricity consumer	Promote establishment of gas regulator with appropriate powers	NERC MoPR (PA)	From 6-9 months onwards	When is a reason an excuse? Sabotage; commercial outlet for gas Penalties cannot exist in isolation from a supply chain that works technically and commercially		✓	✓	
FC 6 **Leg**	NGPTC, TCN starved of investment over decades (also DISCOs below)	Invest; Government has to invest to bring facilities up to workable (and saleable) standard. Then set tariffs to meet replacement and expansion capital requirements	Facilitate loans	FGN NNPC NGPTC TCN (PA)	From 12 months	Investment requirement is huge as backlog is long; not appropriate that consumers should pay for backlog – likely inability of some to pay; would be recessionary on economy	✓		✓	
FC 7 **Reg**	GACN has no role and has not performed to date since inception in 2010	Remove GACN Gas Regulator to ensure GSAs contain general provisions	Encourage willing seller, willing buyer transactions	(PA)	From 6-9 months			✓	✓	

No	Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 8 **Com**	Successor GENCOs starved of investment and now have a higher requirement for maintenance capex and opex	Appropriate tariff and revenue collection and passage of funds up the chain	Tariff reform; DISCO reform (see below)	FGN BPE NERC (PA)	From 9-12 months onwards	NERC needs to be free from interference of other FGN agencies in order to do its job NIPPs and IPPs are new so OK		✓	✓	
FC 9 **Tech**	TCN management capacity to implement necessary projects and probably to run the grid at higher throughput Understood to already be a focus for Power Africa and therefore not a priority recommendation of this Rapid Assessment	Root and branch reform of business processes; management and other training – essential to implement the 22 critical projects and the 128 balance and run the grid; concession the grid in the future is a possibility	Training; business processes reform; (funding for the 22 projects appears to be available through WB and AfDB)	PA	From 6-12 months onwards	Electricity Workers Union resistant to change TCN Board and Management capacities are low Once TCN is up to standard, it could be concessioned out in areas to qualified companies to run and maintain its part of the grid and invest in expansion, all in exchange for a Wheeling Charge		✓		

No	Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 10 **Tech**	TCN Wheeling capacity	(at c.5,000 MW meets short-term throughput possibilities, therefore not a current impediment to short-term Power Africa initiative)	None	TCN		NB: some say that with the 22 critical projects implemented by end year, capacity will be 7,000 MW. In many opinions this is not proven or likely. But even if this is 5,000 MW that will not be a chain constraint in the short term				✓
FC 11 **Tech**	TCN technical losses, up to 40%?	Being addressed as part of the 22 priority projects?	None	TCN		Hear of problem only – no analysis				✓
FC 12 **Reg**	Regulation – NERC = weak	NERC needs powers and needs to use them; use powers of audit of DISCOs; legislation upgrade?	Examine NERC legislation and undertake International peer review; stakeholder engagement Recommend legislation changes if required to give NERC appropriate powers	NERC PA	From 9-12 months	Without confidence of future stability and authority there will be little future investment Appointment of new Commissioners not yet concluded		✓		

No	Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 13 **Reg**	Regulation – Gas = none	Establish gas regulator; general provisions; enforcement of DSO and non-flaring; subsume items of use (if any) from GACN	Provide international examples to work up basis for regulator; stakeholder engagement NB: in many countries a gas regulator can exist independently of an electricity regulator. This works well when gas can be fungibly absorbed within a gas grid. This is not the case in Nigeria	NERC* PA	From 9-12 months	Resistance to alter status quo *NERC, if it is to be gas regulator as well. Otherwise separate agency. Good argument for a single gas-to-power chain regulator as there is such inter-dependence between gas supply and electricity in Nigeria. Start point is actual gas supply (including flaring). Facilities would still remain part of DPR responsibility		✓		
FC 14 **Pol**	Gas Master Plan out of date	Energy policy rather than a new GMP – i.e. embraces power too. [can be segmented to gas/power only for short/medium term]	Catalyze within MoPR and MoPWH – need for joint approach; engage stakeholders	MoPR MoPWH (PA)	3-12 months onwards	Many stakeholders NB: Discourage embedded solutions and 'work arounds' e.g. LNG		✓	✓	
FC 15 **Com**	Contracts e.g. GSAA & PPA understood to have issues	Review contracts in chain; make recommendations where they are not fit for purpose and an impediment for now and for future (in a potentially non-GACN world)	Undertake review; requires engagement with stakeholders to assess issues	PA	3-6 months	Change is difficult for some		✓		

No	Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
	(Revenue starts with Tariff and DISCOs)					NB: Both need reform. We rule out in any revenue solution the use of subsidy.	—	—	—	—
FC 16 **Reg**	Tariff; increase may lead to affordability issues; many on R2 could afford more	Make cost-reflective based on fair capex (i.e. not legacy lack thereof); Restructuring part of the Tariffs e.g. segmenting R2 into lower and higher based on consumption (needs metering) not number of phases; make C1 = R1	Stakeholder engagement, workshops, analysis Support NERC in the process	NERC DISCOs IOCs LOCs GENCOs NBET TCN NGPTC PA	6-9 months	Rule out legacy capex; High earners who can afford alternatives should pay more; low use C1 i.e. just for light should pay R1 – stimulates economy. Tariff should not include elements for DISCO failure to perform		✓	✓	
FC 17	NBET					No comment	—	—	—	—
FC 18 **DISCO**	DISCOs – high level concept (mid-level concerns below) DISCOs already understood to already be a focus for Power Africa and therefore no interventions regarding DISCOs have been included as a priority recommendation of this Rapid Assessment	Investment in the DISCOs through the dilution of current owners, bringing with it stronger management, governance and technical capacity	Facilitate Government and NERC engagement; steward implementation; facilitate other funding agencies' involvement	BPE MoPWH DISCOs PA	9-12 months onwards	Challenge: Stiff DISCO resistance – lever to overcome resistance is DISCO failure to perform according to their license obligations.		✓	✓	

No	Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 19 **DISCO**	DISCO – lack of transparency, poor governance and management, 'paper' technical partners, weak balance sheets	Root and branch shake-up of DISCOs so they perform to acceptable accounting; transparency norms. Plan to fix. Assess robust financial plan that delivers	Fund governance, management audits according to international standards. Roll out plan to fix	MoP BPE DISCOs PA	3-9 months	Owners' reluctance to allow others into their patch. Lever is that they are currently not fit for purpose and not adhering to their performance obligations		✓		
FC 20 **DISCO**	DISCO – lack of technical capacity, lack of strong/qualified technical partner	Technical audit of DISCOs and assessment and involvement of their technical partners. Fix issues	Fund technical audit. Roll out plan to fix	BPE PA	3-9 months	As item above		✓		
FC 21 **DISCO**	DISCO – BPE ineffective governance; conflict of roles (shareholder and audit)	Shear BPE of any regulatory roles and hand to NERC; BPE actively carry out its shareholder governance duties	Involve BPE in 18 above; training for governance	MoPWH BPE NERC (PA)		Resistance from BPE; applause from NERC		✓		
FC 22 **Com** **DISCO**	DISCO – failure to perform – metering	NERC audit and powers; failure to perform must carry penalties; accelerated enumeration and metering plan (capital injection for same as loan with repayment plan); revenue collection performance plan	Assist in tariff design; facilitate capital injection and design on repayment plan	BPE DISCOs NERC PA		As 20 above	✓	✓		

No	Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 23 **DISCO**	DISCO – foreign sourcing of meters = expensive	See if there are Nigerian meter manufacturers that could deliver according to specification and quantity required			3 months	Comment: there will be call for meters for a long time as more connections are made, therefore this is a local content industrial segment worth developing			✓	
FC 24 **DISCO** **Pol**	DISCO dilution	BPE to hold on behalf of people; eventual float including some/all of BPE stake	Design documentation that facilitates this	BPE (PA)		Comment: if NERC is doing its job properly, BPE does not need to have any stake in the DISCOs. Common mistake of FGN to think that it has to have shareholding to exert control. Control is best exercised through effective regulation		✓	✓	
FC 25 **Com** **DISCO**	Revenue at DISCO is source of gas-to-power chain commercial viability	Cost-reflective tariff; collection (mostly pre-pay) from all; Government and agencies to pay their past bills and guarantee to pay their future ones on time	Collection is a national issue, requiring education, setting of example by government	NERC DISCOs IOCs LOCs TCN NGPTC (PA)	3-6 months	Comment: Two sources of money: revenue and subsidy. Our assumption – with which we agree – is that subsidy going forward is (and should be) off the table		✓	✓	

No	Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 26 **Com** **DISCO**	DISCOs – estimated billing	Metering eliminates the dissent surrounding estimated billing Lack of metering issue dealt with in FC 22 above	_____	_____	_____	Comment: most consumers do not have meters. Over time this has encouraged the feeling of entitlement to free electricity, and stokes up resentment in those who believe (with or without cause) that their bill is over-estimated. Disputes cost money to resolve and while there is non-payment there are cash flow consequences in DISCO and up the chain	__	__	__	__
FC 27 **Leg**	Settlement of past debts in value chain and in JVs	Keep separate from the go-forward point; design plan with funding support that solves issue over time even if with haircut	Promotion of concept that future will only work if past is settled albeit over time as necessary and future has commercially viable tariff/revenue	MoPR MoPWH MoF NERC All in chain	9-12 months	Comment: there will only be confidence to invest in the future if there is reasonable certainty of payment by all consumers and remittance through the chain		✓		
FC 28 **Pol**	Little understanding of where demand is or will be – will assist in particular power transmission planning	Undertake a national demand study	Commission / assisting with funding of demand study	MoPWH PA	9-12 months			✓		

8. FUTURE INVESTMENT IN INFRASTRUCTURE (FII)

Whilst there are short-term intervention opportunities relating to the Existing Infrastructure, it is the Fundamental Challenges that are required to be addressed in the Nigerian gas to power sector to create a sustainable commercial and technical chain. Assuming these Fundamental Challenges are addressed (at least in part) then the pipeline of projects to take the sector beyond 7,000 MW also needs to be established. The Rapid Assessment identified a number of activities and interventions to promote the investment in additional infrastructure investment. These are set out in Table 8-1.

However, and as described previously, meaningful levels of investment will only come forward when the fundamental challenges holding back the development of the gas-to-power sector have been resolved. Where there is a fundamental 'blocker' preventing investment, this has been identified in the table. Once the fundamental "blockers" have been resolved there may be opportunity for Power Africa intervention/transaction as indicated in Table 8-1.

8.1 GAS SUPPLY

The development of new gas supplies is a long lead time activity and there are indications that some **LOCs may require both technical assistance and transaction advice for such new projects.** Some LOCs own upstream gas acreage but may not have the expertise to develop their assets. See comment below on bankable projects for intervention possibilities.

In light of the sabotage and vandalism problems constraining gas supply, a number of alternative approaches have been brought forward to deliver gas into the extreme West of the gas network where there is greatest gas demand, e.g. Lagos.

There are no gas production facilities in the West of the country so any deliveries on a large scale, except by pipeline, would have to be achieved by bringing in LNG. Whilst technically this may be possible, the challenge would be the economics. It is likely that the gas price required to attract investment in the LNG regasification infrastructure and LNG supply would need to be higher than for indigenous pipeline gas. If the regasified LNG were to be used in the power sector the power tariff would have to increase to accommodate the higher price fuel supply and secondly the same payment risk would exist for LNG as it does for pipeline gas. **Interventions to encourage the delivery of LNG as a work-around to the sabotage issue are not recommended; addressing the sabotage should be the priority approach.**

One of the cornerstones to the Gas Master Plan was centrally located gas processing facilities. Since its inception there has been very little progress on implementing the GMP and it is unclear in which direction the gas sector is currently evolving. **There is a requirement to develop a new GMP or wider energy policy, and this represents an opportunity for an intervention.** It is likely that any new plan or policy would determine the development of new gas infrastructure to support the development of the

industry, and this may represent opportunities for private investors and the opportunity for facilitation of transactions by Power Africa.

8.2 GAS TRANSMISSION

To increase gas-fired generation in Nigeria and where there is no gas pipeline infrastructure, an option is to use small-scale LNG delivered by road or rail tanker, for off-grid generation. This option would be more expensive than grid power from pipeline gas, but less than the cost of diesel and more environmentally acceptable than burning diesel. This option is more suited to "pipeline remote" locations where there is a reasonable level of industrial demand. e.g. Kano and Kaduna, justifying a larger power station and to support the economics of developing a gas supply chain. **The opportunity in this area could be to undertake an intervention to identify and develop proposals for a small-scale LNG-to-power business that the private sector could take forward – either once the business plan has been developed or once the business is established and operating.**

Similar to the small-scale LNG opportunity CNG could be transported via truck or rail. It would be impractical to use CNG for larger scale generation projects but could be used for smaller off-grid and embedded projects. There are already examples of embedded projects, e.g. Island IPP in Lagos**. As with LNG the opportunity here is to identify and deploy development capital to establish viable projects for the private sector.**

Intrinsically linked to the economic and GDP growth in Nigeria is the availability of energy, both gas and power. If there is to be greater development in Northern Nigeria, the reliability of power delivery and the availability of a gas supply for industry has to be realized. **A first step would be to extend the gas network to Abuja and then, in time, continue to Kaduna and Kano. This will require a major investment and potentially the involvement of private investment. Early development work is required to assess the gas demand requirements and project planning.**

8.3 BANKABLE PROJECT

During the Rapid Assessment the complexity of navigating through Government, i.e. the interface between stakeholders and obtaining necessary permits and approvals for projects, was raised by a number of project developers and potential investors as a challenge (almost barrier to entry). This observation is also borne out by the publication produced by the Azura IPP project entitled "HIGH VOLTAGE A Development Guide to the 459 MW Azura-Edo IPP" which sets out some of the challenges and frustrations experienced in bring the project to a financial close.

It was also stated during the Rapid Assessment that there is a lack of early development capital in the sector. Feedback was that a number of gas-to-power project developers with projects that, at a high-level at least, appear to be financially and technically viable, have exhausted the early development capital available to them before progressing the projects to the level of maturity required before later-stage (and therefore more risk adverse) development capital investors would invest. This has led to frustration on the part of both the project developer at having to abandon a potentially viable project, and on the part of potential investors not being able to progress potentially viable projects because they are too immature.

Provision of early development capital would enable projects to achieve a greater level of maturity, reduce risk and increase attractiveness to project financiers. If this was coupled with the provision of

capable and internationally recognized transaction advisory support this would bring credibility to the financing process. This is an area where an intervention could facilitate positive results in establishing new power generation capacity.

8.4 POWER GENERATION

There is a growing interest in off-grid power generation in Nigeria. Whilst this is not the solution for large scale generation and transmission of power it may have some appropriate applications.

However, caution is required because if off-grid were to be significantly developed in urban locations this would be to the detriment of the remaining grid connected customers. Typically, off-grid electricity is more expensive and is only affordable to the more affluent customers, and therefore only implemented in locations where the customer base that can afford the off-grid power. Hence off-grid has the effect of attracting the 'premium' customers away from the grid.

However, a positive example of an off-grid solution would be power generation from flared gas into a local community that may not otherwise have access to electricity. Such a solution may present pricing issues into a low income community however it provides a solution to the issue of flared gas. **The identification and potential development of potential flared-gas off-grid power projects is an intervention opportunity.**

There is currently not a significant pipeline of new large scale IPPs, i.e. over 500 MW. Whilst such projects will not be required for a number of years, given the opportunities to better utilize the existing generation fleet, the future development of new large scale IPPs needs to be well planned to (i) determine the optimum location of such new projects and (ii) enable the necessary gas and power transmission projects to be identified and scheduled. **Early and appropriate policy planning in development of the gas-to-power sector will greatly assist new entrants to the power market in Nigeria and ensure that the build out of future infrastructure is most effective.**

The table below is structured in line with the gas-to-power chain; starting with gas supply through to evacuation of power. On the right hand side of the table, are four columns headed A to D. These columns indicate the possible opportunities for Power Africa involvement, broken into the following categories:

A. Power Africa investment, with/without other agencies, including loan guarantees

B. Other direct Power Africa involvement/intervention e.g. expert assistance, active direct roles, workshops

C. Power Africa influence by lobbying, persuading other parties

D. None for whatever reason

Table 8-1: Opportunities and Interventions for Future Investment in Infrastructure (FII)

No	Opportunity	Fundamental Blocker	Potential Power Africa Intervention – if Fundamental Blocker Addressed	Who	Challenges / Comments	Opportunities for PA Involvement			
						A	B	C	D
FII 1 GAS SUPPLY	Assist development of new upstream gas resources – particular focus on LOC and Indigenous Companies	Lack of economically viable chain to ensure return on investment	Provide commercial and technical support to Indigenous Companies	PA LOC	Requires underlying gas-to-power commercial chain to be addressed if new gas resources are to be developed	✓	✓		
FII 2 GAS SUPPLY	Alternative gas supply source – LNG regasification into the gas grid Opportunity to supply LNG from NLNG, recognizing that current set of contracts begin to expire in 2019	Lack of economically viable chain to ensure return on investment	Commercial and technical assessment of viability of opportunity	PA NLNG	LNG will be higher priced than upstream indigenous gas. LNG will be competing with international prices (albeit international spot prices currently low) LNG supply from NLNG is a possibility, however not immune to sabotage of upstream pipelines supplying NLNG		✓	✓	
FII 3 GAS SUPPLY	Central Processing Facility (development of strategic plan to maximize availability of processed gas)	Lack of economically viable chain to ensure return on investment	Provide technical support to development of Gas Master Plan (GMP)	PA NNPC	Private interest / investment may be limited unless underlying power commercial chain is addressed		✓	✓	
FII 4 GAS TRANSMISSION	Alternative gas supply source – small scale LNG imports for off-grid power generation		Support development of opportunities and provide development capital	PA InIn	Off-grid power may not be considered as a long-term meaningful solution. It will not address the aspiration of significant power generation in Nigeria See 'off-grid' below	✓	✓		

No	Opportunity	Fundamental Blocker	Potential Power Africa Intervention – if Fundamental Blocker Addressed	Who	Challenges / Comments	Opportunities for PA Involvement			
						A	B	C	D
FII 5 GAS TRANSMISSION	Alternative gas supply and distribution – Small scale CNG for off-grid power generation		Support development of opportunities and provide development capital	PA InIn	Off-grid power may not be considered as a long-term meaningful solution. It will not address the aspiration of significant power generation in Nigeria See 'off-grid' below	✓	✓	✓	

No	Opportunity	Fundamental Blocker	Potential Power Africa Intervention – if Fundamental Blocker Addressed	Who	Challenges / Comments	Opportunities for PA Involvement			
						A	B	C	D
FII 6 GAS TRANSMISSION	New gas pipeline infrastructure – particularly extension of gas pipeline north to Abuja	Lack of economically viable chain to ensure return on investment Lack of effective Gas Master Plan; replace with Energy Policy	Provide technical support to development of GMP	PA NNPC	Unless Government funded private investment is likely to be limited unless underlying power commercial chain is addressed		✓	✓	

No	Opportunity	Fundamental Blocker	Potential Power Africa Intervention – if Fundamental Blocker Addressed	Who	Challenges / Comments	Opportunities for PA Involvement			
						A	B	C	D
FII 7 BANKABLE PROJECT	Reduce the complexity of navigating through Government, the interface between stakeholders and obtaining necessary permits and approvals		Assisting the navigation through development of a 'multi-Ministry transaction roadmap' and provision of transaction advisory support	PA	Requires proactive engagement of various Ministries and willingness to potentially change existing practices		✓	✓	
FII 8 BANKABLE PROJECT	Enhance the ability of potential projects to reach financial close - Development Capital	Lack of economically viable chain to ensure return on investment	Provision of early development capital to enable projects to achieve a greater level of maturity, reduce risk and increase attractiveness to project financiers	PA InIn	Strict management and governance required Risk capital only released in phases and once clear milestones have been reached	✓	✓	✓	

No	Opportunity	Fundamental Blocker	Potential Power Africa Intervention – if Fundamental Blocker Addressed	Who	Challenges / Comments	Opportunities for PA Involvement			
						A	B	C	D
FII 9 BANKABLE PROJECT	Enhance the ability of potential projects to reach financial close – Development Capability	Lack of economically viable chain to ensure return on investment	Provision of capable and internationally recognized transaction advisory support which brings credibility to financing process	PA InIn		✓	✓	✓	
FII 10 POWER GEN	Off-grid power generation	Doesn't address the fundamental issue of the requirement for significant increase in power generation	Technical report on pros vis cons of off-grid power	PA MoP	Removes existing 'premium' customers (C&D) from the transmission grid. Also denies DISCO new 'premium' customers. Potentially leaves the 'on-grid' customer base with a higher cost base In general, off-grid solutions are detrimental to the remaining commercial chain. However, in some situations there could be good reason for an off-grid solution. Concentrate on achieving sustainable operation, improvement and growth of large-scale/national level infrastructure		✓	✓	

No	Opportunity	Fundamental Blocker	Potential Power Africa Intervention – if Fundamental Blocker Addressed	Who	Challenges / Comments	Opportunities for PA Involvement			
						A	B	C	D
FII 11 POWER GEN	Off-grid power generation e.g. from flared gas		Support technical appraisal of opportunities	PA	Could provide micro-power to communities that may not otherwise receive power, and as part of a community solution re sabotage Particularly relevant in the Delta region	✓	✓	✓	
FII 12 POWER GEN	Development of new large scale IPPs	Lack of economically viable chain to ensure return on investment	Technical report on pros vis cons of new large scale IPPs against embedded / off-grid generation	PA	Very unlikely that a new IPP could take FID with the current gas supply challenges Large scale power generation (including IPPs) not required for a number of years Additional large scale IPPs will amplify current issues on gas and power networks		✓	✓	

9. KEY FINDINGS AND CONCLUSIONS

The findings of the Rapid Assessment are there are interventions that can be made to achieve additional gas-fired power generation at least as high as ~5 GW in a 12-month timeframe; however, to have reliable and continual power generation in the medium to longer-term fundamental challenges that are currently constraining the gas-to-power sector need to be addressed. If these fundamental challenges remain unattended to, generation will reduce and new investment in the sector will not be forthcoming.

These fundamental challenges include:

- Legacy debts along the gas-to-power chain, including to upstream JVs, gas suppliers, power generators and DISCOs
- Upstream gas supply constrained by sabotage
- Historic under-investment and under-maintenance in infrastructure in the chain
- Lack of effective policy and regulation
- Power tariff that is not cost reflective
- Revenue collection in the DISCOs

From the many opportunities for potential Power Africa activities and interventions, Gas Strategies has identified what it considers to be the most appropriate areas of focus – based upon a combination of the level of impact an intervention will have on the sustainable development of the gas-to-power chain and the timescale for implementation.

These recommendations combine both the input received during the program of engagement with stakeholders as well as drawing upon the Gas Strategies team's existing knowledge and understanding of the Nigerian gas sector. Gas Strategies has particularly drawn upon its existing experience in the gas elements of the supply chain. An observation from the feedback provided by stakeholders is that aside from the gas supply sabotage and lack of payments by the gas upstream sector (either by revenue not being received for gas sales, or the lack of NNPC JV funding) the gas elements of the gas-to-power chain are more commercially and technically robust than the mid and downstream ends of the power chain. Therefore, when discussing potential solutions to the issues in the gas-to-power chain, stakeholders focused more on the power transmission and distribution end of the power chain, than on the gas supply chain.

The summary recommendations for potential Power Africa interventions are as follows:

- Existing Infrastructure
    - Gas supply – Interventions to reduce the frustrations of the perpetrators of deliberate sabotage in the Niger Delta, including the provision of skills training to improve the capability and capacity of the local population; investing in the development of infrastructure, such as, off-grid generation to utilize flared gas, schooling, and hospital services

- Gas supply – Interventions to restore gas supplies cut off because of non-payment of invoices. For example both the Rivers IPP and Gbarain NIPP have had gas supplies suspended for non-payment. If this matter were settled and a sustainable solution established it is understood that both these power stations would be able to evacuate power if the gas supply were restored

- Gas supply – An intervention to reactivate the CBN loan facility, established in 2014, to settle all outstanding debts from the power sector owed to gas suppliers

- Gas Transmission – Interventions to allocate gas to power stations based on the most effective and efficient use of gas into the power sector. The result being more MWh of generation for the same level of MMBtus of gas

- Power Transmission – Interventions to assist in the delivery of the 22 critical projects identified by TCN to improve the overall power evacuation capability in the system. It is understood that Power Africa is already focused on providing support to TCN

- Fundamental Challenges

  - Interventions primarily aimed at establishing a sustainable economic value chain through increasing the generation and appropriate distribution of revenue, implementing effective regulation, development of appropriate policy for the complete gas-to-power chain and planning the development of future infrastructure development

- Future Infrastructure Investment

  - Early-stage project development – provision of early development capital to enable projects to achieve a greater level of maturity, reduce risk and increase attractiveness to project financiers

  - Developing a bankable project – provision of capable and internationally recognized transaction advisory support to bring credibility to the financing process.

  - Power Generation – Interventions to implement off-grid power generation from flared gas into local communities that may not otherwise have access to electricity.

The table below consolidates the recommended priority interventions for future implementation by Power Africa, the result of which will have a meaningful and sustainable positive impact on the volume of gas-fired power generation in Nigeria over the next 12 months and beyond.

It should be noted that Gas Strategies' investigations covered the whole value chain from gas supply through to the DISCOs and electricity tariffs. Gas Strategies understands that Power Africa is already undertaking a series of interventions regarding power transmission and DISCOs, and therefore Gas Strategies was advised to focus this report more on gas supply through to power generation. This report therefore does that and reports on transmission and DISCOs only in short form. In Gas Strategies' opinion, fundamental reform of the DISCOs is a key part of the solution to an improved gas-to-power value chain. The reforms Gas Strategies suggests would involve FGN and its agencies as well as the DISCOs themselves and without which the revenues than underpin the whole gas-to-power chain will not be sufficiently achieved. Gas Strategies' full commentary on this part of the value chain can be made available if required.

A key point emphasized by the stakeholders was that they would like feedback on the findings of this process in reciprocity of having given their time and knowledge for interviews, and more importantly because they are part of the solutions going forward for Power Africa.

Table 9-1: Recommendations for Power Africa Priority Interventions

No	Opportunity / Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
EI 1 - GAS SUPPLY	Reduce / resolve sabotage of oil and gas facilities and pipelines	Assist Government in resolution of Niger Delta community issues	Investment in Niger Delta and local communities e.g. procurement of services, provision of training programs, investment in infrastructure	FGN STA PA	Uncertain, however would expect some progress in less in 12 months	This is primarily a Government / political issue		✓	✓	
EI 2 - GAS SUPPLY	Reinstate gas supplies cut off to GENCOs through lack of payment to gas suppliers – e.g. Rivers IPP (Independent Power Producer) and Gbarain	Pay existing debts to gas suppliers and agree process for future gas supply / payment	Facilitate debt plan and future payment solution e.g. loan facility to the GENCOs (Power Generation Company). This intervention has the opportunity of bringing immediate results, however needs to be sustainable	PA CBN	Less than 12 months	Requires the underlying gas-to-power commercial chain to be addressed for the intervention to be viable and sustainable		✓	✓	
EI 5 - GAS SUPPLY	Conclusion of CBN loan facility (the loan facility was originally established to settle outstanding debts owed to gas suppliers, but was suspended when IOCs failed to meet CPs related to the facility)	IOCs need to meet their CP commitments for release of funds, e.g. supply of DSO gas	Facilitation of monitoring of IOCs and assistance in funds disbursement	CBN PA DPR	12 – 18 months	IOCs have not shown willingness to progress upstream projects as originally agreed			✓	

No	Opportunity / Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
EI 7 - GAS TRANSMISSION	Optimization of available daily gas supply to the most efficient power generators	NGPTC to schedule gas to the most efficient GENCOs to maximize MWh from available MMBtus	Technical assistance to NGPTC to implement	NGPTC PA GENCOs	Less than 12 months	Requires co-operation of less efficient power plants to not take gas and not dispatch. Government owned NIPPs are in many cases the most efficient, resulting in private sector plants not running (although still receive capacity payments)		✓	✓	
EI 11 -POWER Tx	Address power transmission evacuation constraints (particularly in SE Nigeria)	Complete TCN 22 priority projects (out of a potential 150 projects). WB / AfDB funded – CPs outstanding	Technical / project management assistance to TCN to implement priority projects	PA TCN	Within 12 months, some by year end	Long history of poor management of projects Compounded by conclusion of MHI contract	✓	✓	✓	
FC 1 **Com**	Commercial Value Chain broken/defunct	Improve revenue collection; better financial rigor through chain	Many interventions required – see those issues marked ‘’	_____	From 6 months onwards		—	—	—	—

No	Opportunity / Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 5 **Reg**	Failure to implement DSO and gas flaring penalties	Inadequate regulatory powers or use of powers. Excuses for non-compliance are not allowable but reasons (e.g. sabotage) are Strong argument for a single regulator overseeing from gas supply to electricity consumer	Promote establishment of gas regulator with appropriate powers	NERC MoPR (PA)	From 6-9 months onwards	When is a reason an excuse? Sabotage; commercial outlet for gas Penalties cannot exist in isolation from a supply chain that works technically and commercially		✓	✓	
FC 12 **Reg**	Regulation – NERC = weak	NERC needs powers and needs to use them; use powers of audit of DISCOs; legislation upgrade?	Examine NERC legislation and undertake International peer review; stakeholder engagement Recommend legislation changes if required to give NERC appropriate powers	NERC PA	From 9-12 months	Without confidence of future stability and authority there will be little future investment Appointment of new Commissioners not yet concluded		✓		

No	Opportunity / Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FC 13 **Reg**	Regulation – Gas = none	Establish gas regulator; general provisions; enforcement of DSO and non-flaring; subsume items of use (if any) from GACN	Provide international examples to work up basis for regulator; stakeholder engagement NB: in many countries a gas regulator can exist independently of an electricity regulator. This works well when gas can be fungibly absorbed within a gas grid. This is not the case in Nigeria	NERC* PA	From 9-12 months	Resistance to alter status quo *NERC, if it is to be gas regulator as well. Otherwise separate agency. Good argument for a single gas-to-power chain regulator as there is such inter-dependence between gas supply and electricity in Nigeria. Start point is actual gas supply (including flaring). Facilities would still remain part of DPR responsibility		✓		
FC 14 **Pol**	Gas Master Plan out of date	Energy policy rather than a new GMP – i.e. embraces power too. [can be segmented to gas/power only for short/medium term]	Catalyze within MoPR and MoPWH – need for joint approach; engage stakeholders	MoPR MoPWH (PA)	3-12 months onwards	Many stakeholders NB: Discourage embedded solutions and 'work arounds' e.g. LNG		✓	✓	
FC 15 **Com**	Contracts e.g. GSAA & PPA understood to have issues	Review contracts in chain; make recommendations where they are not fit for purpose and an impediment for now and for future (in a potentially non-GACN world)	Undertake review; requires engagement with stakeholders to assess issues	PA	3-6 months	Change is difficult for some		✓		

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							A	B	C	D
FC 28 **Pol**	Little understanding of where demand is or will be – will assist in particular power transmission planning	Undertake a national demand study	Commission / assisting with funding of demand study	MoPWH PA	9-12 months			✓		
FII 8 BANKABLE PROJECT	Enhance the ability of potential projects to reach financial close - Development Capital	Lack of economically viable chain to ensure return on investment	Provision of early development capital to enable projects to achieve a greater level of maturity, reduce risk and increase attractiveness to project financiers	PA InIn	Strict management and governance required Risk capital only released in phases and once clear milestones have been reached	✓	✓	✓		
FII 9 BANKABLE PROJECT	Enhance the ability of potential projects to reach financial close – Development Capability	Lack of economically viable chain to ensure return on investment	Provision of capable and internationally recognized transaction advisory support which brings credibility to financing process	PA InIn		✓	✓	✓		

No	Opportunity / Issue	Potential Activity / Solution	Potential Power Africa Intervention	Who	Timescale	Challenges/ Comments	Opportunities for PA Involvement			
							A	B	C	D
FII 11 POWER GEN	Off-grid power generation e.g. from flared gas		Support technical appraisal of opportunities	PA	Could provide micro-power to communities that may not otherwise receive power, and as part of a community solution re sabotage Particularly relevant in the Delta region	✓	✓	✓		