EGHUDU REFINERY

100K BPD GREENFIELD PROJECT

Modern Petrochemical Complex

Ovia East, Benin City Nigeria

Presentation Outline

- Project Team
- Market Demand
- Project Overview
- Modern Design
- Future Considerations
- Community Development

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Project Team

Charles Ihaza

Partner

- Production Manager/Senior Engineer with Seadrift Coke. Extensive Refinery operations and process engineering experience on multiple projects such as Shell Motiva Enterprise, Port Arthur, Texas.
- MSc in Chemical Engineering from the University of Texas.
- Experienced chemical engineering with over 35 years experience in the petrochemical industry in management, process/project engineering and maintenance in United States.

Dr. Bashir Ighile

Partner

- Orthopedic Surgeon and Director of CQI and PS, Armed Forces Hospital, Medical Services Department, Ministry Of Defense in Saudi Arabia
- University of Lagos, Bsc of Medicine and Surgery Fellow of the Royal College of Surgeons of Edinburgh, Scotland
- Orthopedic Surgeon with over forty years experience practicing in United Kingdom, Nigeria and Saudi Arabia

Peter Butt - Partner

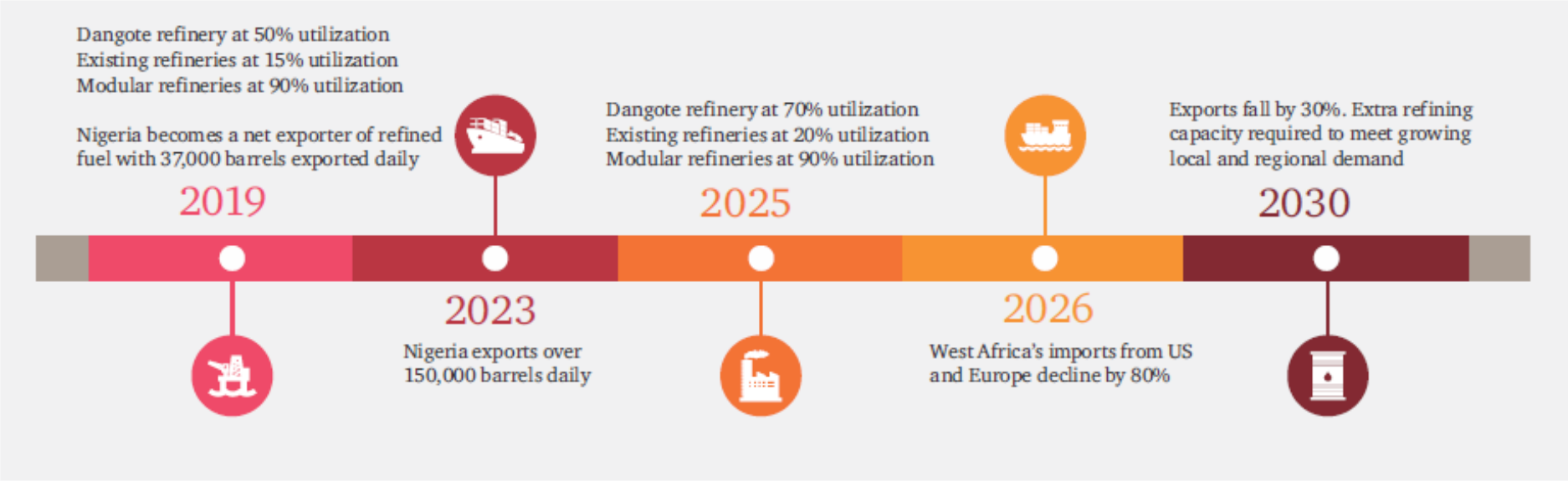
- Energy industry expert with extensive knowledge of power utilities in both advanced and emerging economies. Economic trends adviser and forecaster at the Confederation of British Industries and functioned in various roles for 10 years in the UK electricity industry at Eastern Energy (Texas Utilities TXU), the largest integrated utility in the UK.
- Supervised the development and implementation of market rules and regulatory environments in several countries, including the United Kingdom, Netherlands, South Korea, Pakistan, Bangladesh, Saudi Arabia, Sierra Leone and Nigeria. Worked with funding agencies such as the World Bank, European Bank of Reconstruction and Development (EBRD), Asian Development Bank and African Development Bank.

Zack Moshe - Partner

- Moshe initially served in the Israeli army between 1964 and 1968. He has worked with major construction companies as well as the Ministries of Defense and works in Israel on the provision of infrastructures such as roads and water. Experience in working on construction, civil works and in Nigeria since 1981.
- Supervised multiple various infrastructure projects including railway and housing projects in Israel. Continues to work for a major international construction company on infrastructure projects in Abuja, the Federal Capital Territory.

Market Demand

- According to the Petroleum Pricing Products Regulatory Agency (PPPRA), Nigeria imported 19.18 billion litres of gasoline in 2019, yet periods of severe fuel shortages were experienced. Other products that were imported in 2019 include 4.59 billion litres of diesel, 951.77 million litres of jet fuel, 306.79 million litres of base oil, 128.11 million litres of household kerosene, 125.56 million litres of bitumen and 45.98 million litres of low pour fuel oil. Functioning well below capacity, the country's refineries with a total capacity of 454,000 barrels per day could only manage to produce 166.33 million litres.
- Local refineries have been poorly managed over the years, performing at between 8% and 15% of installed capacity. Attempts by government to overhaul and upgrade them to raise output have failed.
- Several small refineries or topping plants have been commissioned recently. These range from 1,000 barrels per day to 12,000 barrels per day. They are essentially modular refineries capable of producing one or two key products – usually diesel for the marine industry. Their total output falls well short of the country's demand.

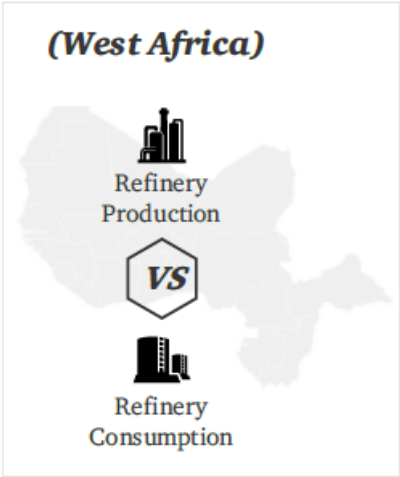


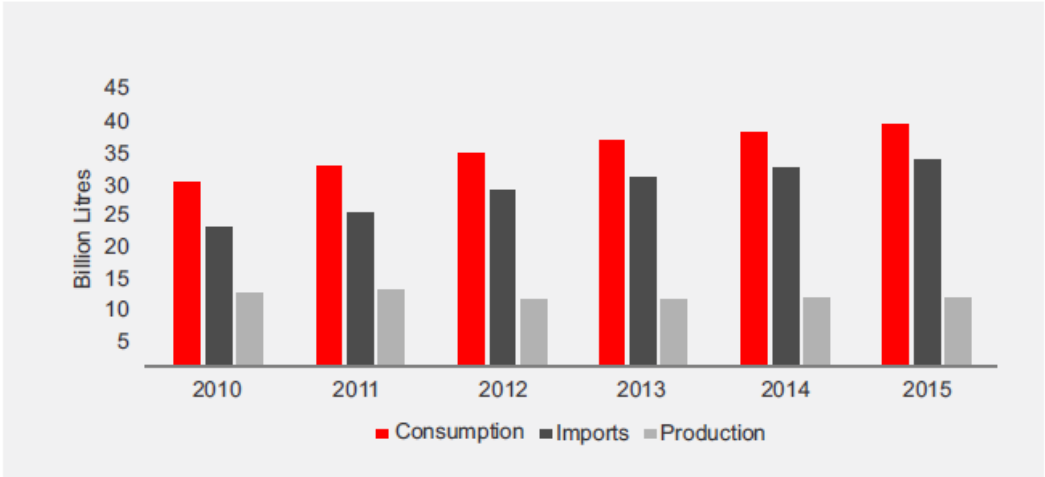
Source: OPEC, EIA, PwC Analysis

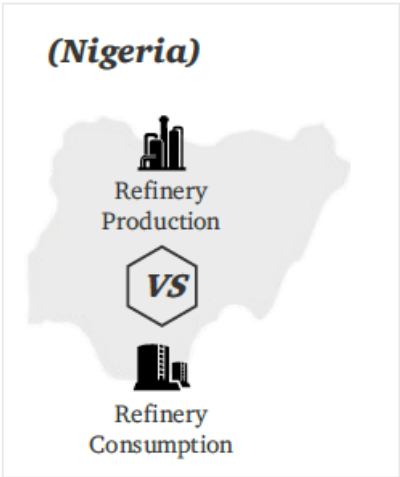
Market Demand

- The only other major refinery under construction is the Dangote refinery being constructed on reclaimed land in Lagos. The projected capacity of the Dangote refinery is 650,000 barrels per day. Construction is phased. Dangote refinery is a Euro-5 refinery. Up to 70% of output will be exported. With a growing local and regional demand, the remaining 30% will not meet Nigeria's total demand.

- The Nigerian and the west African markets are the key targets for Eghudu petrochemical complex. The projected population growth in west Africa and the current pace of deployment of renewable energy sources creates a significant demand for refined products in the energy sector. There is also a strong demand for home grade petrochemical products in the region.







Source: OPEC, EIA, PwC Analysis

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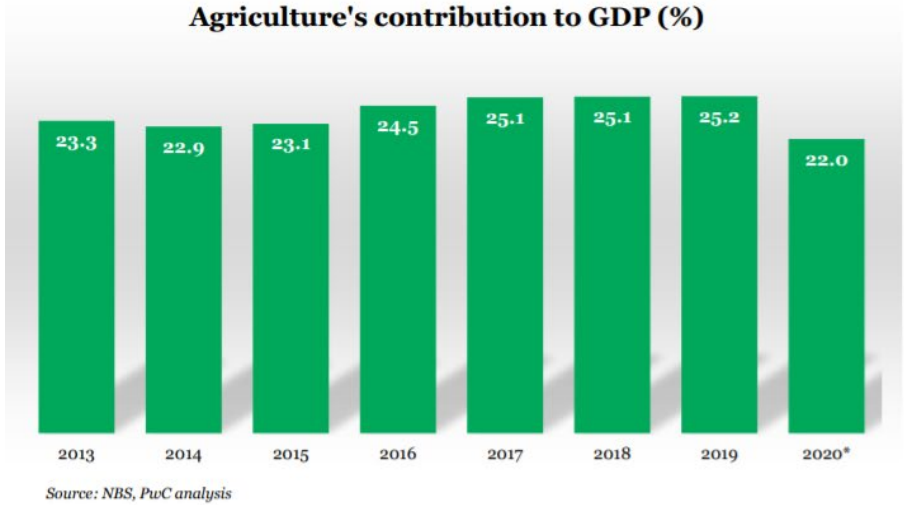
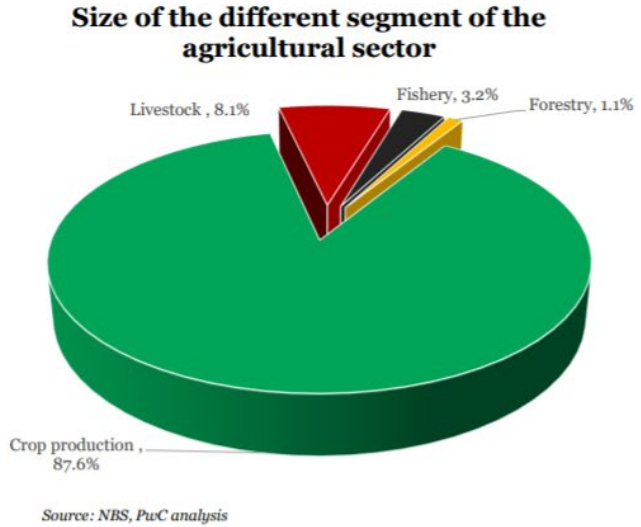
Market Demand

- Ammonia is one of the most highly produced and utilized inorganic chemicals. 80% or more of the ammonia produced is used for fertilizing agricultural crops. Ammonia is also used to produce plastics, fibers, nitric acid (via the Ostwald process) and intermediates for dyes and pharmaceuticals.
- Agricultural consumption of fertilizer produced in Nigeria has increased from 10kg/ha in 2006 to 17.8 kg/ha in 2014. Fertilizer consumption as a percentage of fertilizer production reached 1086.4% in 2010. With a population of roughly 200 million people, Nigeria's agricultural productivity is insufficient to meet the food demand of its rapidly growing population thus creating a massive supply gap in Nigeria and other African countries.
- Africa's food import is estimated at about US$35 billion in 2016 and it's projected to rise to US$110 billion by 2025. In addition, Africa's agribusiness sector is projected to reach $1 trillion in 2025, driven by the continent's rapidly growing middle class.





EGHUDU REFINERY

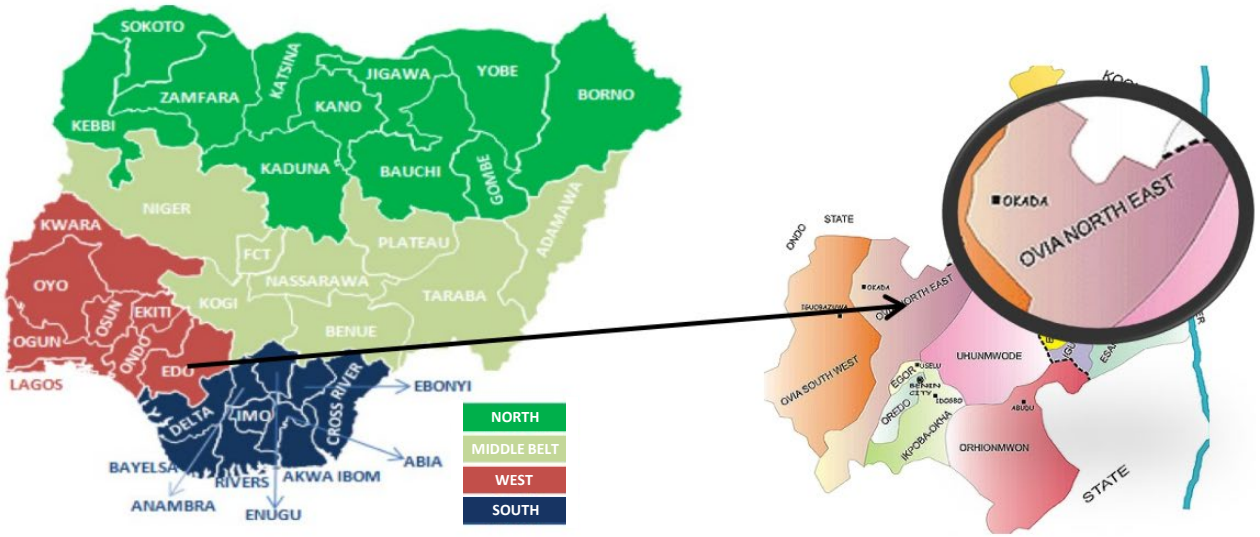
Project Overview

- Introduction
- Environmental & Social Impact Assessment
- Investment Incentives
- Strategic Location
- Project Site
- Refinery
- Petrochemical Plant

EGHUDU
REFINERY

Project Overview

- **Introduction**
  - Eghudu Refinery is a modern greenfield full conversion refinery and petrochemical complex in Ovia North East local government of Benin City, Edo State, Nigeria. The Eghudu Refinery Project will increase the refining capacity of crude oil and other refined products in Nigeria. The project will constitute the design, engineering, procurement, fabrication, construction, commissioning, operation, and maintenance of a 100,000 BPD Euro Spec 7 full conversion refinery and petrochemical complex.



Map of Nigeria

Map of Ovia North-East, Edo State

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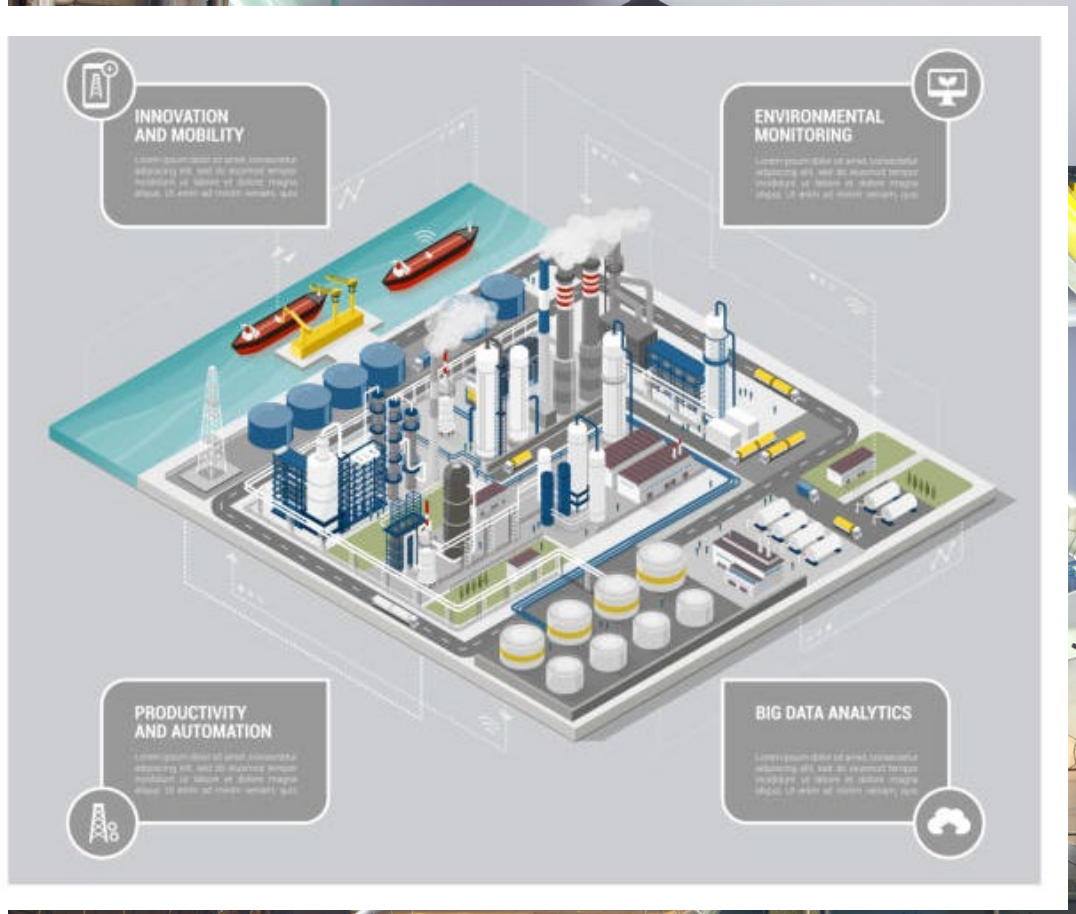
Project Overview

- **Introduction**
  - The plant is to be designed with a modern approach factoring long-term profitability, efficiency, flexibility, extended asset life cycle, global trends, and regulatory standards. The project has received license to establish (LTE) from the Department of Petroleum Resources (DPR).
  - The completed Environmental and Social Impact Assessment (ESIA) report has been approved by the Nigerian federal ministry of environmental.



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Project Overview

- **Environmental and Social Impact Assessment**
  - Environmental and Social Impact Assessment (ESIA) **completed**. Conducted over 15 kilometres radius of the site by seasoned professionals.
  - All impacted communities and beyond were engaged. Townhall meetings were held to discuss project with all the surrounding communities, Edo State Government, Nigerian Local Contents Monitoring and Development Board, DPR, Federal Ministry of Environment and other stakeholders.
  - Comprehensive ESIA was conducted for the project, all utilities and supporting infrastructures (Including Power Plant) – consent and certificate granted on 29 October 2018.
  - Detailed community development plan will be developed with our partners as required by the Nigerian Contents Development and Monitoring Board (NCDMB)
  - There will be planned relocation of 37 households impacted by the project from the existing Eghudu site to a new location approximately seven kilometres from the Eghudu site. This will include housing, school, health facilities, water, electricity and road access.

Project Overview

- **Nigerian Federal Government Investment Incentives**

  Investment:

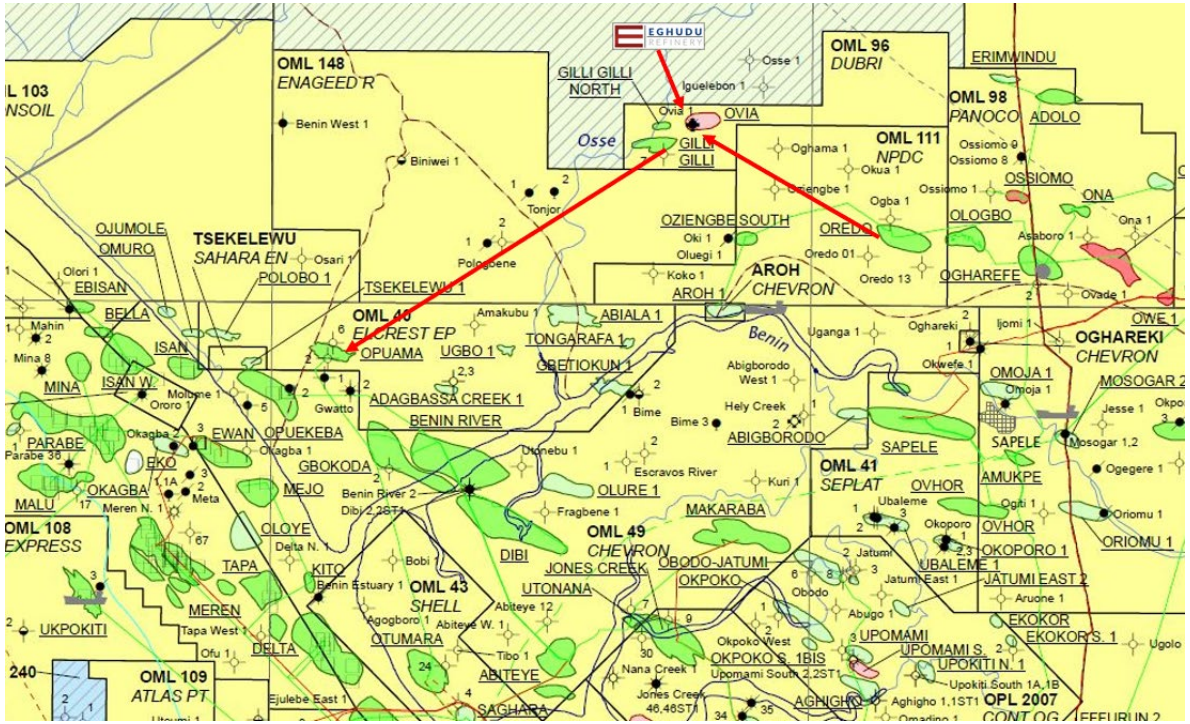
  - 5 years duty and corporation tax waiver.
  - 100% profit repatriation.

  Feed Stock:

  - 60% refinery requirement guaranteed by NNPC.
  - The Eghudu petrochemical complex can also derive significant feed stock from independent operators – SEPLAT, Sahara, Elcrest, Dubris Oil, Pan Ocean, Chevron and Shell all within 40km radius of Eghudu. Furthermore, all suppliers interconnected by elaborate pipeline networks in the area and are willing to enter into agreement.

Strategic Location

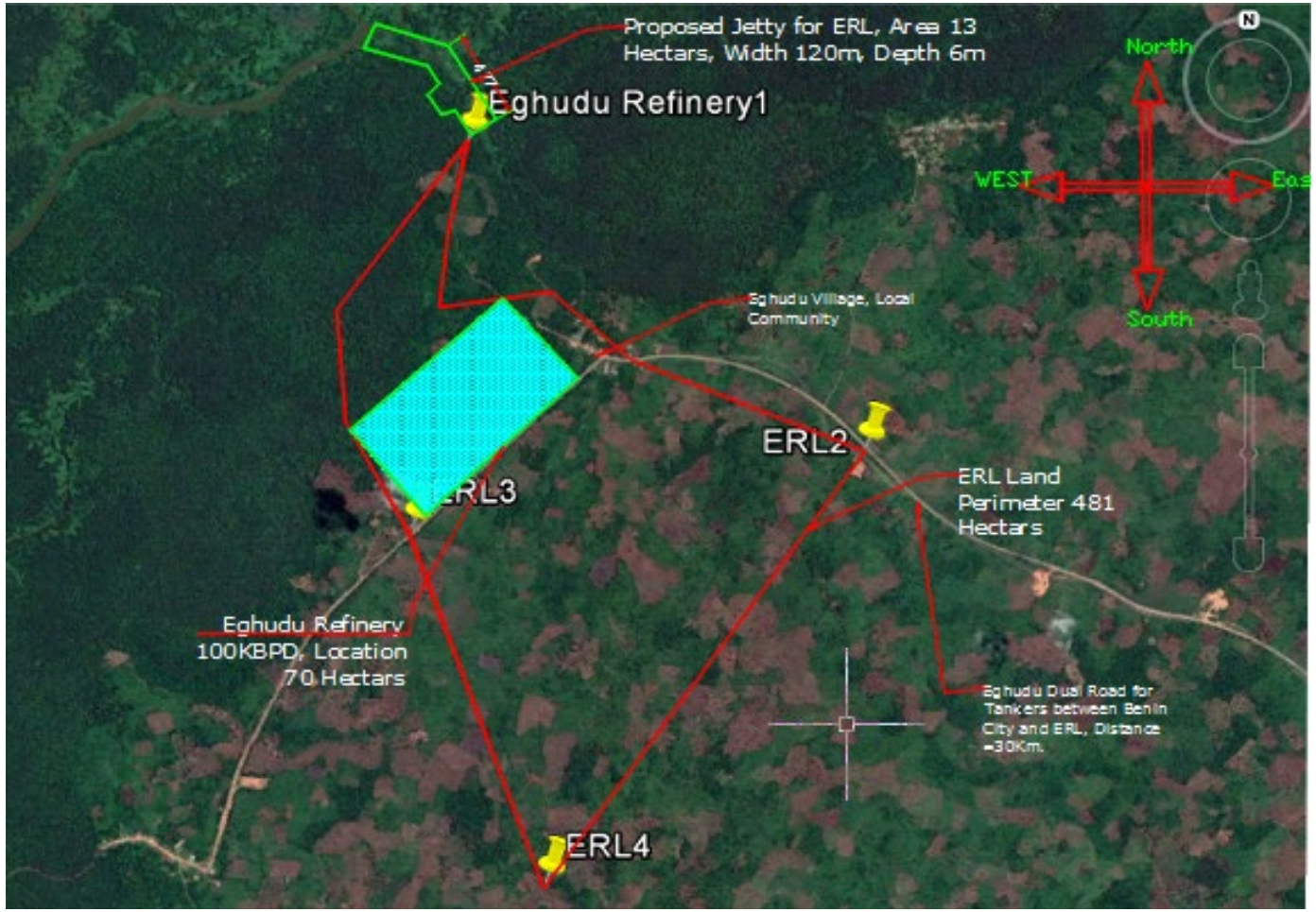
- **Jetty and Pipeline Network**
  - Eghudu Refinery is strategically located in the vicinity of main crude oil storage facilities of Escravos and Forcados within 100 km radius.
  - The land benefits from a riverbank with a jetty feeding into Osse river. The project site is in close proximity to crude oil pipeline line networks with 20 km and from a flow station in Oziengbe.
  - Waterway access for crude oil barges. The estimated type and size of vessels that will dock at the marine terminal is noted below:
  - Vessel Estimated Sizing
    - Vessel Type: Oil tanker 3,200mt
    - Length: 95 m
    - Breadth: 13 m
    - Moulded depth: 7-9 m



Potential Pipeline Tie from NNPC Pipe Network

Project Overview

- **Project Site**
  - The proposed project site will be in Eghudu, a rural agrarian community in Oduna ward, Ovia north east local government area of Edo state (one of Nigeria's oil producing states) Benin City, the Edo state capital.
  - The project site is approximately between latitudes 5°44'N and 7°37''N and longitudes 5°44E and 6'43''E.
  - The refinery will be on a parcel of land area measuring 484.3 hectares.
  - The project will install a Jetty at the NW corner of the site, which will provide unrestricted access for barging in feedstock or shipping out refined products for export via the Osse river.



ERL Mapping (Google Earth)

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Project Overview

Refinery

Feed Stock

- BLCO Crude Oil
- Medium/Heavy Crudes
- Natural Gas
- Fresh Sulfuric Acid

Refined Products

- High Grade Gasoline
- Jet Fuel/Kerosene
- Diesel
- Fuel Oil
- Liquid Sulphur
- Unsaturate (NGLs)
- Aromatics
- Fuel Grade Coke

Petrochemical Plant

Feed Stock

- Unsaturate (NGLs)
- Aromatics (Benzene, Toluene)
- Natural Gas

Refined Products

- Polyethylene (Plastics)
- Ammonia (Fertilizer)
- Poly-Urethane
- Isopropyl Alcohol
- Methanol
- Ethanol

Petrochemical Complex - Potential Feed Stock/Refined Products

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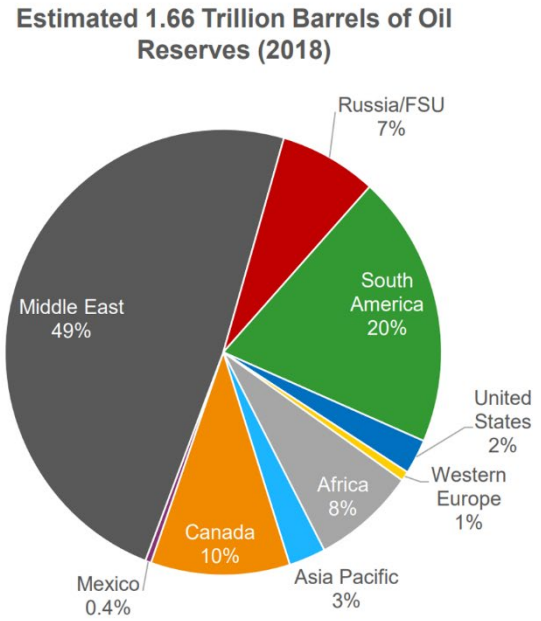
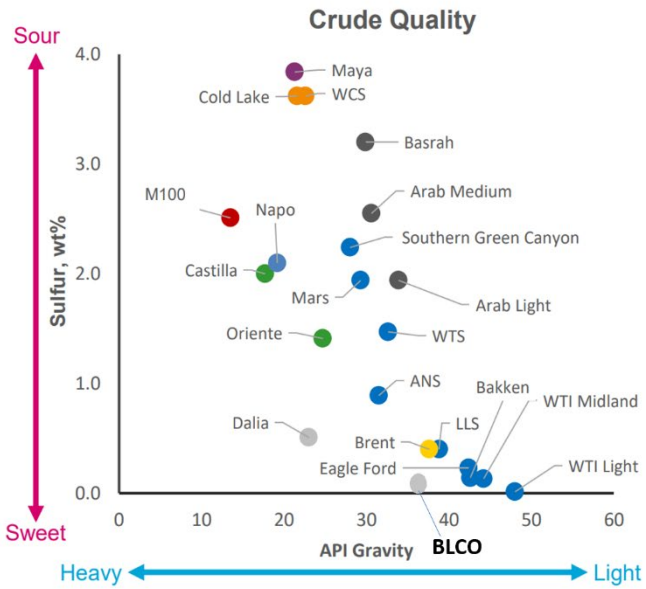
Refinery

- **Feed Flexibility**
  - BLCO is ERL's primary choice of crude slate due to ERL's proximity to the crude supply from NNPC in Benin Nigeria, the ease of processing and the yields of high value products. BLCO is considered a light sweet low corrosive crude slate:
    - Sulphur content of 0.14% < 0.5% maximum content
    - API gravity of 37 >34 minimum threshold
    - Total Acid Number of 0.19 < 0.5 mg of KOH/g





- The trend in crude oil supplies after 150 years of petroleum processing is towards opportunity crude feedstocks (i.e., heavier, lower quality feedstocks). The price of opportunity crude oil is about 80% of the price of conventional crude oil. The extra cost of processing high TAN crude is in the range $1.15–10.73/bbl, but the savings compared to conventional crude processing are $43.54–62.7/bbl. The cost of crude accounts for about 90–95% of the total running costs of refineries, so it is very attractive for refineries to process opportunity crude, especially high TAN crude. It is economically advantageous to design a refinery that can process opportunity crudes vs upgrading the refinery post commissioning.

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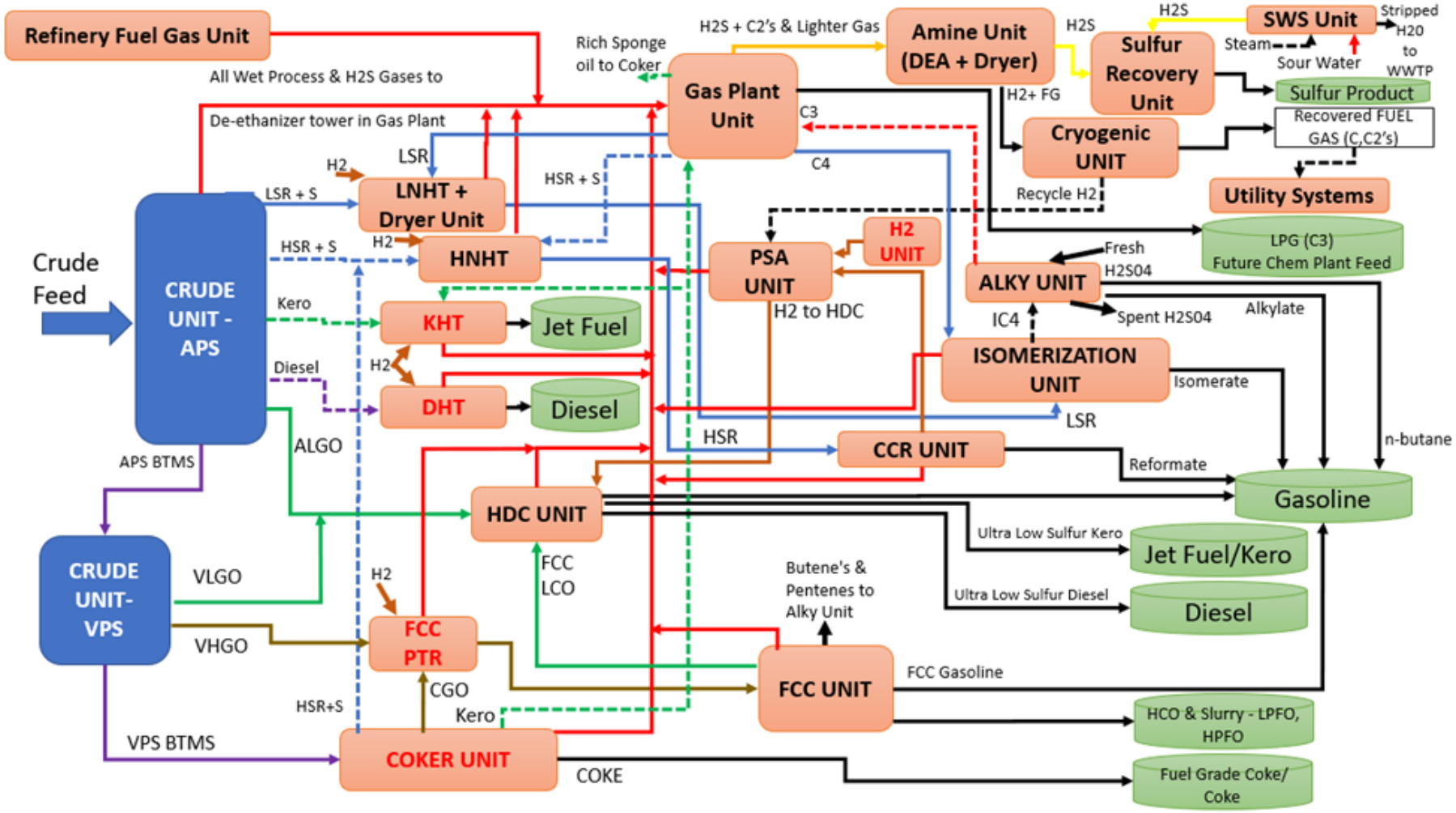
Refinery

Sample Process Unit Flow Diagram



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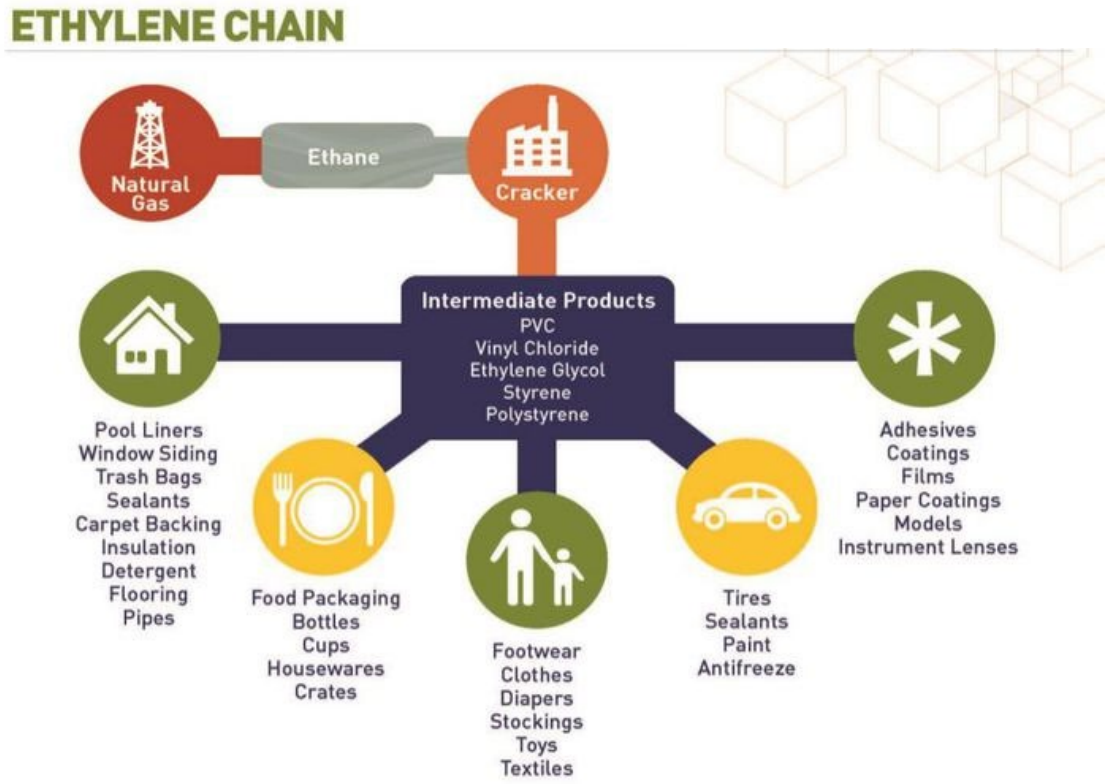
Petrochemical Plant

- **Unsaturates (NGLs) to Plastics**
  - The production of plastics begins with the distillation of crude oil in an oil refinery. This separates the heavy crude oil into groups of lighter components, called fractions. Two main processes are used to produce plastics - polymerization and polycondensation.
  - Natural gas liquids - NGL (Ethane and Propane) from the refinery gas plant can serve as direct feedstock into the petrochemical plant where it is steam thermal cracked to produce Ethylene and Propylene. This is then further processed with catalyst and pressure to produce polyethylene (plastic resin). This increases the profitability and creates further revenue flexibility.
  - As of 2018, the global production of plastics had increased to nearly 360 million metric tons. By the year 2050, plastic production is expected to have tripled and will account for a fifth of global oil consumption.



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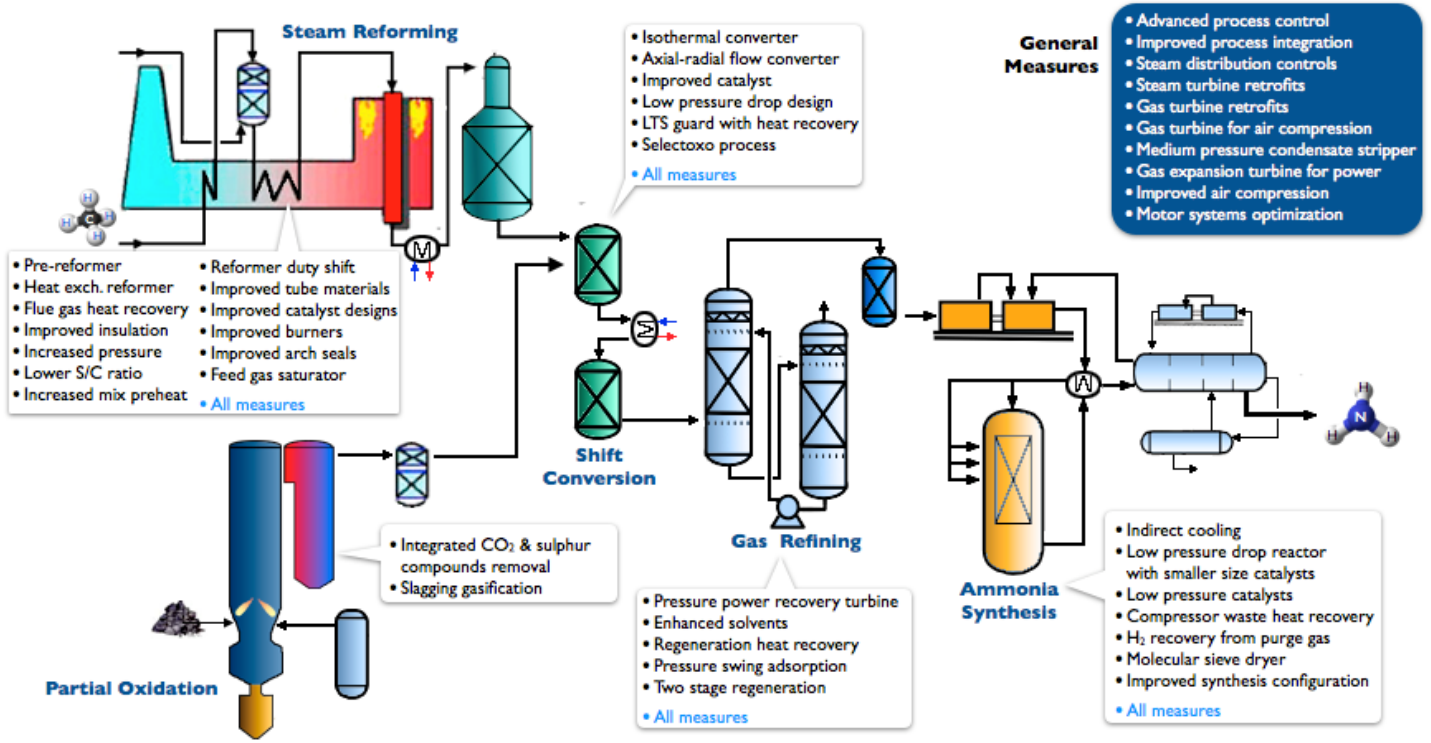
Petrochemical Plant

- **Natural Gas to Ammonia**
  - Natural gas (i.e., Methane) feedstock is purchased and fed to the Petrochemical plant where it is steam reformed to produce ammonia.
  - Ammonia is used as a raw feedstock to the downstream fertilizer unit to formulate the fertilizer end product.
  - Significant demand in the regional Agricultural sector makes fertilizer production highly profitable.



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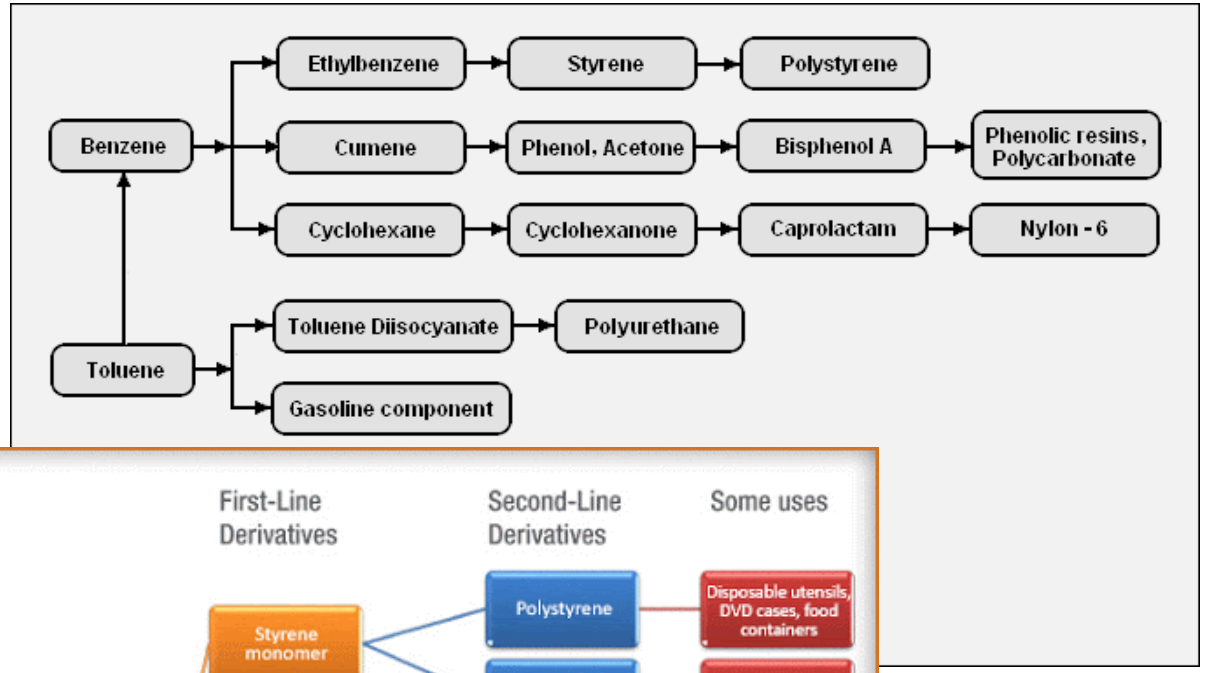
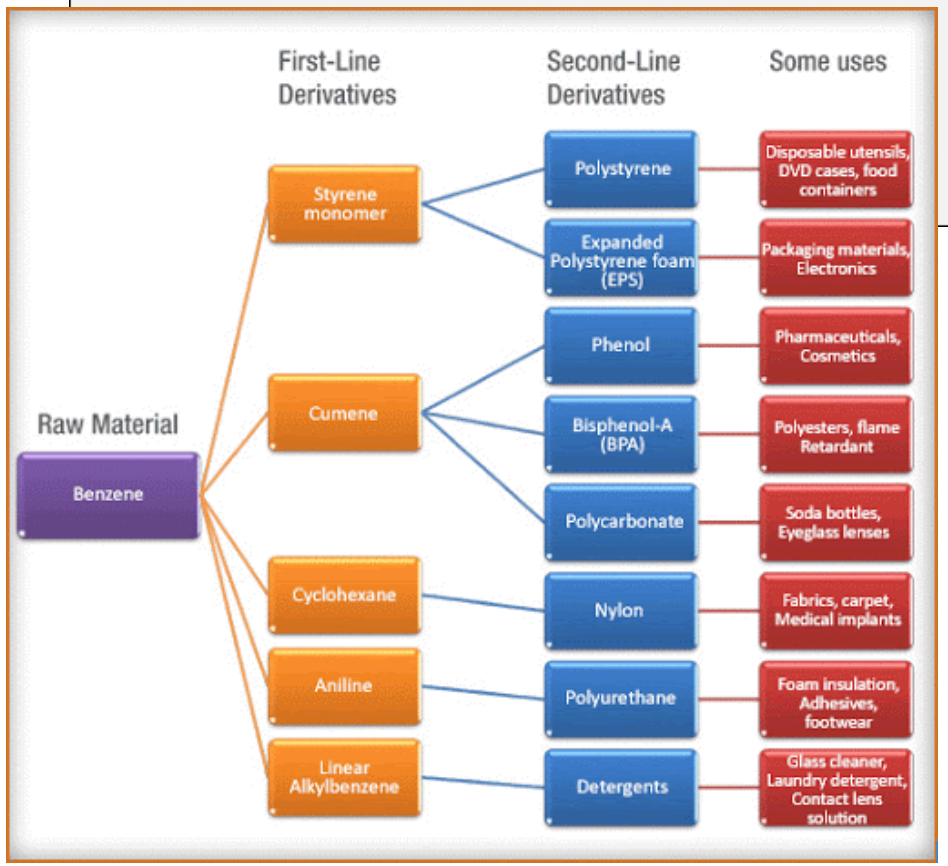
Petrochemical Plant

- **Aromatics to Polyurethane, Polystyrene and others**
  - Aromatics feedstock to the Petrochemical plant is obtained from the refinery Catalytic Cracking Reformer (CCR) unit when the CCR unit operates at a higher severity level than for motor gasoline.
  - Benzene contained in Aromatics has the highest demand, and it can be processed with by solvent extraction, distillation and crystallization to produce 99% Benzene, Toluene and Xylenes.
  - These reformed aromatics are further processed in downstream units to produce Polyurethane, Polystyrene, Nylon and other products used as feedstock to other industries. This increases the profitability and creates further revenue flexibility.





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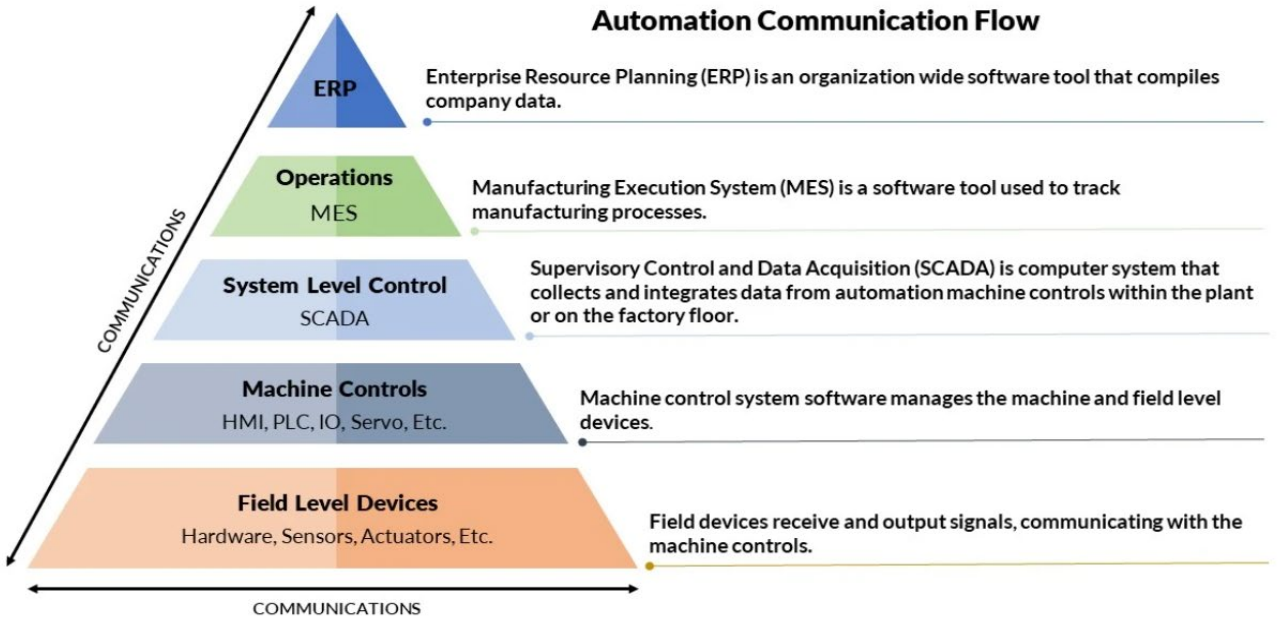
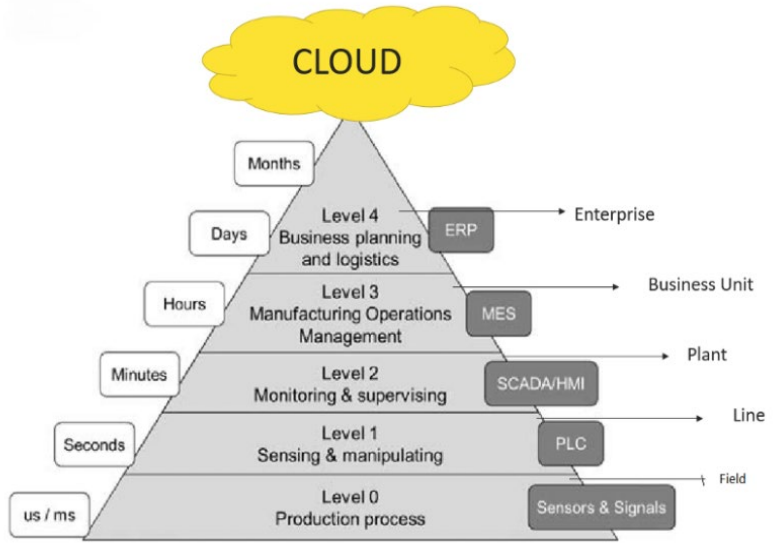
Modern Design

- **Industry 4.0 Business Practices Technology Transformation**
  - It will be advantageous to incorporate a plant wide wireless network and centralized best in class (Level 5) cloud eco-system to store all (Level 0-4) plant, maintenance and lab data vs using a plant local sever.
  - In addition, the global community is currently transitioning its operation to the block-chain, and a cloud eco system will act as a huge enabler for future online secure trust-less block-chain payments and optimization.





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Modern Design

- **Industry 4.0 Business Practices Technology Transformation**
  - Implementing these initiatives will lay the foundation for increased plant data storage space and low latency data, enabling the development of IT SAAS product, thus allowing the automation, performance digitalization and identification of efficiencies. This will result in earnings growth from:
    - Increased productivity
    - Improvement quality throughput and output (Real time Optimization)
    - Reduction in labor costs
    - Reduction in the impact of labor shortages
    - Decreased safety concerns in hazardous environments or those with repetitive tasks
    - Improved energy efficiency gap identification and forecasting for optimal maintenance planning and scheduling
    - Improved supply chain payments, logistics & payment liquidity, wireless instrumentation (IoT) installation cost savings

EGHUDU REFINERY

Modern Design

- **Green House Gases (GHG) Reduction**
  - Under the Paris Agreement, countries agreed to limit warming well below 2 degrees C (3.6 degrees F) and ideally 1.5 degrees C (2.7 degrees F). Climate impacts that are already unfolding around the world, even with only 1.1 degrees C (2 degrees F) of warming — from melting ice to devastating heat waves and more intense storms — show the urgency of minimizing temperature increase to no more than 1.5 degrees C.
  - To comply with current & future GHG guidelines and avoid profitability impacts from non-compliance in lines with the Carbon reduction, it will be advantageous to install state of the art equipment geared towards GHG reduction with the base design.
  - Examples of GHG reduction equipment's to name a few:
    - Ultra-low NOX burners in Fired equipment's
    - Flare gas recovery units (FRGU's)

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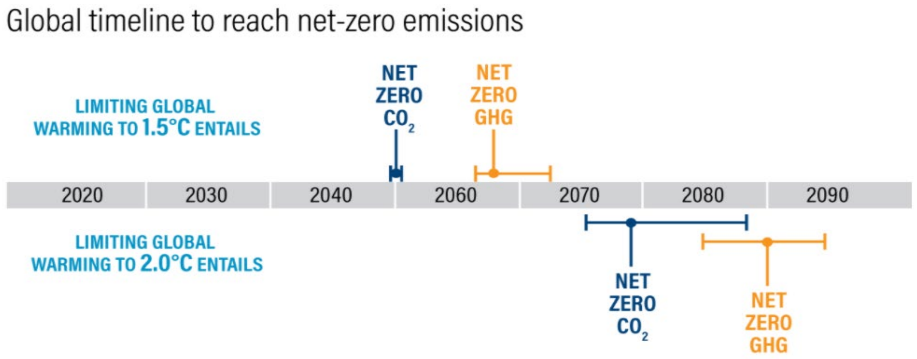

Source: IPCC Special Report on Global Warming of 1.5°C

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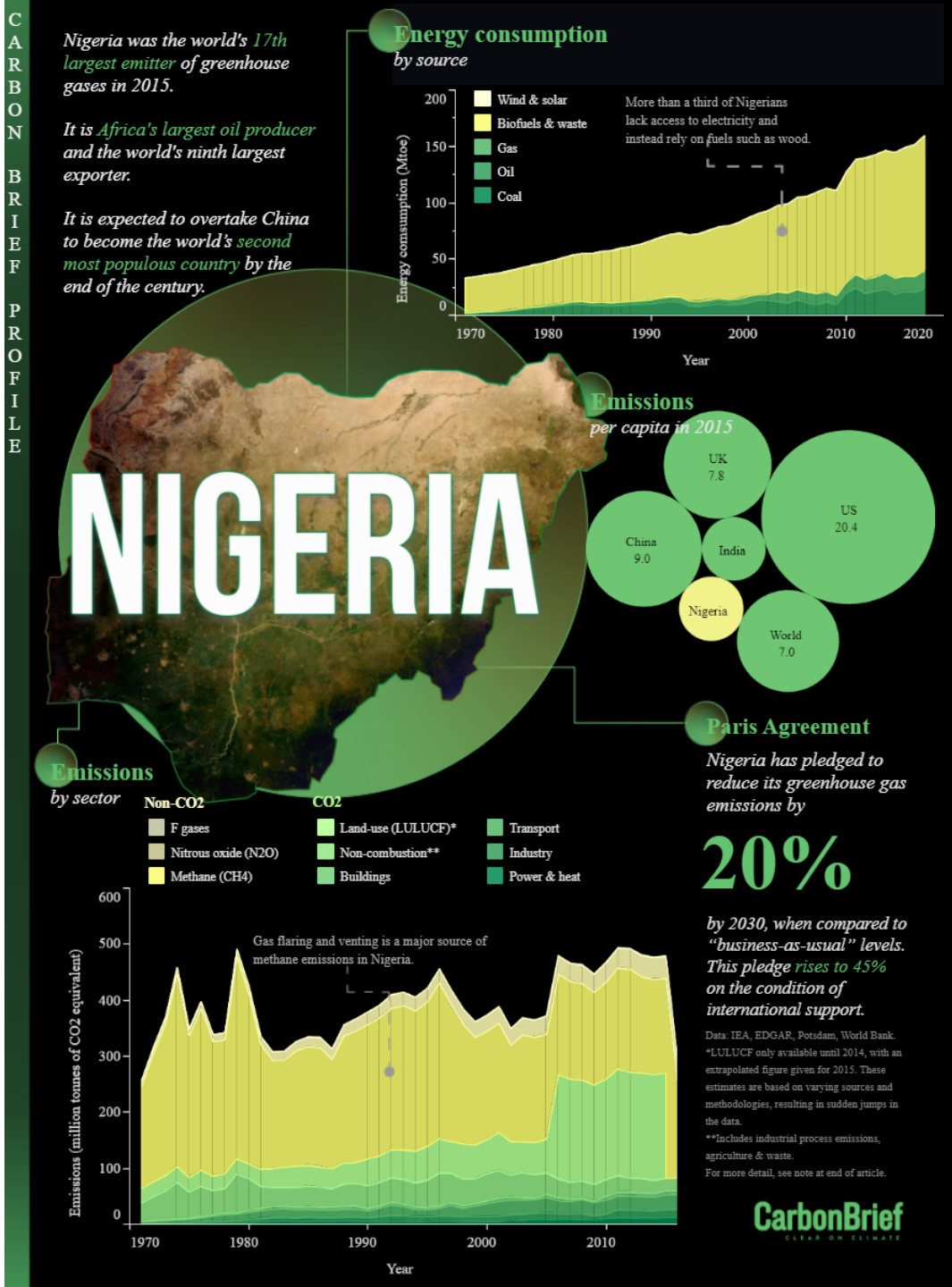
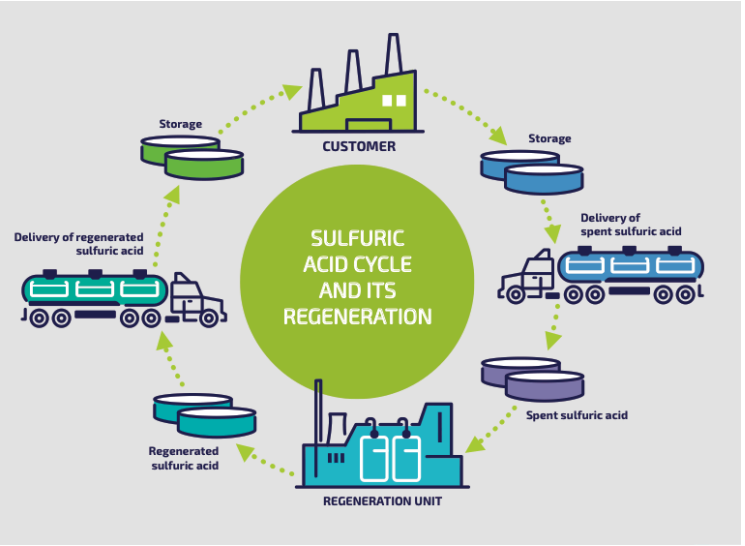
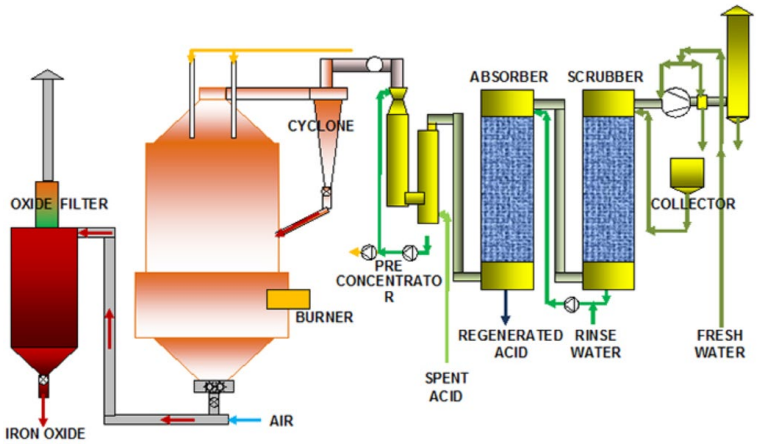


Future Consideration

- **On-Site Spent Sulfuric Acid Regeneration Unit**
  - Fresh Sulfuric acid is used in the Alkylation unit in the presence of other feedstocks to produce Alkylate and n-butane blending feedstocks, which is used in gasoline blending to optimize octane rating, with spent sulfuric acid as a by-product.
  - The spent sulfuric acid is sent offsite to be regenerated and fresh sulfuric acid is purchased and trucked onsite. Below are benefits of regenerating the spent sulfuric acid On-site as an alternative to purchasing fresh acid offsite:
    - Operating cost reduction
      - Lack of local industry expertise to dispose off the spent sulfuric acid, resulting is increased logistics cost to dispose at a remote facility.
      - Less cost spent purchasing Fresh sulfuric acid feedstock if regenerated onsite.
    - Environmental Safety & NOx reduction
      - Mitigation of the transportation and associated hazards of sulfuric acid into and out of the plant.
      - Air emissions from on-site regeneration would include SOx, NOx, and VOC emissions. While performing the regeneration off-site would reduce the local facility emissions, total "global" emissions would be similar and higher than those for a HF Alkylation system.





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Community Development

- **Corporate and Social Responsibility**

  Developing a detailed community development plan is required by the Nigerian Content Development and Monitoring Board (NCDMB) as part social and corporate responsibility obligations of Eghudu petrochemical complex. These including but not limited to:

  - Community support projects can include a health clinic, educational and recreational facilities.
  - The project stakeholders will be expected to provide various types of skills training for indigenes of local communities to create employment opportunities. More advanced training should be made available to those who show potential for higher skilled roles.
  - Scholarship programme to support higher education and community development.

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Modern Petrochemical Complex

Ovia East, Benin City Nigeria

Prepared by

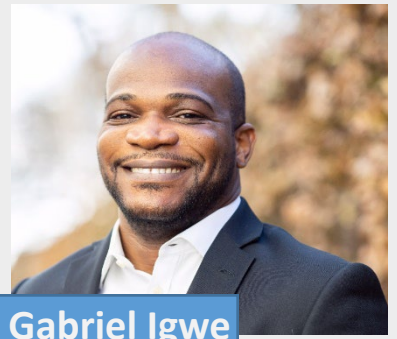
VOSIGHT ENGINEERING

17350 State Highway 249
Houston, TX 77064
www.vosighteng.com
info@vosight.com

Efosa Ighile

Project Engineer

- Senior Engineering Consultant Vosight Incorporated.
- Senior electrical engineer with Honeywell UOP, the world leader in refinery process technologies and patents.
- BSc in Electrical Engineering Technology from the University of Houston.
- 14 years industry experience, worked on engineering design and fabrication of several large-scale oil and gas projects for multinational corporations such as Pemex Dos Bocas, Venture Global LNG Calcasieu Pass, IPPL Alberta and others.



Gabriel Igwe

Project Engineer

- Senior Engineering Consultant Vosight Incorporated.
- Senior mechanical engineering consultant with ExxonMobil.
- Bsc in Mechanical Engineering from the Ohio State University.
- Mechanical engineering leader with 12 years of experience supporting large scale turnarounds, energy efficiency and process optimization. Reliability and maintainability technical guidance for petrochemical plants. Developing and delivering large scale capital projects such as Exxon Beaumont refinery and Dow Chemical Picloram facility life expansion projects.

www.eghudurefinery.com