



KNOWLEDGE MANAGEMENT AND INNOVATION (KMI) UNIT

NATURAL GAS IN SOUTHERN AFRICA

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Abbreviations and Acronyms

ALNG	Angola LNG
bcm	Billion cubic metres. 1bcm gas = 0.72 million tons LNG= 0.0353tcf = 37.3PJ
Btu	British thermal unit, a traditional unit of work equal to about 1055 joules
CBM	Coal Bed Methane
CCGT	Closed (or Combined) cycle gas turbine
OCGT	Open Cycle Gas Turbine
CNG	Compressed Natural Gas
DES	Delivered ex Ship
DoE	Department of Energy
EIA	(US) Energy Information Agency (or Environmental Impact Assessment)
EDM	Electricidade De Moçambique
FID	Final investment decision
FSRU	Floating Storage and Regasification Unit
GHG	Greenhouse Gases
GJ	Gigajoules, one billion Joules [10^9 J] equivalent to 278 kWh
CMG	Companhia Limitada de Gasoduto
GTL	Gas to Liquids
GPP	Gas to Power Programme
GUMP	Gas Utilisation Master Plan
HH	Henry Hub natural gas trading marker price for the United States of America
IEP	Integrated Energy Plan
iGAS	Subsidiary of Central Energy Fund responsible for gas infrastructure development
IOC	International Oil Companies
IPP	Independent Power Producer
IRP	Integrated Resource Plan
JKM	Japan Korea Marker – natural gas trading marker price for Asia
LNG	Liquefied Natural Gas

mmBtu million British Thermal Units – a unit of energy used internationally for pricing natural gas as in US\$/mmBtu.

Mtpa Million tons per annum

MW Megawatt

NBP Natural Balance Point – natural gas trading marker price for UK/Europe

NDP National Development Plan

NERSA National Energy Regulator of South Africa

NG Natural Gas

PJ Petajoule, one million billion Joules 10^{15} J equivalent to 278 MWh

PPA Power Purchase Agreement

ROMPCO Republic of Mozambique Pipeline Company

SNG Synthetic Natural Gas

tcf Trillion cubic feet = 28.3bcm = 1.054PJ

tcm Trillion cubic metres = 724.9 million ton LNG = 35.3tcf = 37.239PJ

1 INTRODUCTION

In the space of less than a decade the status of Southern Africa in the world gas industry has moved from that of marginal producers to potentially significant ones. Major offshore discoveries, notably in Mozambique and Tanzania have put them in the position to harness natural resources for various development imperatives such as power generation, infrastructure, industrial development and employment. Developing the potential that natural gas presents has to overcome a range of obstacles, some specific to the economics of the gas industry and others that cut across national and regional development in general. Furthermore other countries are simultaneously seeking to expand their natural gas industries thereby increasing the competitive context into which new projects need to be launched.

This report examines the routes to monetising natural gas in Angola, Mozambique and Tanzania focusing on gas production and trade, LNG pipelines, gas to power markets and other industrial markets in turn. The aim of this examination is to highlight opportunities that the DBSA might pursue. Problems and obstacles for developing gas resources have purposefully been emphasized on the grounds that this approach would, hopefully, show up gaps for development financing.

Information in this report is current as at end March 2017. It is intended that this briefing paper be updated as new information becomes available in order to retain its value as an internal reference source on natural gas in the region for DBSA staff.

2 SOUTHERN AFRICA'S JOURNEY TO A GAS PRODUCING REGION

For the three countries examined in this paper, namely Angola, Mozambique and Tanzania the volume of gas resources is not a constraint to wider utilisation of natural gas. Each of these countries is attempting to transition to a significant gas producer and consumer from a low base that most notably in the case of Mozambique requires bringing on stream gas reserves that are orders of magnitude larger than the already producing fields. Monetising this new gas is the key challenge. Several common themes are present:

- there are large distances between production areas and major market centers;
- Gas production and transportation by pipeline or gasification are capital intensive investments for which scale economies are critical; and
- Many other countries and regions are also expanding their gas production capacity which feeds into softer world markets and greater difficulties in securing off take contracts necessary to commit investment decisions.

2.1 OPTIONS FOR MONETIZING GAS IN COMMON

Options to monetise gas all include the following core markets:

- Gas to power focused on domestic markets that takes into account the under provision of electricity and the imperative to harness gas as a resource endowment that could both extend electrification and reduce more costly liquid fuels use in thermal generation.
- Export via LNG plants;
- Industrial applications; and
- Pipeline exports.

2.2 GAS TRANSPORT INFRASTRUCTURE

Southern Africa lacks a developed gas transport infrastructure network. Distances between production and consumption centres are large which requires networks achieving economies of scale to be viable, yet markets are insufficiently developed to absorb economic volumes.

2.3 GLOBAL NATURAL GAS MARKET CONDITIONS

Export oriented projects are being developed at an inauspicious time for producers. As of January 2016, global nominal liquefaction capacity totalled 301.5 MTPA. Under-construction LNG capacity stood at 141.5 MTPA, a 47% expansion to installed capacity.

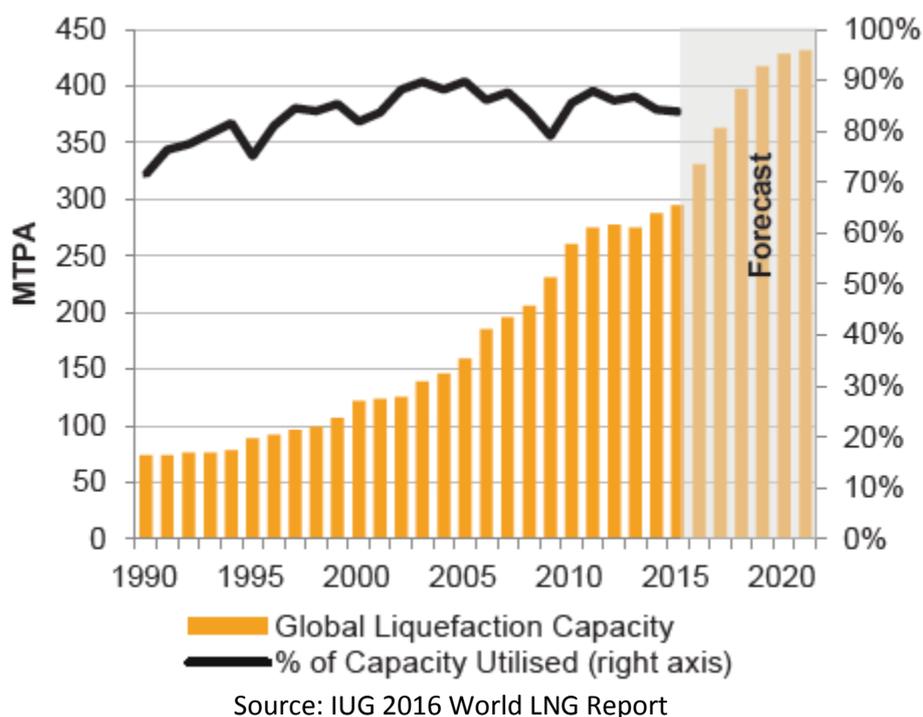
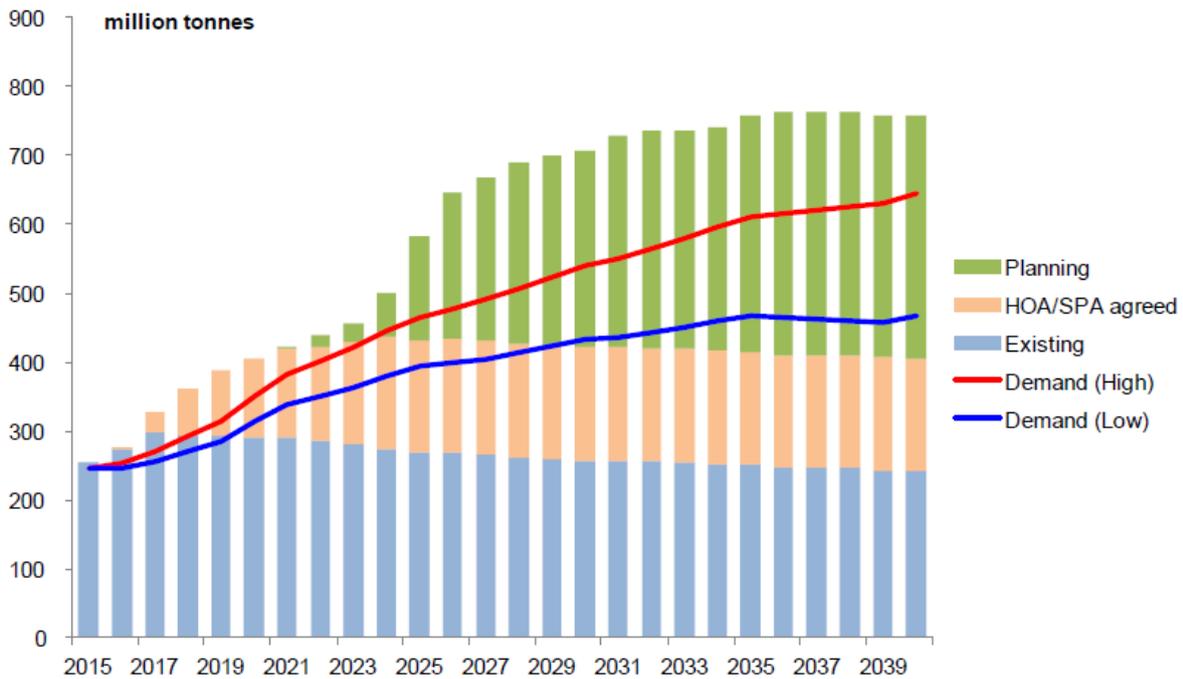


Figure 1 Global Liquefaction Capacity Build-Out, 1990-2021

Future LNG prices are of critical interest to project sponsors and financiers of new capacity. Forecasting by the IEEJ presents a high demand and a low demand view of the LNG market up 2040. It reveals that in the longer term the LNG market could treble in size with the supply surplus maintained to the mid 2020s and very likely beyond. The IEEJ maintains that forecasting LNG prices beyond 2020 is unpredictable due to the uncertainty about macro economic conditions for importing countries, the size and pace of expansion of supply capacity, price movements of energy substitutes – particularly intermittent wind for which gas is highly complementary for system balancing – and policies adopted by LNG consuming countries.



Source: IEEJ

Figure 2 LNG market balance forecast to 2040

3 ANGOLA

Angola stands out from the rest of Southern Africa as being the dominant, and indeed only oil producer. The country’s oil and gas industry started commercial scale production from the off-shore Cabinda fields in the 1960s. Angola has since developed a significant petro-economy with the attendant features of high reliance on oil sector revenues. Gas is a minor part of the Angolan oil & gas industry, although the only country in the region with an LNG gasification plant, natural gas is overshadowed by oil. BMI estimates marketable gas production for 2016 as at 3.5bcm, yet actual production will have been significantly higher, with the excess gas reinjected into oil fields or flared.

3.1 NATURAL GAS RESOURCES AND RESERVES

The natural gas reserves in Angola are estimated at 11 TCF (311 bcm) the majority of which is in associated gas. OPEC gives a 2015 figure for proven natural gas reserves at 308.1 bcm.

Gas development is held back by the fiscal and regulatory environment. Under Article 29 in the country's model production sharing agreement, Sonangol has the exclusive right to appraise, develop and produce all non-associated gas discoveries. International companies may be asked to partner Sonangol, but the nature of this involvement and the extent of potential financial returns remain unclear. There are also restrictions on foreign marketing activities.

Sonangol Natural Gas, subsidiary of national oil company Sonangol E.P maintains the lack of tax incentives in the exploration and production of non-associated gas, which implies that, if discovered, non-associated natural gas wells are likely to be abandoned by the lease blocks contractor groups.

In efforts to increase gas activity the Angolan government has announced plans to boost domestic gas production, with a focus on development of the country's non-associated gas resources. In November 2014 the national oil company Sonangol and Italian major ?? Eni agreed to a joint study of the non-associated gas potential of the offshore Lower Congo Basin. Exploration of the Lower Congo Basin could significantly increase the country's reserves base as the Lower Congo is an established hydrocarbons province and has yielded two non-associated gas discoveries in shallow waters in two lease blocks.

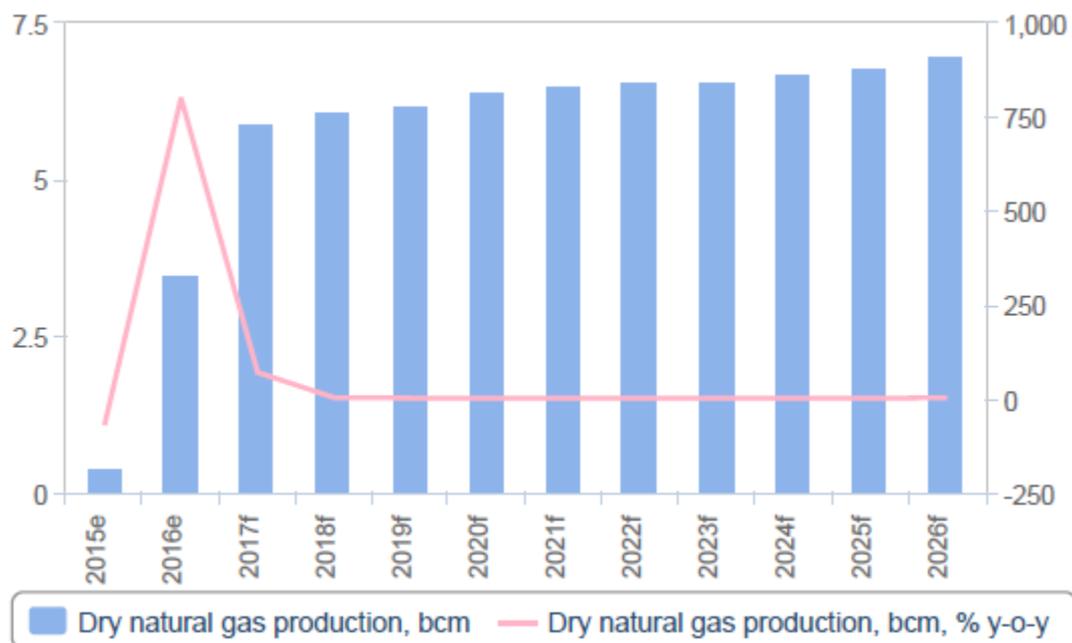
In view of the hitherto limited attention given to natural gas compared to oil in the highly prospective hydrocarbons provinces, there is a high probability that Angola's natural gas reserves will grow substantially. Prospects for monetising additional reserves in the medium term are, however, poor.

3.2 GAS PRODUCTION AND TRADE

Angola's gas industry has two routes to market for its gas. It however faces constraints in developing both of these markets.

3.2.1 LNG Exports

The country's liquefaction facility is Angola LNG (ALNG), a joint venture between the country's major producers, including Sonangol, Chevron, BP, Eni and Total. The facility has one liquefaction train with an annual capacity of 5.2mn tonnes, or 7.1bnm. ALNG came online in June 2013 but has suffered from major technical problems necessitating complete closure and an expensive rebuild and only returning to production at reduced output in 2016 and only expected to reach full capacity by 2020.



Source: BMI 2017a

Figure 3 Angolan Gas Production Forecast 2015-2026

Angola LNG has no long-term sales contracts, selling all of its gas via spot or short-term contracts. The US had been its initial target market but the advent of shale gas production has seen the demand for LNG imports to the US collapse. Directing sales to Asia and Europe will face problems from weakness in those markets.

ALNG and EDF Trading have announced that they have entered into a flexible sales arrangement for the delivery of liquefied natural gas (LNG) cargoes on an ex-ship basis (DES). The sales arrangement covers the delivery of multiple cargoes from 2016 through to 2018. This strategy assumes Asia and Latin America may offer deeper and more lucrative markets for spot trading. The result is that Angola LNG is likely to remain underused.

BMI forecasts LNG exports will plateau at some 5.5 bcm from 2017 to 2020.

3.2.2 Gas to power

Angola has constructed the Soyo combined-cycle power plant that is planned to be operational by mid-2017. The capacity of the plant will be 750 megawatts, demanding around 0.43bcm of gas per year that will nearly double Angolan gas consumption.

The Angolan government is installing high voltage power lines for the distribution of electricity from the Soyo power plant that will serve the provinces of Zaire and Luanda. Gas to power does not present a major development route for gas due to structural features in the power sector and other potential gas consuming markets. This is attributable to the following factors:

- Lack of gas pipeline infrastructure;
- Distance between gas production in the north and core consumption areas further south;
- Severe financial strain on the Angolan power utility companies due to theft of power, non-payment of bills and low electricity tariffs; and
- Heavily subsidised liquid fuels providing little commercial incentive to switch feeds.

Various other markets for gas have been proposed in the industrial sector, including urea, methanol and gas-to-liquids (GTL) facilities. However, these projects are typically highly capital intensive and in Angola would be heavily export driven. Export markets for urea and methanol are highly competitive and given the lack of gas infrastructure and the greenfield nature of the developments in Angola the feasibility of such projects appears poor.

In conclusion Angola's natural gas prospects are tied in the main to LNG exports. However, it is likely to struggle to reach full utilization from its ALNG plant.

4 MOZAMBIQUE

Mozambique has been a modest gas producer since the onshore Pande and Temane fields discovered in the 1960s were brought into production through the Sasol Rompco pipeline to South Africa in 2004. The discovery of major gas reserves in the offshore Rovuma Basin in 2009 has led to the recalibration of Mozambique as a major natural gas resources country, and ranked first in Southern Africa.

4.1 NATURAL GAS RESOURCES AND RESERVES

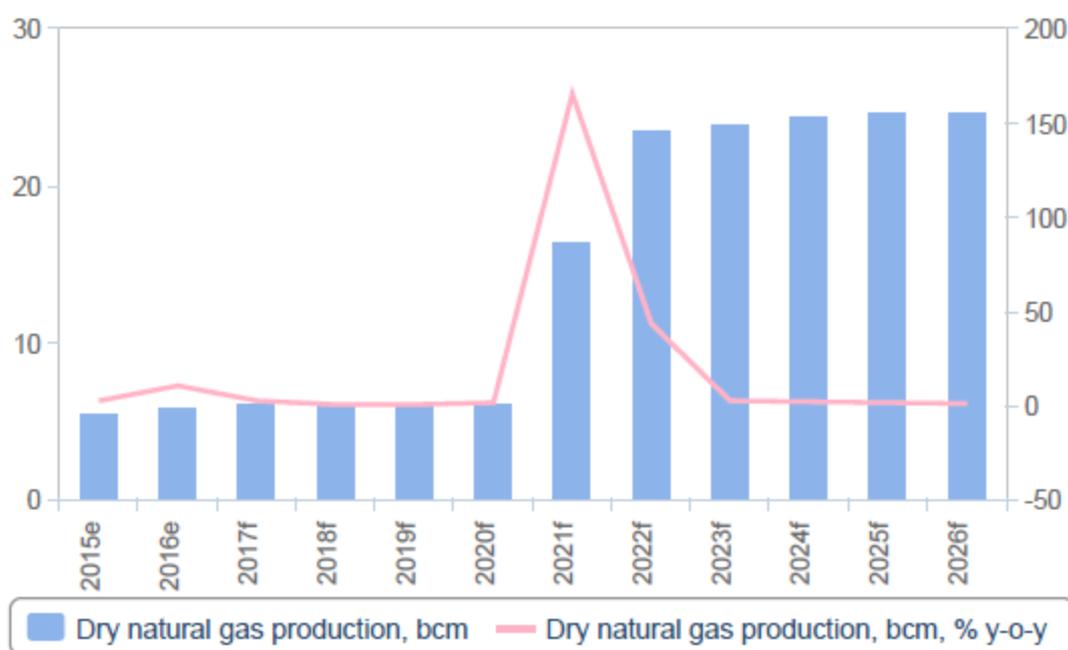
Mozambique's official proven gas reserves have jumped from a mere 130 billion cubic metres (bcm) in 2013 to 2.83 trillion cubic metres (tcm) as of early 2016, according to US Energy Information Agency (EIA) data. This is as operators book large offshore gas discoveries as official gas reserves following appraisal activities.

In view of the size and scale of discoveries to date, the highly prospective nature of the hydrocarbon provinces and with the region remaining relatively underexplored the national energy company Empresa Nacional de Hidrocarbonetos (ENH), estimates that reserves could be in the range of 7tcm are credible.

Anadarko and Eni, the major IOCs operating in Bavuma have both completed their appraisal campaigns and are proceeding to book reserves as proven ones. Recoverable reserve figures will continue to rise as a result of reserve booking, but the final figures to be booked as recoverable reserves will be subject to fluctuations over the coming years due to market and technology changes. What is clear is that operators have sufficiently proved up the region's resources to support substantial LNG projects. The key unknown is the timing of the first LNG which is showing itself to be difficult to predict with accuracy.

4.2 GAS PRODUCTION AND TRADE

Mozambique currently produces about 6bcm pa of natural gas existing and in other small fields. Volumes are expected to grow modestly until the end of the decade but expand rapidly, as much as treble, as offshore gas fields come online to supply LNG projects. The outlook for gas in Mozambique is therefore essentially about developing a credible view on when LNG will flow from the major offshore fields. Successive delays have pushed out estimates for first production and make credible timeframes difficult to construct.



Source: BMI 2017b.

Figure 4 Mozambique Gas Production Forecast 2015-2026

4.2.1 Pipeline exports

Monetisation of Mozambique gas was first achieved from the onshore Pande and Temane fields developed by Sasol. Most of the dry natural gas is exported to South Africa via the ROMPCO international gas pipeline. Current pipeline export is some 3.65 bcm. Those fields have an estimated end of life around 2027, and Sasol is therefore actively exploring adjacent blocks.

Development by Sasol and its partners around the Temane fields in the Inhambane province has moved onto engineering design to handle wet and dry gas as well as LPG. Most of the gas will go to a 400 megawatt (MW) power plant in Maputo with the rest destined for third-party customers using the ROMPCO pipeline.

Reserves in the B?avuma basin are large enough to support multiple routes to valorize them so the possibility of pipeline exports continues to have support, albeit with obvious reservations. South African energy company SacOil announced a proposal for a USD6bn, 2600km gas pipeline that will take gas from the B?ovuma Basin to South Africa. In addition to exporting gas to South Africa, the pipeline will enable the export of gas to the rest of Mozambique to feed the planned gas-based industries such as fertiliser production and power generation. SacOil has seemingly withdrawn from the project, displaced by Mozambican companies including Empresa Nacional de Hidrocarbonetos, Profin Consulting, Sociedade Anónima. The China Petroleum Pipeline Bureau, a subsidiary of the China National Petroleum Company (CNPC) is to lead to project.

Uncertainty about the project's feasibility have pushed out announcements of starting dates for the project. The key problem is the lack of prospective gas off takers in both Mozambique and South Africa. The economics of a 2,600km pipeline require high volumes and there is no obvious anchor project in either country. To illustrate the scale required it has been argued that a 5000MW gas powered station in South Africa would be required as well as to operate at high rates of utilization as a base load station. Proponents of large scale pipeline projects point out that wider availability of gas in South Africa would widen options for the chemicals industry using it as a feedstock. However, it would face hurdles to displace coal which is available at lower cost. Therefore the prospects for new pipeline exports from Northern Mozambique appear poor.

4.2.2 Awaiting LNG Exports

LNG exports will move Mozambique into the mainstream of natural gas producing countries and allow the country to monetise substantially more of its natural resource endowment. Plans for both FLNG and onshore LNG plants are underway.

Offshore

Eni obtained government approval for the Coral FLNG development plan in 2016 for the first phase of the discovery as a 3.3bcm pa floating gasification project. Coral has the advantage of being an independent field. This project is being de-risked through a combination of features:

- Highly experienced design and engineering firms selected for building the FLNG;
- Selection of a hull not barge format which will allow more rapid construction; and
- An offtake agreement for the entire volume of LNG produced by Coral signed with BP for a 20 year period.

The start-up of the Coral FLNG project has been pushed back after constant delays to the final investment decision (FID). Eni's Board of Directors approved the investment plan for the project in Q416 with other project partners following suit save the China National Petroleum Corporation ?? something missing with the sentence(CNPC). Provided CNPC gives approval, FID is expected shortly thereafter. The delays to the FID have pushed back the startup of the 4.6bcm project to 2022.

Onshore

An onshore terminal would allow the monetisation of the Mamba/Prosperidade complexes shared between Eni and Anadarko. In December 2012, the two companies signed a Heads of Agreement (HOA) foreseeing separate yet coordinated upstream development of the common gas resources in their overlapping lease areas, as is required by Mozambican law. Production envisages the construction and commissioning of two 10mntpa onshore LNG trains (6.9bcm each). The plans also provide for two additional trains to be constructed shortly after the first pari, raising capacity to 20mntpa (27.6bcm). Phasing in the LNG project two trains at a time should allow for a quicker construction to delivery time and the opportunity to build up the facility in reaction to global demand.

From the host country's perspective onshore LNG plants have the advantage of creating greater local economic linkages, employment and infrastructure. At the same time they have to overcome location specific obstacles, which in the case of the B?avuma basin includes:

- The absence of infrastructure, namely a lack of roads, adequate power, ports, amenities for the workforce which will raise costs and could lengthen delivery periods;
- Shortage of skilled labour; and
- Funding social programmes to benefit affected communities.

Postponements to lodging development plans have indicated for some time that the schedule for Afungi LNG was experiencing problems relating to the scale and logistical difficulties of developing this as a greenfield site.

Timing now envisages FID in mid-2018 with the project to come online in 2023, which has been pushed back from the original 2022 start-up date.

The latest development involves ExxonMobil buying a 25% indirect interest in Eni's Area 4 for USD2.8bn. Under the terms of the agreement Eni will continue to lead the Coral FLNG project and all upstream operations, while Exxon will take control of the construction and operation of the onshore LNG project. Exxon involvement strengthens the project. BMI reports that the partners have so far managed to secure 80% of takeaway capacity in non-binding long-term commitments. Given the current loose market conditions, securing firm commitments will be difficult.

4.2.3 Gas to power and domestic consumption

The geographic distribution of gas fields and the existing pipeline infrastructure support the intention of the Mozambican government to pursue a number of gas fired generation projects to expand access to electricity within the country.

Electricidade De Moçambique (EDM) has started building a 106MW gas-fired power plant fed by the ROMPCO pipeline near Maputo. The plant, which will be connected to the national grid, is expected to start operating by August 2018. The USD180mn project received a USD167mn loan from the

Japan International Cooperation Agency (JICA) at an annual interest rate of 0.01% payable over 40 years, including a 10-year grace period.

Mozambique's Gas Master Plan has identified potential domestic industries that could use natural gas outside of LNG and power generation. A further upside comes from major planned industrial projects that would take advantage of gas as feedstock. According to a report prepared for the government of Mozambique under technical aid from JICA, demand from gas-to-liquids (GTL), methanol, fertiliser, LPG, pipeline and power projects could reach up to 22.2bcm. This represents a long term view which must be tempered by the current market conditions and low gas prices. However, Mozambique holds much potential for developing a significant gas consuming industrial base in time. In the region it has a several year lead over Tanzania in developing offshore gas reserves which might favor the economics of an export oriented bulk chemicals project.

5 TANZANIA

Major gas discoveries have also been made in the Tanzanian portion of the B?avuma Basin which has substantially altered the resource profile of Tanzania, moving it from a minor producer to a potential LNG exporter. It is uncertain when Tanzania will realize its planned LNG export ambitions as these have been put on hold for the next five years. The distinguishing feature of the Tanzanian gas sector in policy and regulation is the focus on the domestic power market.

5.1 NATURAL GAS RESOURCES AND RESERVES

Tanzania discovered gas in 1974 on the Songo Songo Island followed by a second discovery at the Mnazi Bay in 1982. The Songo Songo natural gas was commercialised in 2004 and that of Mnazi Bay in 2006. These fields comprise 2 TCF of reserves directed to the domestic power market. Exploration work around the country and the substantial discoveries in the B?avuma basin now place total unproven reserves at more than 50 TCF.

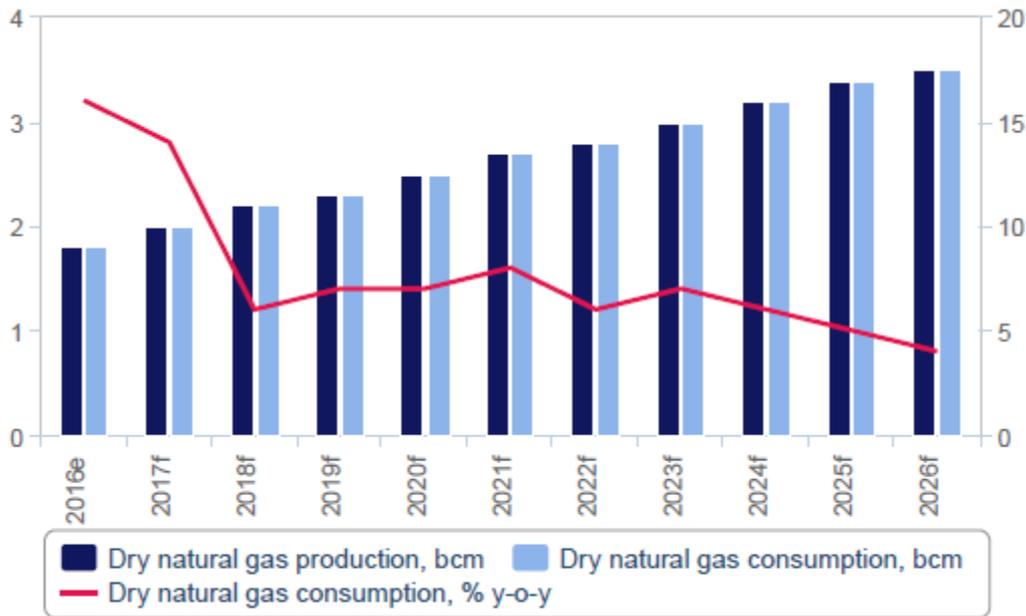
5.2 GAS PRODUCTION AND TRADE

Tanzanian gas production is forecast to grow from current levels of 1.8bcm pa to 3.5bcm pa by 2026 according to BMI. Production growth will be incremental increases from the existing Songa Songa and Mnazi Bay fields.

5.2.1 Pipeline trade

Tanzania producing fields deliver gas by pipeline. The Songo Songo gas field is producing at a rate of 2.0-2.5mn cubic metres per day (Mcm/d) and pipes gas to the Songas Ubungo power plant in Dar es Salaam. Production growth will be constrained by the limited midstream and processing infrastructure.

Output from the Mnani Bay fields is delivered by pipeline to the Mtawara Power Plant and also the Mnazi Bay to Dar Es Salaam Pipeline.



Source: BMI 2017c

Figure 5 Tanzania Gas Production And Consumption Forecast 2016-2026

5.2.2 Distant LNG Exports

The final investment decision (FID) for Tanzania's onshore LNG export facility has been delayed for a minimum of five years and possibly longer according to Statoil, a stakeholder in the project. The export terminal will have capacity of 13.8 billion cubic metres (bcm) and will be owned by Shell, Ophir Energy, Statoil and ExxonMobil. Once the FID has been granted, construction will take five years, therefore even in the best case scenario the facility will not be operational until the late 2020s

The project partners - BG Group (Shell), Ophir Energy, Statoil and ExxonMobil - have delayed FID as a range of legal and regulatory uncertainties continue to hamper progress. Most critical has been the delay in the passage of the country's Natural Gas Act. In July 2015, the Act was abandoned and the country's natural gas policy has instead been subsumed with the Petroleum Act 2015. However, several key fiscal and regulatory uncertainties remain, including those relating to taxation, domestic supply obligations, and local content requirements. Further clarification will be needed before a FID can eventually be taken (BMI 2017c).

5.2.3 Gas to power and domestic consumption

Government policy plans to install an additional 1,500MW of new gas-fired generation capacity in the period up to 2020. The government also hopes to significantly boost electrification rates - which currently stand at 24% - and ease reliance on the country's cost-inefficient diesel generators. Tanzania plans to continue investment into necessary transmission and distribution infrastructure that will connect a large share of the population to the grid, thereby increasing demand for natural gas over time. In September 2016 a plan to connect gas-rich regions of Mtwara and Lindi to the grid was announced.

The 240MW Kinyerezi combined cycle natural gas plant under construction by project developer Sumitomo Corporation is proceeding. Once complete, the plant will be the largest in the country and will supply 20% of the country's power generating capacity. It is expected to come online in 2018.

This drive to develop a significant gas fired power capacity faces two major hurdles that will cap consumption growth in the power sector, namely small domestic gas output, and a lack of midstream infrastructure. First, small domestic output is a major constraint. Tanzania has no gas importing/ation?? capacity and the power sector will rely on increased production domestically for feedstock. However, production growth will be limited, driven by the development of marginal offshore fields such as Mnazi Bay and Kiliwani North. Potential onshore gas resources may be developed, however the core reasons that have led to the postponement of the offshore development weigh against that occurring.

Second, the lack of pipeline capacity to connect new gas production to the domestic power sector is a key issue. Slow infrastructural development has weighed heavily on marginal offshore field developments and is a major threat to the security of feedstock supply for new gas-fired power plants. There is a significant risk that new power plants could remain relatively underutilized in the short to medium term.

6 IMPLICATIONS AND OPPORTUNITIES FOR THE DBSA

In a 2015 report on Investment Opportunities in the Oil and Gas Sector in Sub-Saharan Africa prepared for the DBSA, Frost & Sullivan (2015) recommended:

For an investor like the DBSA, Frost & Sullivan would recommend investing in long-term debt facilities related to oil & gas projects in the midstream and downstream sectors. Frost & Sullivan tends to believe that midstream projects such as pipelines and storage facilities present less complexity, and thereby less risks, as opposed to upstream and downstream projects. Nevertheless, downstream projects with strong fundamentals should also be considered (Frost & Sullivan 2015:66).

Results from the three country examination above suggests that this view has merit from a risk exposure perspective, yet it is not particularly helpful in directing DBSA on where to focus attention. Two cross cutting themes stand out from all the country reviews above:

- First, that network gaps are significant infrastructure constraints, both in the form of pipelines and their complement namely electricity transmission networks.
- Second, the new onshore facilities needed for LNG production from the B??avuma basin will need infrastructure to supplement the production works to be constructed by the primary developers.
- Finally, financing of gas to power projects or infrastructure ancillary to such projects will continue to be an important focus area.

7 CONCLUSION

Infrastructure financing opportunities within the mandate of the DBSA that may be created by the gas development activities taking place in the region need to be considered in the following three areas:

- Building out networks, both pipelines and transmission networks;
- Filling gaps on greenfield development; and
- Financing of gas to power projects.

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