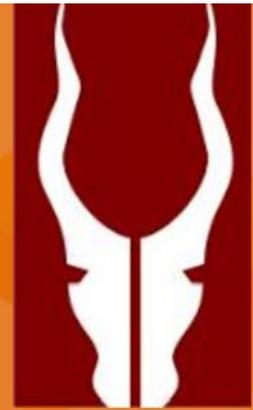


Key Development Considerations

# Modular Refinery Project Development & Financing

NIGERIA



Since the drilling of the first commercial well in Oloibiri (Bayelsa State), Nigeria has been regarded as a major producer of crude oil. With an estimated 35.3 billion barrels of hydrocarbon both onshore and offshore assets mostly domiciled in the Niger Delta basin, Nigeria is ranked Africa's largest producer of oil and the sixth largest oil producing country in the world, with a production rate of over two million {2,000,000} barrels per day.

Ironically and for decades now, Nigeria has been dependent on importation of refined petroleum products. This is arguably attributed to the inability of the crude oil refineries in Nigeria to meet the local demand for the product which currently stands at an estimated sixty million {60,000,000} litres of refined petroleum products {PMS, DPK and AGO} per day.

Taking into account Nigeria's large population and given the market potential of Nigeria, savvy investors will do well to invest in the local refining of hydrocarbon in Nigeria. While noting that investment opportunities in the Nigerian oil and gas

industry can be stratified along three categories namely the upstream, midstream and downstream, this publication focuses on investment opportunities an aspect of downstream, to wit, refining of crude oil.

It is against the foregoing background that this publication makes a case for establishing modular refineries in Nigeria and what the key development considerations should be for investors considering to invest in this aspect of the petroleum industry in Nigeria.

Our publication comes at a time when Nigeria seeks to transit from being an import dependent country into a net exporter of refined petroleum products. Should the potentials investment in modular refineries be fully explored and well harnessed, there is great confidence that huge investment opportunities in this aspect of the petroleum industry will bring about growth in the nation's GDP and increase creation of jobs.

## Table of Content

- Introduction
- The Case for Modular Refineries in Nigeria
- Modular Refinery Explained
- Demystifying Modular Refineries
- Prospects
- Challenges
- Motivation for Modular Refinery Operation
- Modular Refinery Economic Analysis
- Modular Refinery v. Conventional Refinery
- Benefits of Building Modular Refineries
- Modular Mini-Refinery Configurations
- Conclusion
- References



## The Case for Modular Refineries in Nigeria

Recent attempts made in driving the growth of refineries through private investment notwithstanding, Nigeria still has a long way to go in establishing refineries that are capable of producing at full potentials. Quite commendably, there have been some efforts in recent years to upgrade existing refineries. One commendable step taken in the right direction is the issuance of twenty-five (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. By estimation, 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.

## Modular Refinery Explained



By way of definition, a modular petroleum refinery is a process plant for refining crude oil that is engineered and constructed on largely skid-mounted structures. Each skid contains an section of the entire process plant and through interconnecting piping the component skids are linked together to form an integrated operable process plant at the site. A modular skid unit houses a process system within a frame so that the system can be transported easily. The modular process skid offers a high level of quality control, efficient use of space and pre-delivery testing to ensure ultimate functionality. Modular refineries are usually available in capacities ranging from 1,000 to 30,000 barrels per day (bpd).

Modular mini-refineries, from simple diesel production units to more sophisticated cracking refineries are increasingly becoming a flexible and cost-effective supply option for crude producers. This is particularly true where there is a need to adapt rapidly to meet local demand. Relatively low capital cost, speed and ease of construction are some of the key advantages of a modular mini-refinery.

## Demystifying Modular Refineries

Modular Refineries are ideally suited for remote locations and are viable for investments by Public-Private Partnership (PPP) as a source of rapid production of primary fuel products and raw materials for Petrochemical Downstream Industries.

Establishing a crude oil refinery requires approval from the

Department of Petroleum Resources (DPR) in Nigeria. Investors may need to apply for oil block allocation or partner with government at different level on a PPP basis to guarantee investment and feedstock for the production plant.

The conditions required to make such an investment in modular refinery workable will include: proximity and access to crude supply; location to sizable markets with logistics advantages; project finance on preferential terms from development credit agencies; and government incentives.

## Prospects

Modular refinery which is ideal for stranded production fields and remote locations could be sited in the riverine areas where accessibility to the petroleum products at present seems to be very difficult due to logistics. This will allow the dwellers in such areas to purchase the products at cheaper price than what is obtainable there at present. Modular refinery can be put together within a short time span of about 15 to 20 months for modular refinery of 20,000bpsd and can be established within a short period of time at different locations. This ultimately does away with the need for expensive transportation of crude oil through pipeline covering long distance, which more often than not, are susceptible to vandalization as has been the case in several parts of the oil producing States in Nigeria.

In addition to promoting availability of petroleum products and helping to conserve foreign exchange utilisation for the importation of petroleum products, establishment of modular refineries in Nigeria will bring about rapid production of feedstocks for downstream petrochemical plants.

## Challenges to Modular Refinery Operation in Nigeria

### 1. Regulatory Uncertainties

The Nigerian oil and gas industry is heavily regulated by multiple regulators including the Ministry of Petroleum Resources (MPR), Department of Petroleum Resources (DPR) and even the Nigeria National Petroleum Corporation (NNPC). The effectiveness of these bodies in the refining sector has remained debatable. Recent refusal of President Buhari to assent to the passage of the Petroleum Industry Governance Bill (PIGB) and full deregulation of the downstream sector are some of the factors which have dampened investor's confidence. According to the Nigerian Extractive Industries Transparency Initiative (NEITI), Nigeria loses an estimated \$15 billion yearly in foreign investments due to regulatory uncertainty. Uncertainties in regulations have discouraged various institutional and Individual investors in setting up modular refineries in Nigeria.

### 2. Security

Industrial sabotage, crude oil theft, illegal refining operations, pipeline vandalism and piracy present significant challenges in the oil and gas industry. Modular refinery investors can be swayed by the security condition of the country as investors would, more often than not, desire an environment, where their investment is not only safe but also secure. The several initiatives to curb instability within the Niger Delta Region of the Nigerian government as well as multinationals notwithstanding, security still mains a major challenge. As a matter of fact, instability in the region has compelled some companies to declare force majeure on oil shipments.

### 3. Infrastructure

Damaged pipelines, shallow channels and the absence of an effective logistics backbone are some major infrastructural impediments that have constrained growth of refineries in Nigeria. For a while now, damaged pipelines have impeded the supply of crude for refining operations. The rail system which can be a viable alternative for transporting huge product volumes, is highly capital intensive and requires huge investment.

Furthermore, the inland waterways are too shallow to accommodate safe use of oil tankers to transport crude oil and refined products to the hinterlands. This has not been quite helped with the paucity of considerable investment in dredging and barges.

### 4. Feedstock Access

One of the biggest challenges which local and new modular refineries are most likely going to be faced with is how to access feedstock supply on a regular basis. Guaranteed feedstock access has not been aided by inadequate infrastructure, insecurity and unstable production.

### 5. Sanctity of contracts

Inability to predict whether contractual terms will be honoured and not be deviated from pose a great challenge. Every investor is concerned about the performance of contracts and often wary of contractual breach. Past antecedents of the Nigerian government in its disposition in some of the joint venture contracts with some of its International Oil Companies (IOC) partners sometimes leave a lot to be desired.

While there is some motivation that the government is desirous of honouring contracts executed by its representatives, more efforts should do more to ensure that agreements entered into on its behalf are kept.

## Motivation for Modular Refinery Operation in Nigeria

### 1. Establishment of Oil and Gas Free Zone

Modular refineries proposal should go with the establishment of oil and gas free zones in all oil producing states as a means of diversifying the country's economy. Siting modular refineries in the oil and gas free zones would cut investment cost. Modular refineries should be modelled after the U.S. export-oriented refineries to produce special products such as petroleum, aviation fuel and industrial raw materials.

### 2. Incentives from Government

Availability of government incentives through a well-balanced legal and regulatory framework to promote investments and guarantee returns on investments. Also, economic incentives such as tax holiday and grants will encourage investors to come into the sector in their droves.

### 3. Adequate Security



Restoring security and safety would require a multi-faceted approach involving the use of various pragmatic measures. 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. Interventions need to be sustainable and address the agitations of the South-South communities; which range from developmental neglect to environmental degradation.

Furthermore, these plans can be more efficient and effective if delivered as a mix of diplomacy and advanced security intelligence measures

### 4. Friendly Regulations

Effective Regulations will be a key driver for growth within the refining sector and therefore bold and decisive reforms are necessary. Regulations are pertinent to driving confidence within the refining sector and boosting attractiveness to potential investors. 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.

### 4. Functional Infrastructures

## 5. Uninterrupted Access to Feedstock

Modular refineries will be required to explore varied options to ensure constant access to feedstock required to keep refining output at optimal levels. Refiners will do well to look beyond heavy reliance on the government for feedstock.

Leveraging strategic partnerships with upstream oil and gas producers and setting up close to crude sources are likely considerations to guarantee steady supply of crude.

### Modular Refinery Economic Analysis



#### Adding-up the Numbers

The overall economics or viability of a refinery depends on the interaction of three key elements:

- ⇒ the choice of crude oil used or crude slates;
- ⇒ the complexity of the refining equipment or refinery configuration; and
- ⇒ the desired type and quality of products produced

#### Crude Slate

It goes without saying that crude oil is the primary input in the petroleum refining industry and forms the bedrock on which the petroleum industry is built.

Generally, the transportation costs associated with moving crude oil from the oil fields to the consuming regions and the greater choice of crude qualities make it more economic for distant refineries to use imported crude oil. Consideration such as this is what has led to the development of modular mini-refineries in crude producing regions.

Essentially, modular mini-refineries can be located close to the source of the crude to minimize crude logistics and distribution cost. This approach has been successfully applied in Kurdistan and Indonesia.

While the use of more expensive lighter or sweeter crude oil requires less refinery upgrading, usage of cheaper or heavier crude oil means more investment in upgrading processes. In this wise, costs and payback periods for refinery processing units must be weighed against anticipated crude oil costs and the projected differential between light and heavy crude oil prices.

The expansion of larger complex refineries is driven by the foregoing consideration, in addition to better operating efficiencies and the ability to process cheaper, heavier crudes. Bigger units can more easily recover the substantial capital cost of secondary conversion capacity, such as a 'coker' or

hydro-cracker.

However, if lighter, sweeter crudes are available a modular mini-refinery, with only primary distillation capacity, under the right conditions can still have significant competitive advantages. Such a unit requires much less capital; it is quicker to implement projects and it is more flexible to respond to demand changes in fast developing regions.

### Refinery Configuration

Refineries fall into three broad categories. The simplest is a **topping plant**, which consists only of a crude distillation unit and probably a catalytic reformer to provide gasoline. Yields from such a plant would most closely reflect the natural yields from the crude processed. Typically, only condensates or light sweet crude would be processed at this type of facility, unless markets are readily and economically available for heavy fuel oil (HFO is a combination of Residual Fuel and Cat Feed below). Modular mini-refineries generally fall into this category.

The next level of refining is called a **cracking refinery**. This refinery takes the gasoil portion from the crude distillation unit (a stream heavier than diesel fuel, but lighter than HFO) and breaks it down further into gasoline and distillate components using catalysts, high temperature and pressure. A more sophisticated modular mini-refinery can be configured in this way.

The last level of refining is the **coking refinery**. This refinery processes residual fuel, the heaviest material from the crude unit and thermally cracks it into lighter product in a 'coker' or a hydro-cracker. The addition of a fluid catalytic cracking unit (FCCU) or a hydro-cracker significantly increases the yield of higher-valued products like gasoline and diesel oil from a barrel of crude, allowing a refinery to process cheaper, heavier crude while producing an equivalent or greater volume of high-valued products. In special cases, it would be possible to acquire and re-install a used hydro-cracker as an add-on to a modular mini-refinery to obtain a full conversion refinery.

applications there is characteristically a high demand for both gasoline and distillates for transport.

## Product Slate

Refinery configuration is also influenced by the product demand in each region. Refineries can produce a wide range of products including: propane, butane, petrochemical feedstock, gasolines (naphtha specialties, aviation gasoline and motor gasoline), distillates (jet fuel, diesel, kerosene, and intermediate fuel oil), heavy fuel oil, lubricating oils, waxes, and asphalt. The last three products require a special refinery configuration and are not suitable for a modular mini-refinery.

In Nigeria, the demand for gasoline is much larger than distillate demand and, therefore, refiners configure their installations to maximize gasoline production.

Gasoline sales account for nearly 50% of demand while distillate sales account for less than 30% of product demand. In developing markets and for common modular mini-refinery

## Modular Mini Refinery Versus Conventional Refinery

In the paragraphs below, we have made an attempt to provide a short comparison and why investors should be more inclined in investing a modular mini-refinery as opposed to a conventional refinery.

- ⇒ Unlike a conventional refinery which requires huge capital investment, a modular mini-refinery requires a low capital investment;
- ⇒ While a modular mini-refinery is flexible to meet demand and can be built in a phased manner, a conventional refinery is often restricted to de-bottlenecking (the process of getting more production out of existing plants and equipment by improving processes or revamping equipment, which could significantly impact on an organization's finances).
- ⇒ A Modular mini-refinery is usually located close to existing or potential markets unlike a conventional refinery which has a location for different markets.

## Benefits of Building Mini Refineries over conventional refineries

Some of the advantages of building mini refineries over traditional refineries include the following:

- ⇒ Option of small capacity refining units as equipment modules that are constructed off-site in a specialized fabrication shop built to UOP specifications. These are assembled and tested before shipping to site.
- ⇒ Installation of the modules is much faster compared to a conventional stick building approach.
- ⇒ While the traditional larger refineries have improved economy of scale and can produce a wider variety of refined products, can be integrated into petrochemical operations and offer more flexibility, mini-refineries offer the following benefits:
  - lower investment costs;
  - sized for lower local demand;
  - modular fabrication off-site for higher quality;
  - shorter schedule, and;
  - possibility for future relocation.

## Modular Mini-Refinery Feasibility

Normally, there exists a number of 'special conditions' to

make a hydro-skimming modular refinery viable:

- ⇒ Proximity and access to crude;
- ⇒ Proximity to sizeable markets;
- ⇒ An acceptable market for HFO;
- ⇒ Logistic advantages—decreases high distribution costs in remote regions;
- ⇒ Project finance on preferential terms from development credit agencies; and
- ⇒ Government incentives to support regional development

These conditions and the refinery economics must be analysed in a feasibility study, which is independently verified as a technical requirement of most development credit agencies.

In addition, it is essential to have an adequate regulatory framework and evident support from the host government to obtain the project financing.

## Modular Mini-Refinery Configurations

Mini-refineries are typically available in units from 4,000 to 30,000 bpd. Smaller refineries tend to be topping or hydroskimming refineries that may range from 5,000 to 30,000 BPSD crude capacity.



Configuration tends to be simpler and can include process units such as a Crude Distillation Unit (CDU), Diesel Hydrotreating (DHT), Naphtha Hydrotreating (NHT), Reforming, Isomerization, Sulfur Treating, amongst others.

The different configurations available for modular mini-refineries, with increasing degree of sophistication are discussed in the next succeeding paragraphs on the next page.

## 1. Atmospheric – Topping Unit

This is a low capital cost crude distillation unit for diesel and/or kerosene production, with naphtha and fuel oil as by-products.

## 2. With Gasoline Train

With a reformer or hydro-treater added (higher capital cost) produces high octane unleaded gasoline and LPG. This configuration can include an isomerization unit to boost total Octane rating of gasoline and produce more premium unleaded gasoline.

## 3. Vacuum Distillation – Cracking

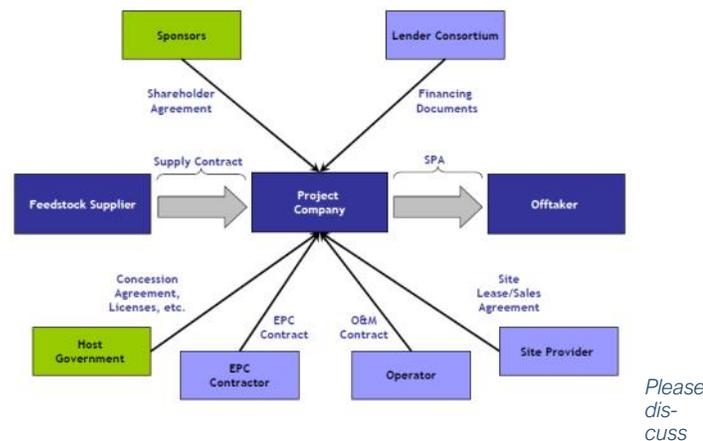
A second distillation tower can be added to vacuum distil the fuel oil component from the atmospheric tower into a clean heavy diesel (vacuum gas-oil) and heavy residual oil.

## 4. Hydrocracker Unit – Full Conversion

The hydro-cracker Unit (high capital cost) is a device that converts light and heavy gas oils to more valuable lower boiling point products. The yield across a hydro-cracker may exhibit volumetric gains as high as 20-25% for light end products from fuel oil, making it a substantial contributor to refinery profitability.

While the economics of such a topping unit or 'hydro-skimming' mini-refinery are not comparable to a 200,000 bpd complex or 'full conversion' refinery with hydro cracking; the relatively low capital cost and flexibility can make it a cost effective supply option in the right circumstances.

## Project Finance Framework for Refineries



around the key participants of Refinery Project Finance

The idea of running a modular refinery is usually initiated by a sponsor or **sponsors**, who is also called the **project sponsor**. The project sponsor may be an existing company, a developer, or a government institution or agency. It is worth noting that there is no limit to the number of sponsors. Hence, there can be a consortium of sponsors with the same or different backgrounds e.g. public-private partnerships.

More often than not, the sponsors hardly have the financial stamina to execute the project and do rely on a **consortium of lenders**.

Given the logic behind **project sponsors** avoiding to put their corporate balance sheets directly at risk in these often high-risk projects, project financings use the project company as the financing vehicle and raise limited or non-recourse debt. To further buffer corporate liability, many of the multinational sponsors establish local subsidiaries as the project's investment vehicle.

Where there is more than one sponsor, it is common for them to enter into a "pre-development" or "project development" agreement. The purpose of this agreement is to regulate the relationship between the sponsors prior to the project.

Equity can be contributed by **sponsors** ordinarily subscribing to the share capital of the project company, or through shareholder loans.

Equity can also be contributed through a bank-funded equity bridge loan (which will be guaranteed by the sponsors and typically repaid at project completion), the use of which optimises shareholders' return profiles through delaying the timing of equity contributions to the project.

While the focal objective of **sponsors** (especially private sector sponsors) in a project is to make profits, monetary gain is not the only reason for private sector involvement in a project. For instance, the owner of a refinery which operates on steam may well promote an electricity co-generation project on the same site as the refinery in order to secure a steam supply (without which the refinery would have to shut down).

Other objectives that private sector sponsors might have, include the following:

- ⇒ to share the risk in carrying out a project – a company may decide to fund a project through **project finance** rather than from its own resources simply because of the damage the project could do to its finances if it went wrong. Commercial banks providing project finance are the most obvious people with whom such a company might seek to share risk;
- ⇒ to carry out a project off balance sheet – this essentially means a sponsor financing a project without having to show any borrowing for the project among its own borrowings in its consolidated accounts;
- ⇒ to obtain political risk insurance when carrying out a project – for example, when the host government or lenders like export credit agencies and the World Bank are participants in a project finance transaction, it gives some kind of de-facto insurance against political risks such as expropriation and arbitrary withdrawal of license.

## Lenders in Refinery Project Finance

Like sponsors, there is no limit to the number of lenders in a refinery [project finance transaction](#). The lenders are the debt financiers of the project – they finance the project by providing long-term loans – and they are prepared to accept the risk involved in the venture.

There are many types of lenders and there are a variety of debt finance products which can be applied in a project financing but the specific mix of products available to a project will depend on the sector, jurisdiction, project size, sponsor profile, transaction risk profile and source of capital equipment. The principal lenders in a project financing are:

### 1. Commercial banks

[Commercial banks](#) (especially international banks) represent a primary source of funds for project financings – they are the largest providers of debt capital in project finance. Lending to a project exposes banks to great risk, so the banks pay particular attention to the feasibility of the project, and the evaluation of the credit risk. The banks also offer financial advisory services in the project, and seek to have a high level of control over the management of the project because if the project fails, it may damage them heavily.

The syndicate is important not only for raising the large amounts of capital required, but also for *de facto* political insurance – a syndicate of banks might be chosen from as wide a range of countries as possible to discourage the host government from taking action to expropriate or otherwise interfere with the project and thus jeopardize its economic relations with those countries.

### 2. Export Credit Agencies (ECAs)

Essentially, an export credit agency (ECA) is owned (or franchised) by a government. An ECA is a public agency or entity that provides a loan guarantee or funding to projects for an amount that does not exceed the value of exports that the project will generate for the ECA's home country. Notable examples of ECAs are the Export-Import Bank (Ex-Im Bank) of the United States, the Export Credit Guarantee Department (ECGD) in the United Kingdom, and the Nigerian Export-Import Bank (NEXIM). Because infrastructure projects in developing countries often require imported equipment from the developed countries, the ECAs are routinely approached by sponsors and contractors to support these projects.

### 3. Multilateral agencies

Multilateral agencies are established by intergovernmental agreements and unlike ECAs are independent of the interests of any single country member or recipient government – they are designed to promote international and regional economic co-operation. They can provide direct lending, political insurance to other lenders and even equity participation. Because they are developmental in nature, they are predominantly emerging-markets-focused and will seek a strong socio-economic developmental rationale for a project to consider support. Multilateral agencies are often present, through their loan and guarantee products, in project finance transactions located in developing countries – where a great deal of pro-

ject finance takes place.

In addition, these institutions often play a facilitating role for projects by implementing programs to improve the regulatory frameworks for broader participation by foreign companies and the local private sector. In many cases, the multilateral agencies are able to provide financing on concessional terms. The additional benefit they bring to projects is to provide further assurance to lenders that the government and state owned companies will not interfere detrimentally with the project.

### Conclusion

No doubt, Nigeria's refining sector holds great prospects for the future. There have been some government initiatives to increase local refining capacity to offset continued growth of importing finished products for growing consumer demand. The goal is to provide lower cost, steady supply of fuels and products on a local level.

This is very commendable as it will go a long way in increasing local security of supply for transportation fuels, local electricity as well as sustained use of LPG cylinders for cooking and heating fuel. obtained in-country, benefiting from lower regional pricing, transportation, and other incentives such as local jobs creation.

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