EAST AFRICA — OPPORTUNITIES AND CHALLENGES FOR LNG IN A NEW FRONTIER REGION

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KEYWORDS: deepwater, frontier, integrated project, LNG

ABSTRACT

BG Group has for some time recognised that East Africa presents an exciting opportunity as a relatively unexplored frontier play with material resource potential, stable and progressive governments, favourably located for Asian Pacific LNG markets. Recent material discoveries in the deep/ultra deep offshore have confirmed the region as a new exploration hotspot. In the last 20 months, BG Group has farmed into three blocks in Tanzania, equivalent in size to 140 UK blocks, and into two blocks in Kenya. It has completed an initial three well programme in Tanzania under the initial operatorship of Ophir and, following transfer of operatorship to BG Group in mid 2011 and establishment of a significant presence in country, is now in the middle of a second drilling campaign. The four deep water frontier wells drilled so far have discovered material, high quality gas reservoirs, representing a 100% success rate. Discovered resources are well on the way to confirming potential for a world scale LNG project. This paper gives an overview of BG Group's progress so far in developing its East African opportunities and the challenges of setting up a successful E&P business in a region remote from oil and gas industry infrastructure. It reviews the role that LNG can play in the sustainable development of the region and the likely challenges ahead on the road to setting up a LNG project in this new frontier area.

I. INTRODUCTION/BACKGROUND

BG Group has recognised for some time that East Africa presents an exciting opportunity as a relatively unexplored frontier play, with material resource potential and stable, progressive governments. The region is also favourably positioned to access robustly priced Asian Pacific LNG markets. Recent material discoveries in the deep/ultra-deep offshore have confirmed the region as the world’s newest exploration hotspot and a prime target for the next wave of LNG developments.

In June 2010 BG Group farmed into three blocks in Tanzania. BG Group, with its partner Ophir Energy, has completed an initial three well programme in country under the initial operatorship of Ophir Energy; and following transfer of operatorship to BG Group in mid-2011 is now in the middle of a second drilling campaign in which four exploration and two appraisal wells have been drilled. All the deep water frontier wells drilled so far have discovered material, high quality gas reservoirs, representing a 100% success rate. Discovered resources are well on the way to confirming potential for the development of a world scale LNG project. Further drilling campaigns in 2013 and 2014 are planned for offshore Tanzania, which could further enhance projected plans.

BG Group also has extensive offshore acreage holdings spread across Kenya and Madagascar with two large exploration blocks in Kenya and a non-operated position offshore Madagascar. Drilling programmes for offshore Kenya are in the preliminary planning stages and will be conducted in late 2013/early 2014.

From a geophysical data acquisition perspective, BG Group and its co-venturers have acquired in excess of 18 000 km² of 3D seismic in the region. Over the next six months BG Group plans to acquire a further 2 500 km² across the inboard area of Block 1, offshore Tanzania.
In summary, this paper gives an overview of BG Group’s progress so far in developing its East African opportunities with emphasis on the developing Tanzania story and the challenges of setting up a material business in a region remote from oil and gas industry infrastructure. A summary of the global LNG market going forward is provided along with the opportunities for East African LNG developments to access this market. The likely challenges ahead on the road to setting up an LNG project in this new frontier area are covered in addition to a review of the role that LNG can play in the sustainable development of the region.

II. OBJECTIVES

The primary objectives of this paper are outlined as follows:

- provision of an overview of the BG Group led exploration thrust in the region to date and the geologic nature of the discoveries, along with a review of future seismic acquisition and drilling plans;
- prospective development scenarios taking into account reservoir characteristics, nature of offshore and on-shore facilities and site selection;
- the potential competitive advantages that East African locations may have in a rapidly expanding Asian Pacific LNG market; and
- the benefits that could accrue to the Governments and people of this region provided the forecasted revenues and cash flow are managed appropriately and the people of the region take full advantage of employment and investment opportunities during the construction phase(s) of the project.

III. EXPLORATION AND APPRAISAL TO DATE

East Africa is emerging as a new and potentially highly significant hydrocarbon province. Based on a regional evaluation, BG Group recognised the prospectivity of this frontier fairway and moved quickly to secure deepwater offshore acreage in Tanzania and Kenya. A strong acreage position was established ahead of the recent high profile discoveries in the region and subsequent industry interest. In June 2010 BG Group acquired a 60% interest in three large, unexplored, deepwater blocks in the Ruvuma Basin, offshore
southern Tanzania, in water depths between 200 and 3 200m. This was followed in early 2011 by the award of two blocks offshore Kenya, in water depths between 500 and 1 900m.

In Tanzania, BG Group and its partner Ophir Energy have invested in excess of US$800 million in a fast track exploration and appraisal programme spread across the three blocks. The results have been hugely successful with nine consecutive successful wells. Gas discoveries have been made in all three blocks of BG Group’s operated acreage (Figures 1 and 2). These discoveries are in slope channel sandstone reservoirs from Turonian to Miocene age at depths below sea level from 2 500 to 4 700m. These are some of the first deepwater wells ever drilled in Tanzania and mark an important milestone in oil and gas exploration in East Africa.

Figure 2 exhibits the wells and discoveries to date offshore Tanzania.

Figure 3 shows an example seismic line illustrating the response around the Jodari-1 exploration well. Broadly speaking, the yellow events are the top of gas-bearing sands and the red events are the base of gas-bearing sands or gas-water contacts.

Critical to the 100% exploration drilling success to date has been the rapid acquisition, processing and interpretation of a large volume of high-quality long-offset 3D seismic data. By April 2013, in excess of 13 500 km² of data will have been acquired over the three blocks. This high quality dataset, combined with the application of a variety of interpretation techniques, represents a step change in subsurface understanding compared to the 2D data available previously.

Further exploration and appraisal work is ongoing. The first drill stem testing programme undertaken offshore Tanzania began in late January 2013. The ongoing appraisal programme will provide an improved understanding of the gas discoveries to date and will help shape the overall monetisation strategy. A successful programme will help confirm significant natural gas reserves capable of underpinning an international scale multi-billion dollar LNG export project.

Figure 2: Location Map of BG Group Operated Blocks in Tanzania showing discoveries as of January 2013
In Kenya, BG Group has acquired 4,670 km$^2$ of 3D seismic data and has recognised both carbonate and clastic plays with encouraging prospectivity. The first drilling campaign in this acreage is planned for late 2013/early 2014.

**IV. DEVELOPMENT OPTIONS & SITE SELECTION**

**Offshore Pre-Development Activities**

From a development perspective, there are many challenges to overcome before the discovered resources can be commercialised. In addition to the commercial challenges of having a plethora of arrangements in place to facilitate the processing, allocation, transportation via ships and marketing of the LNG, there are many technical challenges and decisions to be made before a project can be sanctioned. These broadly fall into three categories: the development of the reservoir; the offshore facilities and processing; and the LNG plant.

**Reservoir Development**

In themselves, the discovered reservoirs are not particularly complex geologically, they reside only 1,500 to 2,500 m below the sea-bed and comprise highly permeable massive sandstones which were deposited in deep marine channel systems. They are normally pressured, relatively low temperature and contain dry gas with little or no contaminants. The hydrocarbon pools are large and multi-TCF in volume although the average gas column thickness is in the range of 40 to 50 m. Therefore, the greatest subsurface challenge is to design high deliverability wells to minimise the well count and maximise the recovery, while at the same time effectively managing the risk of water and sand production. The detailed design for each type of well will need to be considered and evaluated to determine the most effective completion design using screens and/or gravel packing solutions. Particular attention will be required with regard to the exact positioning of the wells in the reservoir in order to drill large horizontal drainholes to minimise drawdown, while evaluating opportunities to cluster wells at the seabed to optimise the subsea layout and production gathering system.

The main drilling challenges associated with the wells are related more to the extreme water depths (1,000 to 2,200 m) than the depth of the reservoir below the sea-bed. In fact in some cases, the limited distance between the sea-bed and the reservoir creates challenges with the placement of horizontal wells in terms of directional control and high build rates in relatively soft rocks.
**Offshore Facilities**

The key challenges with the design of the offshore facilities are the extreme water depths and the distance between the discovered fields and the land. While the use of a Floating Liquid Natural Gas (FLNG) option eliminates the problem of distance from land, it does not eliminate the water depth challenge; however the approach is still under consideration. Key elements in the design of the offshore facilities are the requirement for on-shore or offshore compression and the timing of when it will be required, and also a judgement surrounding the relatively unproven technology such as sub-sea compression. In these water depths there are restrictions on pipeline sizes which in turn impact on the compression requirements and the overall flow assurance considerations.

Options for the configuration of these facilities are still under review but BG Group will consider sub-sea only solutions controlled and monitored from the beach, and the use of a floating deep-water production unit (FPU). An FPU would be moored adjacent to the field and would be used to control the wells, provide some limited processing capability and cater for future compression capability. The ability to operate these facilities safely and reliably will be key criteria by which these decisions will be made when further information relating to reservoir properties and the location of the LNG plant are known in the future.

**Site Selection**

In the case of an on-shore LNG export plant the choice of the LNG site is critical. This process has started and a number of locations from Dar-es-Salaam to Mtwara in the south of the country are being evaluated for their potential as export LNG terminals.

The critical path through a project of this type is nearly always through the site selection, site data, consultation, permitting and site acquisition processes. The location of the terminal is a major cost and schedule driver and the local conditions relating to logistics, constructability, environmental and marine operations are important to understand. An LNG project is not a process project – it is an infrastructure project.

Initially, our site selection process made extensive use of GIS mapping and publically available data and considered both technical and social performance issues. On the technical side, considerations were land availability for multi-train plants, proximity to deepwater, sheltered sites and the topography and geology of the proposed sites. On the social side, consideration has been given to cultural heritage, host communities and coastal access, environment (species and habitats), noise, emissions and nuisance. Considering all the factors early and consistently through the site selection process will ensure that the project will comply with not only BG Group standards and local laws, but the World Bank Guidelines as well. A comprehensive Environmental and Social Impact Assessment (ESIA) will also be carried out by a reputable environmental consultant at the appropriate time. This will include a comprehensive assessment of a basket of issues including land acquisition and involuntary resettlement, biodiversity conservation and sustainability, management of living natural resource, indigenous people and cultural heritage.

Having shortlisted a number of a sites, a more comprehensive evaluation is required to choose the optimum site location. Our most recent work has involved collecting detailed information, particularly with respect to bathymetry, geotechnical and social and environmental factors with a view to choosing one site later in the year. In all cases, a significant amount of national and local engagement will be required to ensure the project is successful.

**V. GLOBAL LNG CONTEXT**

Over the next decade or so the LNG industry faces a supply challenge of increasing magnitude as the gap between expected demand and supply from existing supply projects and projects under construction continues to widen. By 2025 global LNG demand is expected to reach around 440 mtpa compared to a supply capacity of around 270 mtpa based on projects currently in operation and projects currently under
construction. This will leave a supply-demand gap of around 170 mtpa in 2025, a gap equal to the entire size of the LNG trade as recently as 2008.

The majority of the demand gap will be located in the Pacific Basin (east of Suez) where the forecasted top four importers of 2025: Japan, China, South Korea and India, will be located. In 2025 the Pacific Basin will account for an estimated 74% of total global demand, compared to 63% in 2010. Despite the dominance of the Pacific Basin markets, LNG demand is expected to continue to grow in the Atlantic Basin (west of Suez) as well. LNG demand growth is also forecast for Europe and South America over the period to 2025; albeit at lower volumes than in Asia (the figures in this demand outlook have been based on BG Group’s interpretation of the Wood Mackenzie global LNG tool, November 2012 data-set).

Recent growth in LNG supply has been underpinned by significant growth in two supply locations in particular, Qatar and Australia, which between them account for nearly half of existing capacity and capacity under construction. The contribution of these two locations is even greater when considered in the context of supply growth, representing almost 80% of supply growth since 2007. Until recently a key question for the supply-side of the industry was “Where is the next Qatar?” With 13 LNG trains currently under construction and one FLNG unit under development, it has become apparent that the answer is Australia and the question has moved on to “Where is the next Australia?”

One of the answers to that question is almost certainly East Africa, which over the past two years has seen the discovery of a significant natural gas resource in Mozambique and Tanzania. The speed with which this new resource has emerged has been staggering. The first discovery in Mozambique was announced in February 2010. Since then the participants in offshore Blocks 1 and 4 have announced over 120 Tcf of reserves based on Anadarko and ENI press releases. Tanzania has also had exploration success with circa 20 Tcf of gas discovered across all offshore exploration blocks.

![Figure 4: Global LNG supply demand outlook](image)

In addition to representing a prolific new gas resource that could feed multiple LNG export schemes in the region, East Africa is geographically well placed to supply multiple markets. It is extremely well located in respect to west coast Indian markets at 2 432 nautical miles (nm) and the emerging markets of S.E Asia at 4 057 nm to Singapore. It is also broadly equidistant from the key markets of north-east Asia and north-east

Source: BG Group interpretation of Wood Mackenzie data (Nov 2012)
Note: supply adjusted by BG Group to account for chain losses
Europe, at 6 747 nm to Tokyo and 6 151 nm to the United Kingdom. East Africa is thus a similar distance from the markets as middle-east based exporters and like these exporters is well placed to supply into either market on a long-term basis or in response to short-term market fluctuations (all shipping distances reference: Dataloy).

The projects currently under development in East Africa are emerging at the same time as we are seeing the potential for significant new supply positions to be developed in the US and Canada. In the US twenty-four applications (this includes one expansion application and one duplicate application for the same terminal, Lake Charles) have been filed with the U.S. Department of Energy (DOE) to export over 210 mtpa; one project has already taken Final Investment Decision (FID) for 9 mtpa and is expected to sanction an additional 9 mtpa in 2013. In Canada there are approximately 45 mtpa of projects proposed with at least one project expected to take FID in 2013. In addition Russia, Nigeria and Alaska all continue to progress LNG export plans, while a number of existing plants are planning expansions. The new projects in East Africa will have to be mindful of this competition as they develop, ensuring a timely, customer-focused and cost-effective execution.

VI. POTENTIAL ECONOMIC IMPACT OF A LNG PROJECT IN TANZANIA

East African countries have experienced significant economic progress in recent years but remain at a fairly modest level of human development with Kenya, Tanzania, Madagascar and Mozambique ranking 143,152,151 and 184 respectively out of 187 countries in the United Nations Human Development Index (UNDP, 2011). Taking Tanzania as an example, the presence of significant gas discoveries to date enables the country to contemplate the development of the first phase of a multi-train LNG export project. The development of such a project in a relatively undeveloped country has the potential to transform the economy. This creates many challenges and opportunities for a developing economy.

Existing production, stranded near shore gas and the recent deepwater discoveries are well positioned to provide sufficient gas for medium to long term requirements for both domestic and export markets. In October 2012 the Tanzania Petroleum Development Corporation estimated on-shore and offshore gas resources to be up to 25 tcf. Further exploration drilling planned for 2013 and 2014 by BG Group and other players in the region should add further to the discovered resources.

A potential two train LNG project, given the discovered resources to date, could contribute anywhere between US$2 to 5 billion per annum to the Tanzanian economy at plateau. This forecasted revenue at the lower end of the scale is equivalent to 20% of the present annual budget of the Government of Tanzania. There are several sources of income available to a Government from a major project such as an LNG deep water development. This can be via direct and indirect taxes that can be aggregated to provide revenue to the State. Direct benefits include Government take from the upstream and midstream project, taxes paid by employees, retained national income and expenditure and foreign direct investment. Indirect benefits include induced and multiplier impacts such as net salaries in the local economy being spent into the local economy and creating further employment and taxation. Although not yet fully quantified by BG Group, further effects may be present from lower debt and debt service costs and increased capacity in the workplace.

During the construction phase of a LNG project there could be 3 500 to 5 000 people directly engaged in building the plant; of these, some 80% would be skilled technicians to professional staff. To maximise the use of national staff requires cooperation with the Government and support from Investors to ensure that the appropriate pre-investment in training and skills development is undertaken. Appropriate local content strategies can also assist in this objective. Phasing of the initial trains and continued exploration success can extend the numbers directly engaged. As Figure 5 shows, indirect employment is more significant through local companies in the supply chain. Studies conducted on behalf of BG Group indicate that job creation would average 8 400 jobs per year in the projected plant size and project presented. This is significant in the Tanzanian context based on an average local expenditure of US$170 million per annum.
However, large construction projects in other industries have seen significant shanty towns and unplanned development grow around work sites that may ultimately provide only transitory indirect employment adjacent to the site. This negative element must also be carefully managed. In addition, the enduring growth in indirect employment can end up located elsewhere in the supply chain.

Figure 5: Direct and Indirect Employment for a notional 2x3.7mmtpa LNG plant. For every one worker directly employed in the plant, some five to six indirect or induced jobs are created.

East African Governments, including Tanzania, are aware of the challenges ahead in ensuring that all the right policies, systems and regulations are in place to ensure a mutually beneficial outcome to both the in-country populations and the multinational investors. Investors therefore have to play a significant role in working hand in hand with Governments to achieve long term success. In Tanzania, BG Group and its partners have begun this process, recognising that while this is just the beginning, it is important that a solid foundation of partnership is developed from the onset. Initial programmes include:

- a build-up of stakeholder relationships across the full spectrum of Government agencies and state organisations;
- utilisation of study groups to assess the economic impacts of potential LNG projects in country (examples of which were provided in the foregoing) and identify what measures need to be in place to enable Tanzanians to benefit from deep water LNG;
- engagement with international institutions e.g. the World Bank and International Monetary Fund to focus on a joint approach to infrastructure development and planning;
- launching of awareness programmes for the media and other key professions on the oil and gas industry;
- progressing and funding of key social performance initiatives especially around areas of activity e.g. Mtwara in south Tanzania; and
- development of a strategic social investment portfolio focused on vocational education training, higher education opportunities and capacity development.

In addition, the discovery of vast natural resources in the region has created extensive debate on the nature of industrialisation to be implemented. Extensive discussions on the development of fertiliser plants and power generation utilities are not surprising given the food challenges and shortage of domestic and industrial power in the region, especially in Tanzania. While deep water LNG projects in the area can represent a step change in economic development of the region, the road to this successful outcome must also take into account the present day challenges. BG Group is therefore addressing these near term challenges with stakeholders via technical and professional exchanges.
VII. SUMMARY/CONCLUSIONS

In order to bring an LNG project in East Africa to FID, BG Group and its partners are required to implement several work streams in parallel. Top of the agenda is the continued exploration thrust in the region. Exploration drilling and well testing will continue in Tanzania to mid-2013 and resume again in the latter half of 2014. Exploration drilling offshore Kenya is scheduled for late 2013/early 2014 and will test several new plays in the area.

From a development perspective, the focus at present for BG Group is Tanzania due to the fact that the country is already endowed with discovered resources. Appropriate site selection is on the critical path to enable preliminary engineering work to proceed and substantial progress in this area is expected in 2013. Reservoir development studies and offshore facilities engineering are also key to maintaining progress for the discoveries that are in water depths which will challenge conventional procedures and require cutting edge technology for optimal economic returns.

BG Group’s view is that global gas demand will outstrip supply in the coming years. Under this scenario, offshore East African gas discoveries are well positioned to benefit from this market opportunity; a situation that is further enhanced, by the region’s geographic location relative to the Asia Pacific market.

An integrated two train LNG project has the potential to provide a significant contribution to the Tanzanian economy in the next decade. This will result in a substantial increase in revenue compared to the present day. Tanzania under this scenario can have the ability to review its dependence on donor nations, substantially upgrade its physical infrastructure and agricultural requirements, reduce its fuel import bill and strive to be a leader in the economic development of sub-Saharan Africa. BG Group will play its role helping the country prepare for this eventuality via key socio-economic initiatives which will be appropriately tested during the construction phase of the LNG development.

Upcoming drilling in offshore Kenya can potentially provide another growth opportunity for BG Group within East Africa. A positive outcome can only continue to build East Africa’s importance as an emerging key global gas supplier.