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# *Nigeria's Refining Revolution*



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## ***Content***

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Refining in Nigeria ***3***

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Taking the Leap ***6***

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Event Triggers for the  
Transformation ***10***

---

Considerations for Setup:  
The Investor's Guide ***12***

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## Foreword

Over the last four decades, Nigeria has consistently struggled to keep its refineries functioning optimally. Despite having a nameplate refining capacity that exceeds demand, Nigeria ranks as the 3rd highest importer of petroleum products in Africa, importing over 80% of products consumed. In spite of the setbacks, the inherent opportunity for Nigeria's erstwhile dormant refining sector holds bright prospects for the future and a recognition of key drivers will accelerate the imminent refining revolution.

This paper provides a studious analysis of the current state of the refining sector and the refining revolution we predict will take place over the next 3-5 years. It draws attention to the existing gaps in the supply of refined petroleum products in Nigeria and the West African region and it highlights the sizeable potential for domestic refining of petroleum products.

Importantly, it identifies key drivers that will spur the growth of the refining sector in Nigeria.

Lastly, this paper highlights refining asset economics and structural commercial considerations for investors and identifies the modular refinery, an off-the-shelf solution, as the cost effective supply option for investors especially when diesel is the lightest yield.

The world is expected to continue to run primarily on fossil fuels to supply its energy in the near to medium term. This continuous dependence should see countries such as Nigeria focusing on adding value to its natural resources. With oil prices expected to remain relatively low in the medium to long term, the focus on refining should become imperative. This also creates a new opportunity to transform the fundamentals of the downstream sector and shifting from a "net imports" to "net exports" structure is becoming more imminent.

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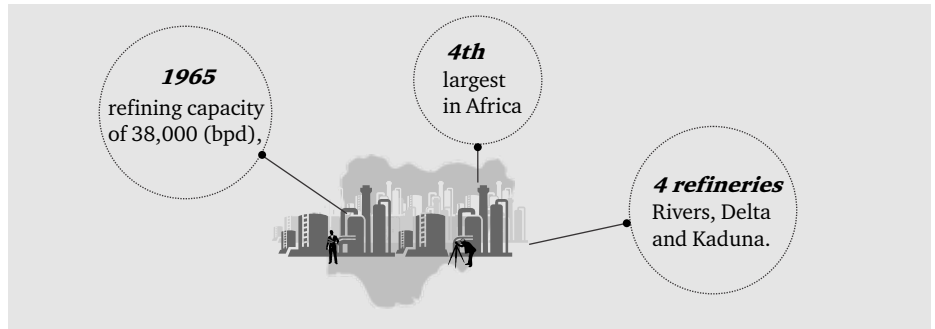
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# Refining in Nigeria

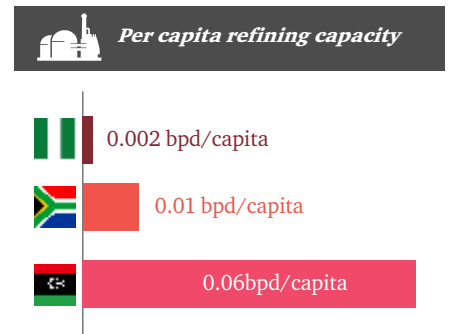
Refining in Nigeria began a decade after oil was discovered in the oil-rich Niger Delta region in the 1950s. Initially starting out in 1965 with a refining capacity of 38,000 barrels per day (bpd), Nigeria's refining capacity has grown over the years and is considered the 4th largest in Africa. The nameplate capacity of 445,000 bpd is housed by 4 refineries strategically located in various states around the country: Rivers, Delta and Kaduna. Despite having a nameplate capacity that should meet domestic demand, Nigeria still imports over 80% of refined products to meet its current needs. Unlike the production of crude, the production of refined products has been suboptimal and Nigeria has consistently struggled to keep its refineries functioning optimally. The outlook for refining has been tainted with uncertainty due to the adverse effects of subsidies, poor maintenance, general operational failure and



inconsistent supply of feedstock. As a case in point, Nigeria's per capita refining capacity is 0.002 bpd/capita, low even by Africa standards. Libya by comparison is 0.06 bpd/capita, and South Africa 0.01 bpd/capita.

However, recent events such as advancement of the Nigerian National Petroleum Policy and the sustained depression in crude oil prices are ushering in fresh waves of optimism for the sector and we predict a paradigm shift from a “net imports” to “net exports” structure. This shift will see

Nigeria become a net exporter of refined products and the refining hub of West Africa by the start of the next decade.



## The Refining Opportunity

Nigeria is the second largest producer of oil in Africa, producing over 1.5 million bpd (as at January 2017). With proven crude oil reserve estimates of about 37 billion barrels as at 2015, Nigeria boasts of about 29% of the continent's crude reserves (2nd in Africa).

Nigeria is also one of the largest consumers of refined products in Africa (5th as at 2014, behind Egypt, South Africa, Algeria and Morocco) and accounts for over 7% of Africa's refined

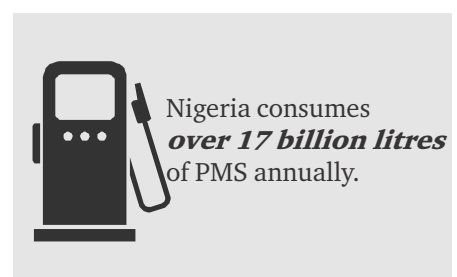
products consumption. In 2015, the refined products consumption was estimated to be about 24 billion litres and products consumed include: Premium Motor Spirit (PMS), Automotive Gas Oil (AGO), Dual Purpose Kerosene (DPK) and Aviation Turbine Kerosene (ATK). To the detriment of national earnings, these products are majorly imported from United States, North Western Europe and other sources.

Imports currently account for over 80% of Nigeria's refined product supply, creating a huge potential for local refining. The West African market also holds significant potential as refineries such as SIR (Ivory Coast), SOGARA (Gabon) and SAR (Senegal) cannot meet current demand for refined products in the region, estimated at 39 billion litres. There is an opportunity for potential uptake by neighboring countries if the market has Nigeria's refined products readily available.

## Product Analysis

Premium Motor Spirit (PMS): Nigeria consumes over 17 billion litres of PMS annually. Transportation and power are the major drivers of demand for PMS in the country. Imports currently account for over 90% of PMS supplied in the country and this is likely to continue in the future.

Imported PMS is primarily sourced from North Western Europe and United States. West Africa consumes over 22 billion litres of PMS annually. Imports currently account for over 90% of PMS supplied to the region.



## Automotive Gas Oil (AGO):

 "over 3 billion litres of AGO annually."

Nigeria consumes over 3 billion litres of AGO annually. The erratic state of the country's power sector has been the major driver of AGO demand. The power sector is currently plagued by a plethora of challenges, increasing the demand for self-generation options such as AGO-powered generators. Imports currently account for

about 60% of AGO supplied in the country.

West Africa consumes about 11 billion litres of AGO annually. Imports currently account for over 70% of AGO supplied to the region.

## Aviation Fuel:

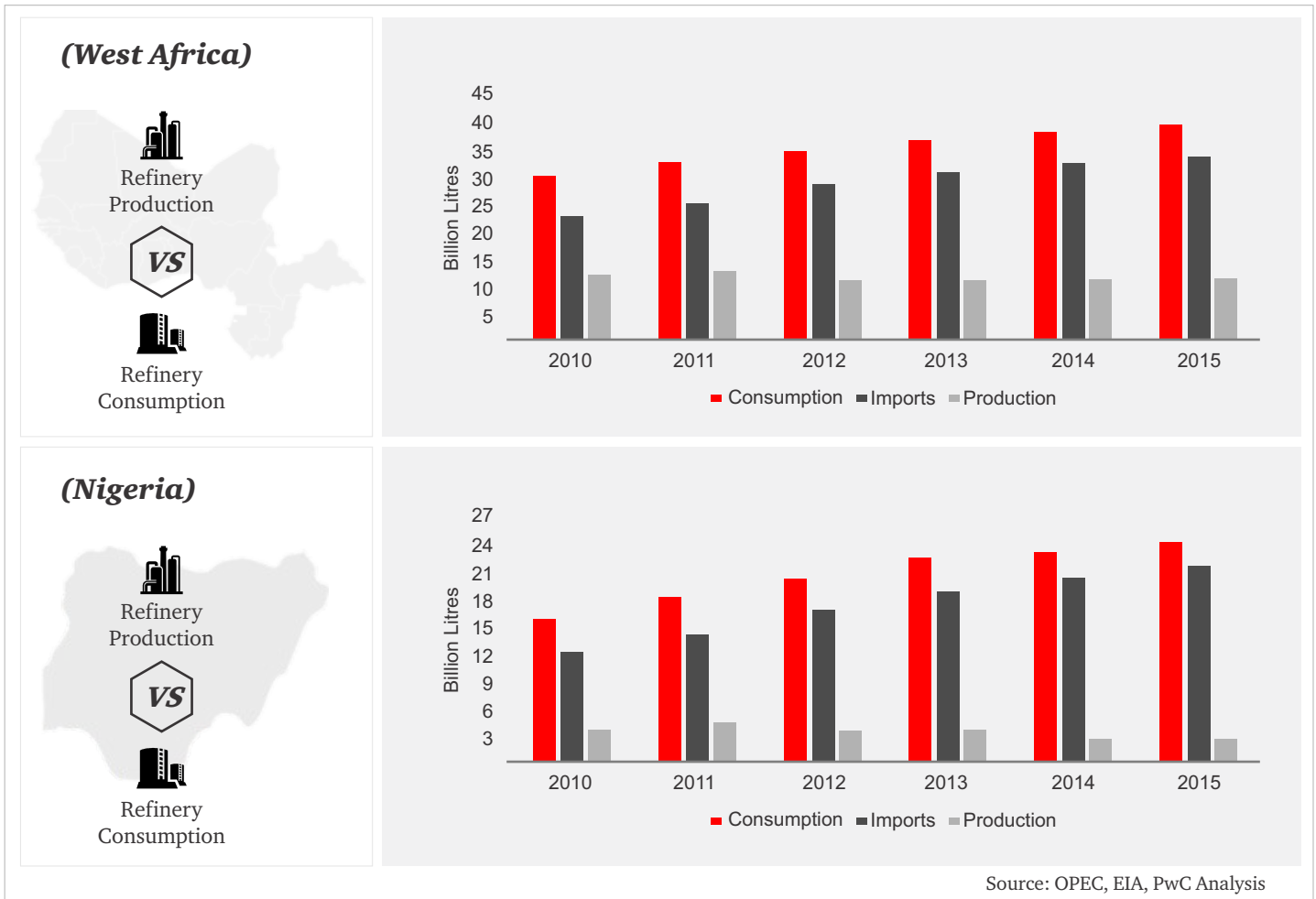
 "over 400 million litres of aviation fuel annually."

Nigeria consumes over 400 million litres of aviation fuel annually, most of which is primarily sourced from the United States. In 2014, Nigeria was the 2nd largest importer of US aviation fuel in the world. Imports account for 100% of the aviation fuel supplied in Nigeria due to the inability of existing refineries to produce the fuel. There is a current deficiency in supply which is likely to continue in the short to medium term

and this is primarily due to the shortage of foreign exchange and less to do with availability of the product.

West Africa consumes over 1 billion litres of Aviation fuel annually with imports currently accounting for over 80% of Aviation fuel supplied to the region. SIR (Ivory Coast) is responsible for a significant portion of locally refined Aviation fuel within the region.

**Figure 1: Product analysis (West Africa/Nigeria)**



With oil prices expected to remain low in the medium to long term, the focus on ramping up domestic refining capacity should become imperative. Lower oil prices would mean cheaper crude feedstock and higher refining margins for refiners. Separately, following the combination of rising shale production in the US, continued oversupply in the

export market and weak demand, the market for Nigerian crude is tainted with uncertainty. A shift from crude production to crude value realisation will see Nigeria becoming a net exporter of refined products by start of the next decade.

# Taking the Leap



“The combined capacity of the 25 candidate refineries stands at approximately **1.6 million bpd.**”

Nigeria's refining sector is currently not operating at full potential and laudable attempts are being made by the current administration to drive private investment. These include plans to upgrade existing refineries and the issuance of 25 refining licenses (conventional and modular) to indigenous companies. These initiatives, if executed rigorously, will drive growth and reforms within the sector in the medium to long term.

The combined capacity of the 25 candidate refineries stands at approximately 1.6 million bpd. Three (3) of the licensed companies are billed to construct conventional stick-build plants with capacity estimated at over 850,000 bpd, while 22 licenses are to construct modular units estimated at about 700,000 bpd in combined capacity.



“The 650,000 bpd Dangote refinery, a crucial development within the sector, is expected to come **onstream by 2019.**”

## Scenarios and Our Projections

We have run our thesis, (Nigeria will become a net exporter of refined products by start of the next decade) through a number of scenarios which depict possible outcomes in the refining sector up until 2030. The scenarios are based on some forward assumptions about refining in Nigeria and the West Africa region. Our outlook illustrates the potential of the sector with focus on the volumes that modular refineries can contribute to bridging the supply gap in the country and regionally. These are presented in three different scenarios.

In our scenarios, key assumptions are made across refinery setups: modular and conventional. Modular refineries are assumed to be set up close to crude sources either within existing refineries or on onshore marginal fields. They are also assumed to be set up close to consumption clusters thereby making them better positioned for domestic supply. On the other hand, conventional refineries are assumed to be set up to source for crude internationally and to supply both international and domestic markets.

The 650,000 bpd Dangote refinery, a crucial development within the sector, is expected to come onstream by 2019. At optimal utilisation, the refinery is capable of meeting the country's demand, however a major headwind to achieving a fully optimised run, is availability of crude feedstock. At full capacity, the refinery will require about 19 (1 million barrel) cargoes of crude monthly, approximately half of Algeria's (third largest producer in Africa) production. For the initial years of operation, this may be a significant challenge. Therefore, the current supply gap within the country and region creates an opportunity not just for conventional refineries such as the Dangote refinery but also for modular refineries which will be set up primarily to meet domestic demand. This provides the “bottom-up” supply into the fuels value chain. Another critical assumption is that the modular refineries yield will be limited to fuel oils and diesel as the lightest hydrocarbon produced.

## Scenario 1- Downside

“By 2026, Nigeria's exports to the region **exceed 130,000 bpd** (approximately 21 million litres daily)”

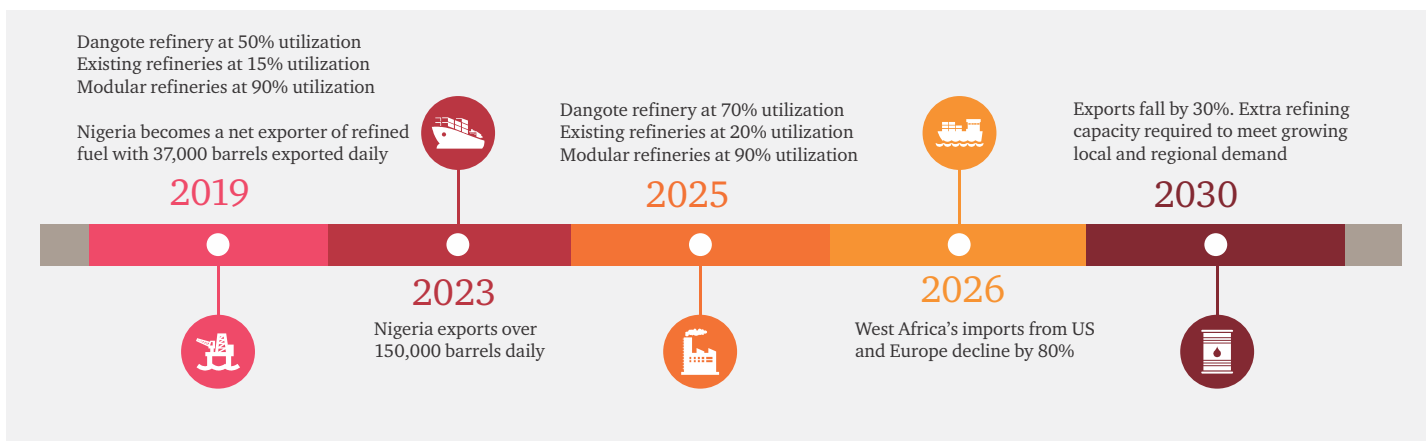
**Our Assumptions:** Dangote refinery (650,000 bpd) opens its gates mid-2019, operating at 50% utilisation, existing refineries (445,000 bpd) are operating at 15% utilization and modular refineries (combined capacity of 100,000 bpd) also come onstream early 2019, operating at 90% utilization. These ramp up to 70%, 20% and 90% respectively by 2030.

**Net effect:** By 2019, Nigeria becomes Africa's 3rd largest refiner of petroleum products and a net exporter of refined petroleum products. Its exports are estimated to exceed 37,000 bpd

(approximately 6 million litres daily). The modular refineries bridge a supply gap of 53,000 bpd (approximately 8.5 million litres daily) in Nigeria.

Nigeria becomes West Africa's refining hub by 2019, supplying the region with at least 37,000 bpd (approximately 6 million litres daily). By 2026, Nigeria's exports to the region exceed 130,000 bpd (approximately 21 million litres daily), reducing the region's imports from US and Europe by approximately 80%.

Figure 2: Scenario 1



## Scenario 2- Base case

“The modular refineries bridge a supply gap of **30,000 bpd (approximately 5 million litres daily)** in Nigeria.”

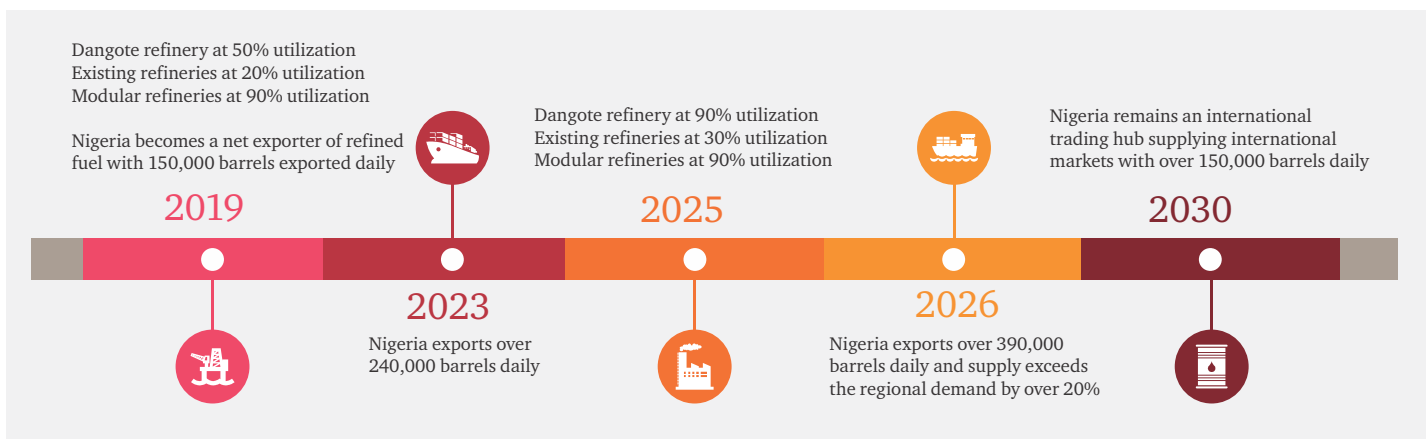
**Our Assumptions:** Dangote refinery (650,000 bpd) opens its gates mid-2019, operating at 50% utilisation, existing refineries (445,000 bpd) are operating at 20% utilization and modular refineries (combined capacity of 200,000 bpd) also come onstream early 2019, operating at 90% utilization. These ramp up to 90%, 30% and 90% respectively by 2030.

**Net effect:** With production figures exceeding 590,000 bpd (approximately 94 million litres daily), Nigeria becomes the

largest producer of refined products by 2019. Its exports are estimated to exceed 150,000 bpd (approximately 24 million litres daily) by 2019. The modular refineries bridge a supply gap of 30,000 bpd (approximately 5 million litres daily) in Nigeria.

By 2023, West Africa becomes self-sufficient with over 70,000 bpd (approximately 11 million litres daily) being traded to other regions.

Figure 3: Scenario 2





## Scenario 3- Upside

exports exceed  
**300,000 bpd**  
**(approximately**  
**48 million litres**  
**daily)** by 2019.

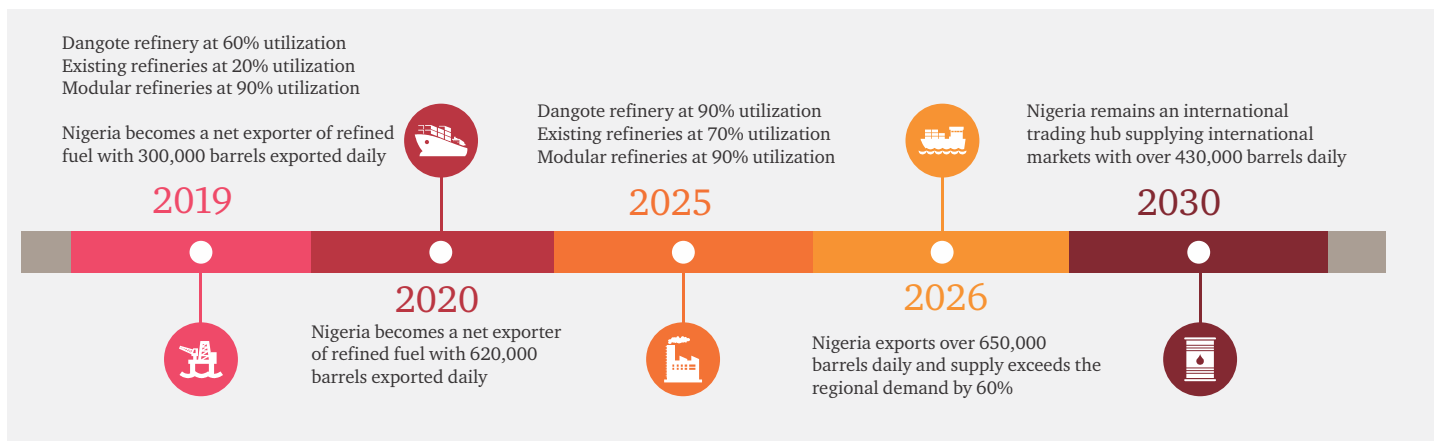
**Our Assumptions:** Dangote refinery (650,000 bpd) opens its gates mid-2019, operating at 60% utilization, existing refineries (445,000 bpd) are operating at 20% utilization and modular refineries (combined capacity of 300,000 bpd) also come onstream early 2019, operating at 90% utilization. These ramp up to 90%, 70% and 90% respectively by 2030.

**Net effect:** By the turn of the decade, Nigeria assumes the status of the largest

producer of refined petroleum products in Africa. Its exports exceed 300,000 bpd (approximately 48 million litres daily) by 2019.

In the same year (2019), West Africa becomes self-sufficient, eliminating the need to source for refined products from US and Europe. Nigeria becomes an international trading hub similar to Asia Pacific, North West Europe and US Gulf Coast (USGC).

**Figure 4:** Scenario 3



Based on the scenarios played out, the opportunity for modular refineries is quite clear even using the conservative downside scenario. For the upside scenario, the impact of the modular refineries both locally and internationally is evident.







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# Event Triggers for the Transformation

## Regulations

### Current situation

The Nigerian oil and gas industry is heavily regulated and comprises multiple regulators including the Ministry of Petroleum Resources (MPR), Nigeria National Petroleum Corporation (NNPC) and Department of Petroleum Resources (DPR). The effectiveness of these bodies in the refining sector has remained debatable. Delays in the passage of the Petroleum Industry Bill (PIB) and full deregulation of the downstream sector are major factors which have consistently dampened investor's confidence in the potential of the refining sector. According to the Nigerian Extractive Industries Transparency Initiative (NEITI), Nigeria loses an estimated \$15 billion yearly in foreign investments due to regulatory uncertainty.

### Our Assessment

Effective Regulations will be a key driver for growth within the refining sector and therefore bold & decisive

reforms are necessary. Regulations are pertinent to driving confidence within the refining sector and boosting attractiveness to potential investors. Full deregulation of the downstream sector remains the most glaring to boost the attractiveness of the sector. Removal of price caps on PMS is the key trigger.

The current institutional construct and policies need to be rationalized and reconstituted to drive efficiency of the sector. Setting up institutions that will be responsible for the co-ordination and regulation of all commercial activities relating to the downstream sector of the oil and gas industry and the regulation of transportation, transmission/distribution and marketing of downstream products will help drive efficiency and healthy competition within the sector. Policies which foster legal bunkering, access to feedstock for local refiners and export of refined products into the West African sub-region also need to be

established.

Increasing refining capacity remains crucial to the government's plans for the downstream sector. The Ministry of Petroleum Resources' 7 Big Wins framework to reform the industry is the main vehicle to transit Nigeria from being a large-scale importer of petroleum products to a net exporter of petroleum products. Focus is also on increase in value-added petrochemicals to diversify its export base and enhance import substitution. Plans within the framework include committing about USD 1.8 billion for the rehabilitation of local refineries through private sector participation and promoting the set up of modular refineries.

Prima facie, these are encouraging steps in the right direction which increase the likelihood of a revitalisation of the existing refineries as well as the enactment of reforms which will drive private investment into the oil and gas industry.

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## Security

### Current Situation

Industrial sabotage, crude oil theft, illegal refining operations, pipeline vandalism and piracy present significant challenges in the industry. These have adversely impacted onshore oil and gas production and presented challenges in delivering the same to market. Nigeria lost over NGN 50 billion to pipeline vandalism between January and April 2016. The Government and oil and gas companies have embarked on several initiatives to curb instability within the Niger Delta region, however these have not yielded the desired results. Instability in the region has repeatedly forced companies to frequently declare force majeure on oil shipments.

### Our Assessment

The major security threat in the oil & gas industry has been the disruptive activities of various militant groups. Restoring security and safety would require a multi-faceted approach involving the use of various pragmatic measures. In recent past, the government has adopted various measures to stabilise and engender peace within the Niger Delta region. These include: implementation of the amnesty program, the creation of the Ministry of Niger-Delta Affairs, and the establishment of the Niger-Delta Development Commission (NDDC). However, these institutional arrangements have not delivered effective results and therefore are being reconsidered & fine-tuned.

Institutions, and by extension programmes need to be structured to deliver specific developmental outcomes within the region. Interventions need to be sustainable and address the agitations of the South-South communities; which range from developmental neglect to environmental degradation. Intervention packages should be delivered as part of a 'social contract' with the citizens. Furthermore, these plans can be more efficient and effective if delivered as a mix of diplomacy and advanced security intelligence measures.



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## Infrastructure

### Current Situation

Damaged pipelines, shallow channels and the absence of an effective logistics backbone are major infrastructural impediments which have constrained growth within the refining sector and the broader oil and gas industry. For a sustained succession of months, damaged pipelines have impeded the supply of crude for refining operations. The rail system which will have been a viable alternative for transporting huge product volumes is suboptimal and requires deep investments to be made. Similar issues exist on the inland waterways which are too shallow to accommodate for the safe use of oil tankers to transport crude oil and refined products to the hinterlands, so investment in dredging and barges is required.

### Our Assessment

There is an urgent need for a well-planned intermodal transport system to ensure the efficient distribution of refined products. Rail and the Inland waterways are obvious, viable channels for transporting refined products across the country. These would complement the dominant road transport system and drive the efficiency and safety around transporting products.

Public-Private Partnership (PPP) is a key consideration for bridging Nigeria's infrastructure gap. However in Nigeria, despite the benefits associated with PPP, there are challenges to the use of PPP and these include: lack of contribution from the

government, concern over expropriation by future administrations and risk of continuity. However, the onus is on the government to develop a structured model to deliver such projects efficiently.

The recent announcement of the USD 2 billion Nigeria railway concession project and plans by the National Inland Waterways Agency (NIWA) to improve the waterways for crude oil and refined products transportation, and the recent bid for concession of the narrow gauge Eastern & Western railway line are steps in the right direction. These efforts are required to bridge the existing gap caused by inadequate infrastructure.

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## Feedstock Access

### Current Situation

Without a doubt one of the biggest challenges which local refineries will be faced with is guaranteed supply of feedstock. This can be attributed to several reasons already cited in this paper, namely inadequate infrastructure, insecurity, unstable production amongst others.

### Our Assessment

In Nigeria, local refineries will be required to explore varied options to ensure constant access to feedstock

required to keep refining output at optimal levels. Feedstock can be sourced from various locations, however each location will have its corresponding cost implications. Distance from source and type of feedstock are two key considerations because they impact refining economics.

Refiners would be required to look beyond heavy reliance on the government for feedstock. Leveraging strategic partnerships with upstream

oil and gas (onshore) producers and setting up close to crude sources are likely considerations to guarantee steady supply of crude. Sourcing for crude in international markets would be a likely option for conventional refineries which have sizeable crude requirements. On the other hand, modular refineries are likely to explore co-location within existing refineries and onshore marginal fields.



# Considerations for Setup: The Investor's Guide



## Refinery Options

### Modular Refineries:

These are usually available in capacities ranging from 1,000 to 30,000 barrels per day (bpd). Modular refineries provide flexibility and can be constructed in a phased manner. The relatively low capital cost and flexibility for upgrades can make it a cost effective supply option for investors, especially if diesel is planned to be the lightest yield.

### Conventional Refineries:

These are usually larger refineries with capacities higher than 100,000 bpd. Conventional refineries are not as flexible as modular refineries and they require relatively high investment in resources and specialised labour to run, maintain and upgrade.

 <b>Modular Refineries</b>	
Pros	Cons
Flexible to meet demand (easy to add modules)	Fewer configuration options (usually topping or hydro skimming plant)
Lower capital requirements/ Short payback period	Production mostly restricted to middle distillates, naphtha, and lights
Minimal space/land requirements	More staff per Effective Distillation Capacity (EDC)
Quick and easy installation	Low production capacity
Greater control over the environment and work process during construction	Lower margins on products
 <b>Conventional Refineries</b>	
Pros	Cons
Multiple configuration options (topping, coking, cracking, hydro skimming etc.)	High initial capital outlay/long payout
Fewer staff per Effective Distillation Capacity (EDC)	One location for different markets
Production of higher value products	Significant space/land requirements
High production capacity	Increased storage requirements for a broader range of product yields that need to be stored separately
Economies of scale leading to higher margins on products	Significant turnaround time for construction. Minimal control over environment during construction

Sources: Cenam Energy partners, PwC Analysis

## Refining Economics

The economic viability of a refinery is dependent on the interaction of three elements: type of crude oil used, the complexity of the refining equipment (refinery configuration) and the desired type and quality of products produced.

Different types of crude oil yield a different mix of products depending on the crude oil's natural qualities. Crude oil types are typically differentiated by their density (light/sweet and heavy). Heavy crude tends to produce a larger yield of lower-value products (fuel oils) and also requires significant investment in the refining process. On the other hand, light, sweet produces large yield of higher-value products (transportation fuels) and requires less investment in the refining process. Nigeria currently produces light, sweet

crude, meaning Nigerian refineries may be able to source and process crude at lower rates, increasing the viability of refining assets, particularly modular refineries which have lower feedstock requirements.




A key requirement for refining profitability is finding the sweet spot between cost of inputs and price of outputs in a highly volatile environment influenced by global, regional, and local supply and demand fluctuations. Refineries have minimal influence over the price of input and outputs and, therefore, must ensure operational efficiency to improve profitability and gain competitive edge. This entails reducing operating costs such as labour, maintenance, energy (electricity and natural gas) etc. to the

barest minimum. Efficiency is achieved through operational excellence, innovation, maintenance & upgrades and optimisation to produce more output from fewer inputs.

Although refineries share certain similarities, each refining asset is a unique and complex industrial facility, with some flexibility in the crude slate it can process and the mix of product yields it can refine. Factors such as refinery configuration and complexity directly impact refinery end products while location and transportation infrastructure impact energy, labour and compliance costs.

### Assumptions

- Modular refineries are co-located with existing refineries or marginal onshore fields
- Modular Refineries - Bonny light as feedstock
- Conventional refineries - Brent as feedstock
- Crude Oil price - USD 54
- Weighted Average Cost of Capital (WACC) - 17.3%
- Utilisation rate - 60%

Refinery Configuration Analysis	 Conventional	 Modular Refinery (with PMS)	 Modular Refinery (Diesel)
<b>Capacity (bpd)</b>	200,000	30,000	20,000
<b>Investment (USD)</b>	7 billion	187 million	92 million
<b>Revenue (USD)</b>	3 billion	413 million	291 million
<b>Payback (Years)</b>	18	8	2.6
<b>Margins</b>	13%	6%	12%

Sources: Cenam Energy partners, EIA, Vfuels, PwC Analysis

### Modular Refinery Analysis (Diesel)

Capacity	Cost (USD)	NPV (USD)	IRR	Payback (Years)
<b>20,000</b>	92 million	242 million	48%	2.6
<b>10,000</b>	55 million	116 million	38%	3.3
<b>7,000</b>	44 million	78 million	31%	3.9
<b>5,000</b>	38 million	52 million	22%	5.1
<b>3,000</b>	29 million	27 million	10%	7.4

### Modular Refinery Analysis (Diesel) cont'd

Capacity	PMS	Kerosene	AGO	Residual Fuel	Naptha
<b>20,000</b>	-	97,498,800	250,711,200	243,747,000	97,498,800
<b>10,000</b>	-	48,749,400	125,355,600	121,873,500	48,749,400
<b>7,000</b>	-	34,124,580	87,748,920	85,311,450	34,124,580
<b>5,000</b>	-	24,374,700	62,677,800	60,936,750	24,374,700
<b>3,000</b>	-	14,624,820	37,606,680	36,562,050	14,624,820

Capacity in bpd, Annual Product volumes in



## Deal Structure

### Structuring a modular refinery deal.

There are two major options to structuring the deal:

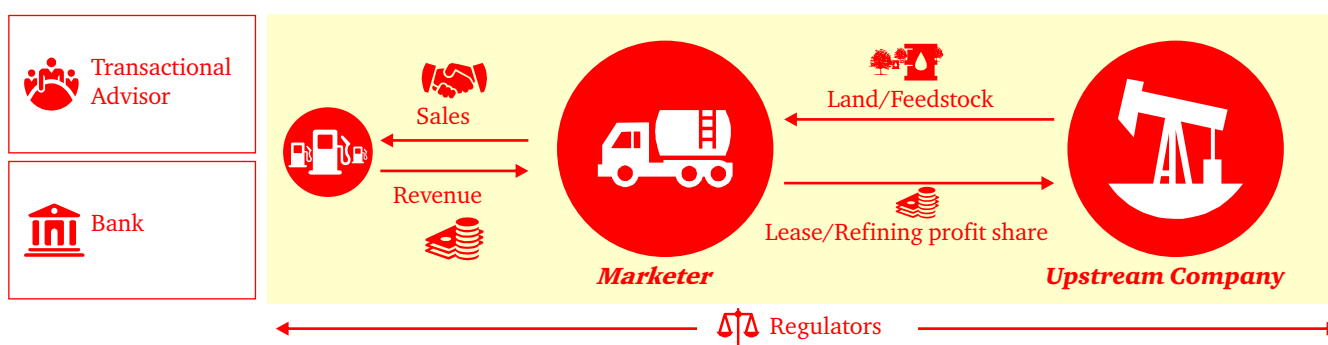
#### Traditional model:

The marketer partners with an upstream company which has an onshore marginal field. The upstream company provides land and feedstock and a sharing ratio is agreed upon on sales of refined products. Key players involved in structuring the deal include Transactional advisors, Bank(s), Regulators amongst others.

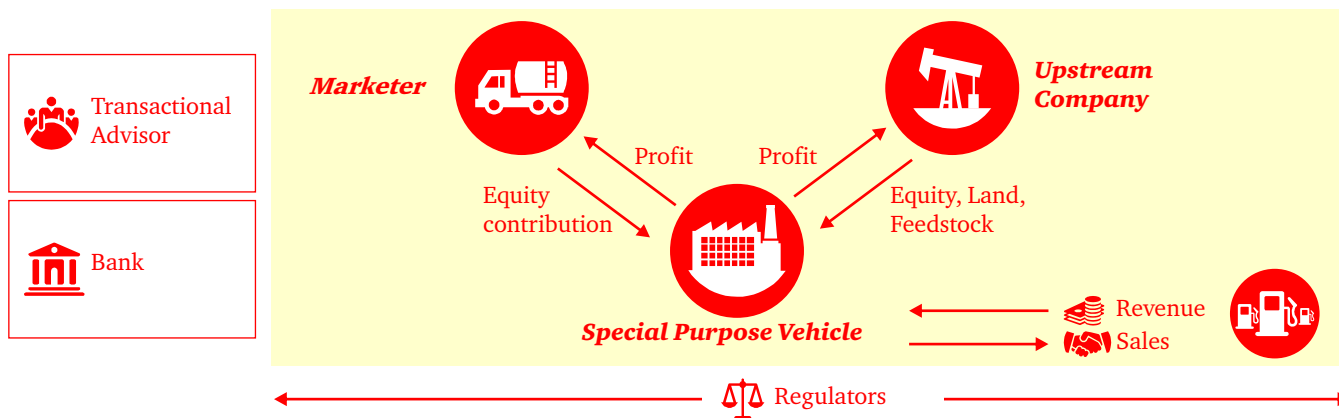
#### Special Purpose Vehicle model:

The marketer and upstream company create a refinery company and share profits based on sales made by the refining company. Key players involved in structuring the deal include Transactional advisors, Bank(s), Regulators amongst others.

#### Option 1: Traditional model



#### Option 2: Special Purpose Vehicle model



## Conclusion

Investors are constantly faced with tough decisions on refinery setup options which will yield the highest returns. Our analysis reveals that the modular refinery, an off-the-shelf solution, is a cost effective supply option for investors especially when diesel is the lightest yield. The relatively low capital cost, flexibility and short payback period make it distinctly attractive.

For the independent producer, participating in a modular refining project improves cashflow, ensures crude oil production is sufficiently optimised and delivers value beyond the traditional oil production business model. For downstream marketers seeking to hedge against foreign exchange exposure, domesticate fuel supply and build local capacity, the modular refinery is a winning strategy.

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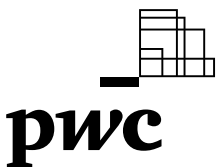


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