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Concept Note for Development of Nigeria LNG Limited R&D Plan



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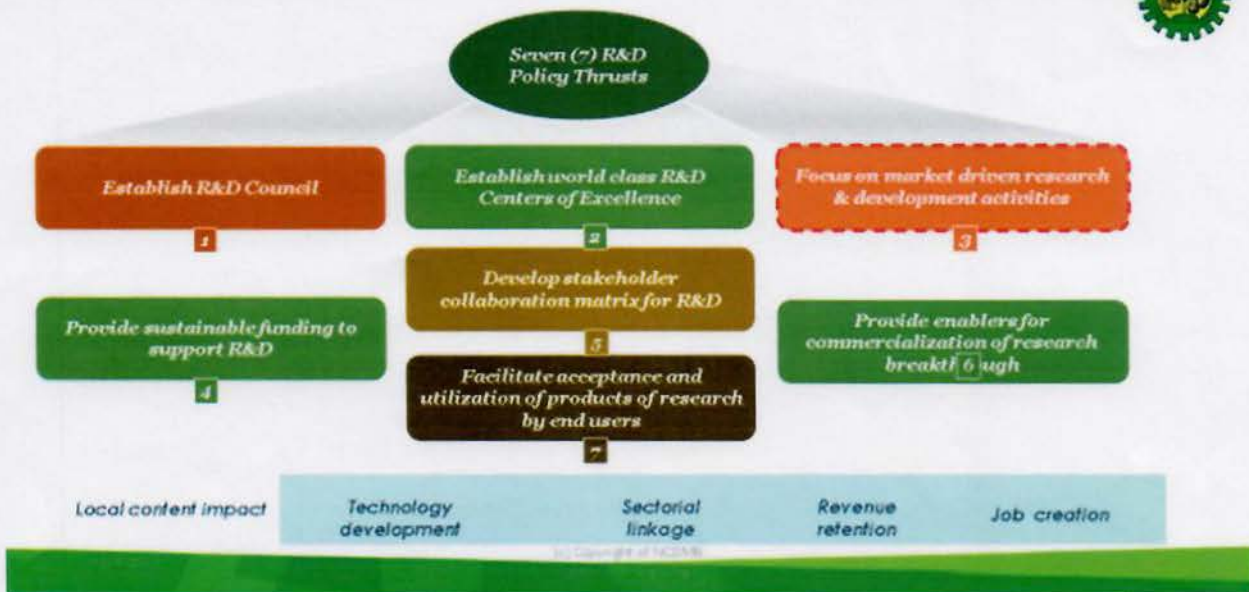


1. Introduction

This paper seeks to provide a guide to Nigerian Liquefied Natural gas (NLNG) on the development and implementation of R&D plan for the Train 7 of the plant.

The concept is intended to drive the establishment of a R&D ecosystem that will support the Natural gas plant in the construction, operations and maintenance phase. The concept is based on the NCDMB R&D framework depicted below

NCDMB R & D Operating Framework



2. Problem statement

Nigeria currently has one LNG plant with 6 trains, and arguably one of the most commercially viable ventures entered between the Nigerian Government and the private sector. However, minimal local capacity has been developed on the back of the LNG especially as regards technology adaptation and local material substitution since the delivery of the first LNG train in 1999. After 6 trains, there is need for more local content to be derived from future trains development.

The NLNG project is considered a major economic development imperative to achieve increase in national revenue and gross domestic product. For the plant to maintain the national aspirations of being a leader and trend setter in the public/private partnership model there is a necessity to develop holistic pre-plan. It is in this regard that the Nigerian Content Development and Monitoring Board is leveraging the provisions of the Section 36-39 of the NOGICD Act 2010 to guide the development and implementation of R&D philosophy for NLNG train 7.



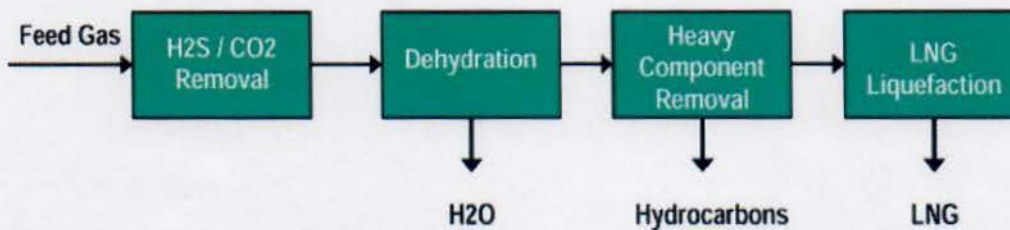
3. Liquefied Natural Gas Processing

Engineering, Procurement, Construction, Installation, Testing and Commissioning schedule for Train 7 could be about 4 years while the operations of the train could be up to 25 years and beyond. A solution center that will support the operations of LNG trains is most desirable.

Gas processing is basically a two-step process chain- cleaning the natural gas & liquefaction of the gas. A series of processing steps allows the separation and removal of the various extraneous compounds from the natural gas prior to liquefaction.

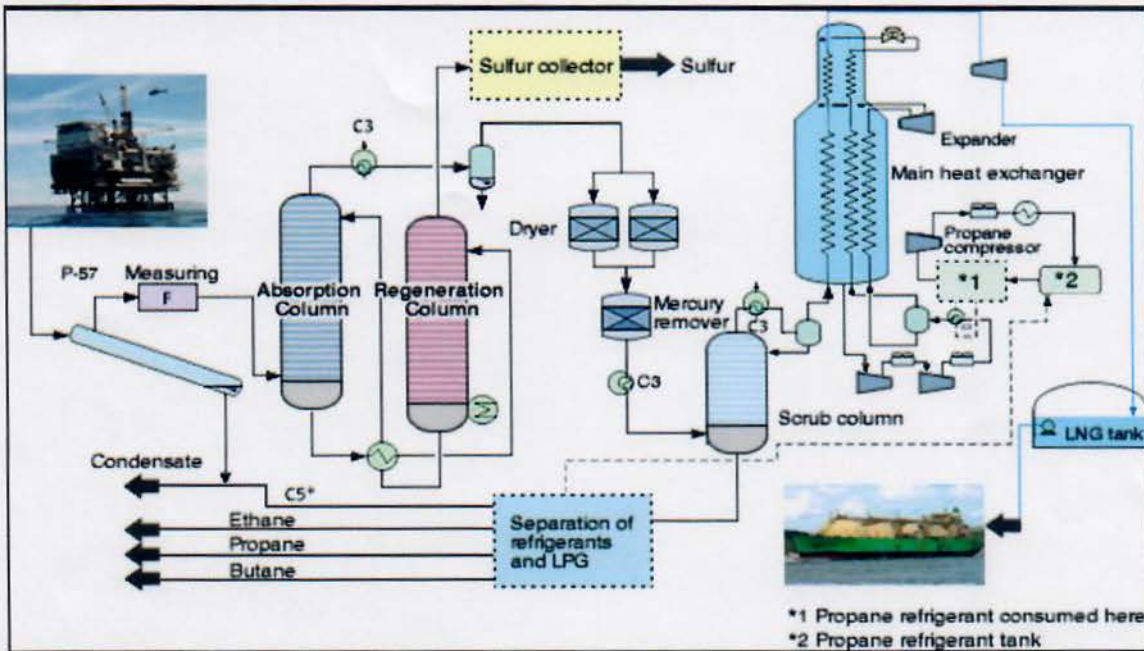
3.1 Production Purification

One of the primary purposes of the liquefaction plant is to provide consistent composition and combustion. Pipeline-quality natural gas typically contains 85% to 99% methane. It also contains the heavier hydrocarbons and other substances which are not removed during the processing. The Figure below provides a summary of the stripping process that is used to remove many of the compounds present in the feed gas as it comes out of the ground, prior to beginning the liquefaction process.



2.2 Liquefaction

Following the removal of most contaminants and heavy hydrocarbons from the feed gas, the natural gas advances within the facility to undergo the liquefaction process. The natural gas being converted to its liquefied form is almost entirely methane at this point. To obtain maximum volume reduction, the gas has to be liquefied through the application of refrigeration technology which makes it possible to cool the gas down to approximately $-162\text{ }^{\circ}\text{C}$ (-256°F) when it becomes a liquid.



Process Flow Diagram LNG

From the forgoing processes, NLNG performance metrics will include

- a. Zero unscheduled down time
- b. Deliver high quality products to customers
- c. Achieve at least 90% plant capacity utilization
- d. Optimize local content rating in the O&M operation
- e. Create robust local supply chain supporting the NLNG with services, products and manpower
- f. Maximizing stream quality (Export gas water content, condensate Reid vapour pressure (RVP), LPG mercaptan content)
- g. Achieve high equipment reliability index
- h. Attract and retain high performing team

The forgoing KPIs can be achieved with a robust R&D ecosystem supporting the LNG Operations and Maintenance

4. Pillars of the R&D Plan (NLNG center of excellence)

The pillars of the R&D plan shall be anchored around the themes of the NCDMB framework for R&D delivery:

1. R&D project – establishment of a multipurpose LNG Research and Development Center to serve as technology solution center for NLNG operations. The R&D Center shall have the following features:
 - a. Infrastructure: The Center shall be built and equipped with state-of-the-art equipment for research and training delivery in any one of the Federal Universities or Polytechnic's in Nigeria. The equipment shall comprise teaching aids including simulators, mini LNG prototype plant etc.



- b. Location: The Center may be located in any suitable Federal institution of higher learning offering Chemical Engineering or Petroleum Engineering course and located close to Nigerian LNG operations
- c. Purpose: The primary purpose of the Center shall be to carry out research and investigation on technical challenges during construction, operations and maintenance in the LNG complex. The Center will also offer technical and leadership courses for employees of the LNG
- d. Scope: The R&D Center shall consist of 5 solution centers
 - I. Materials development center– will focus on finding local substitutes for Polymeric membranes, Triethylene glycol, Deliquescent chloride desiccants, Diethanolamine (DEA), Monoethanolamine (MEA), Methyldiethanolamine (MDEA), Diisopropanolamine (DIPA), Aminoethoxyethanol (Diglycolamine) (DGA), corrosion inhibitors, octane improver.
 - II. Maintenance solution center- focus on proactive maintenance- work with the micro-LNG & NLNG maintenance units to develop a proactive maintenance culture for solving identified maintenance challenges ; and develop a local ecosystem that can assist in the development of homegrown maintenance techniques
 - III. Product development center- the solution center for product development shall focus on equipment components and spare parts required for maintenance and repairs. Of interest should be Cryogenic seals, valves, mechanical seals, crossover adapters, bolts & nuts, gears, switches, compressor spares, insulation materials, HV/LV cables, Software, instrumentation & control units etc.
 - IV. Testing & analysis center- center for testing new products and processes developed within the micro-LNG Solution Center before application in the NLNG.
 - V. Manpower training and development center - A Gas processing plant of this scale creates enormous human capacity development potential. Beyond the creation of employment for Nigerians, it is important to establish a training and development center for continuous professional development of the LNG workers. The envisaged training and development center which may be attached or affiliated to the institution of higher learning (university or polytechnic) hosting the prototype LNG plant shall also be equipped to be awarding globally recognized certificates to participants. Capacity building for researchers working within the NLNG solution center shall also be pursued in the manpower training and development center. The Australian center of LNG futures (ACLNGF) is an excellent case study where a similar center exists for training, research and demonstration capabilities.



2. Funding – NLNG shall fund the Center through annual budget provisions. The governance structure for the center shall be designed in a manner that will give NLNG oversight on expenditure and ownership of research breakthroughs
3. Collaboration: NCDMB shall assist in the establishment of collaboration network between the R&D Center, academia, product developers and relevant government agencies responsible for development and certification of products of research. The collaboration network will ensure value for money on research expenditures through approvals and application of research breakthroughs
4. Commercialization of research and development of startups- It is expected that over time the Center will achieve some research breakthroughs that may have commercial benefits to NLNG operations and other LNG plants, thereby creating income stream for NLNG R&D Center. We also estimate that start-ups will evolve from the research outcomes and these start-ups will join the pool of local supply chain delivering products and services to NLNG.
5. Compliance with NOGICD Act- the ability of NLNG to develop and implement the R&D plan will bring its operations into compliance with provisions of the NOGICD Act as it relates to R&D plans and reporting.

5. Benefits of R&D Plan to NLNG Operations

1. Minimize facility downtime
2. optimize NLNG profitability
3. Enhance Nigerian content index for NLNG operations
4. Develop pool of local supply chain entrepreneurs that will supply the raw materials, spare parts, equipment components to the gas plant
5. Create new businesses on the back of innovative research solutions that will serve the NLNG operations and other LNG plants.
6. Maintain healthy pipeline of talented workforce
7. Enhance profile of NLNG as a leader in exposing Nigerian academia to the intricacies of operations and maintenance of a fully functional LNG complex

6. Next steps

Upon alignment and approval of the concept the following are the next steps:

1. Hold meeting with NLNG to explain concept
2. NLNG to develop R&D plan along the concept
3. Develop monitoring and reporting system to track progress and report accomplishments



Approved for implementation

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