

Baseline Assumptions of the 2019 Tanzania Natural Gas Model

These briefings are informed by an economic model of Tanzania’s LNG project that we developed. Like all models, the results depend crucially on the assumptions used. There are varying degrees of uncertainty around key inputs into the model—including the project’s design, costs and regulatory framework, and the trajectory of the wider economy and public finances—any of which may have a significant impact on our estimates. Indeed, we adjusted a number of assumptions made for our analysis in 2017, resulting in changes to our estimates.

Our main assumptions are presented in Tables 1 and 2 and discussed further below. Other assumptions can be found in the model.

ABOUT THIS DOCUMENT

This publication is an annex to two related NRGi briefings: “How Tanzania Can Secure a Good Deal for its Offshore Gas” and “Managing Expectations about Tanzania’s Uncertain Gas Revenues.” They are available on NRGi’s website, www.resourcegovernance.org.

Element	Assumption
Final investment decision (FID)	2023
Production start	2027
Minimum return required by companies to trigger investment	13%
Blocks involved	1, 2 and 4
Gas reserves	26.65 trillion cubic feet (tcf)
LNG plant size	Two trains, each with capacity of seven million metric tons per annum (mmtpa)
Domestic market obligation (DMO)	9% of production
Project structure	Segmented: upstream and midstream are separate entities for regulatory and tax purposes
LNG tolling fee	Provides LNG plant a return of 8%
Exploration expenditure	\$4 billion
Development expenditure	
Upstream (blocks and pipelines)	\$16 billion
Midstream (LNG plant)	\$14 billion
Replacement capital expenditure	
Upstream	\$0.16 billion per year of production
Midstream	\$0.14 billion per year of production
Operating expenditure	
Upstream	\$0.60 / million British thermal units (mmBtu)
Midstream	\$0.50 / mmBtu
Domestic pipeline tariff	\$0.25 / mmBtu
LNG shipment cost	\$1 / mmBtu
Domestic price	\$4 / mmBtu
Fiscal regime	
Upstream	Based on Block 2 production sharing agreement (PSA) addendum
Midstream	Based on general legislation

Table 1. Baseline assumptions for the LNG project (2018 USD)

Element	Assumption
GDP in 2017/18	\$53.7 billion
Annual non-gas GDP growth	5.5%
Government own revenue in 2017/18	\$8.0 billion
Annual non-gas revenue growth	5.5%
Grants received in 2017/18	\$0.43 billion
Annual reduction in grants as GDP per capita rises	5%
End of grants	Upper middle income status
Government primary expenditure in 2017/18	\$9.9 billion
Annual primary expenditure growth	5.5%
Government debt in 2017/18	\$20.9 billion
Government real interest rate for debt \leq 40% of GDP	1.5%
Government real interest rate for debt \geq 40% of GDP	4.5%

Table 2. Baseline assumptions about the economy and public finances (2018 \$)

TIMELINE

The government and companies must at least agree upon key terms of the host government agreement (HGA) before companies can conduct feasibility studies (what the industry calls “preliminary front end engineering design”, or pre-FEED), while more advanced project planning (called “front end engineering design”, or FEED) will not take place until parties have signed the HGA. Only once these two planning stages are complete will companies make a final decision on whether to invest. Equinor suggests that once key terms are agreed, it will take three years to get to FID.¹ Therefore if the key terms in the HGA are agreed by the end of 2019 as intended by the government, a FID could be made in early 2023.² Construction of the project is expected to take four to five years. We therefore assumed that, if investment does go ahead in 2023, production will commence in 2027. This timeline is one year later than our previous assumption.

RESERVES

While around 58 tcf is estimated to have been discovered in Tanzania to date, we were relatively conservative and only considered reserves for which there are currently development plans. For the three offshore blocks that comprise the LNG project, we used Wood Mackenzie’s estimate of 2p (proved and probable) reserves of 26.65 tcf. This estimate is from 2016, but we understand there has been little change in estimated reserves since then.³

Block	Reserves (tcf)
1 and 4	16.64 ⁴
2	10.01

Table 3. 2p reserves in blocks 1, 2 and 4

- Equinor. *Block 2 Tanzania* (2018), 6-7, www.equinor.com/content/dam/statoil/documents/where-we-are/equinor-block-2-project-121018.pdf.
- Fumbuka Ng’wanakilala, “Tanzania to conclude talks for delayed LNG project in September,” *Reuters*, 23 March 2019, af.reuters.com/article/commoditiesNews/idAFL8N21A04P
- Wood Mackenzie. *Tanzania Upstream Summary September 2016* (2016), 17.
- Wood Mackenzie reports aggregate reserves for blocks 1 and 4. We assume these reserves are split equally between the two blocks.

PRODUCTION

As previously, our production estimates are based on the size of the LNG plant and the amount of gas we assumed is required for it to operate at full capacity; projected domestic demand for the gas; and the estimated output capacity of the offshore blocks. If production does commence in 2027, we estimate that current 2p reserves will run out in 2064.

SUPPLY ALLOCATION

The majority of gas will be processed and exported as LNG. We previously assumed the LNG plant will have three trains, each with a capacity of 5 mmtpa. The companies have since indicated a smaller plant with a different configuration is likely. Discussions with company officials suggest it may be similar to that of Shell's Canada LNG project.⁵ We therefore assumed a LNG plant with two trains, each with a capacity of 7 mmtpa. However, it may be even smaller. The Minister of Energy recently indicated that it may have a total capacity of only 10 mmtpa.⁶ We will need to amend our assumptions and do further analysis if the likelihood of a plant this size increases.

While the government is considering building at least one pipeline to export gas to Tanzania's neighbors, the viability of this project is yet to be properly assessed.⁷ We therefore continued to assume that any offshore gas not exported as LNG will be supplied to the domestic market. The offshore blocks will supply gas to the domestic market up to the volume required to satisfy their DMO or domestic demand, whichever is smaller.

The government and companies have not disclosed the PSAs, but the addendum to the Block 2 PSA has been leaked. Our previous assumption of the DMO was based on this addendum, which has a DMO of 10 percent of production.⁸ The PSAs for blocks 1 and 4 are still not public, but we now understand that they contain a DMO of around 8 percent. We therefore assumed a DMO of 9 percent, which is the average of these obligations weighted by the size of the reserves in each block.

The government's Natural Gas Utilisation Master Plan estimates that domestic demand will average 0.64 tcf per annum over 2016-45, but presumably with increasing demand over time.⁹ This estimate includes demand that would be generated from activities that will involve significant capital expenditure and are not yet certain. As previously, we used the lower estimates set out in Demierre et al., which are based on projections of GDP and population growth, the energy intensity of GDP and the energy mix.¹⁰ This results in domestic demand averaging 0.49 tcf per annum over 2019-60.

5 See: Natalie Obiko Pearson, Stephen Stapczynski, Elffie Chew, and Kelly Gilblom, "Shell, Partners Announce \$31 Billion LNG Canada Investment," *Bloomberg*, 2 October 2018, www.bloomberg.com/news/articles/2018-10-02/shell-partners-announce-31-billion-lng-canada-investment.

6 Fumbuka Ng'wanakilala and Nuzulack Dausen, "Tanzania says construction of LNG plant to start in 2022," *Reuters*, 28 May 2019, af.reuters.com/article/commoditiesNews/idAFL8N23459P.

7 The government is currently considering a pipeline to Uganda. Elias Biryabarema, "Tanzania wants to build pipeline to pump gas to Uganda," *Reuters*, 6 August 2018, uk.reuters.com/article/uk-tanzania-energy-uganda/tanzania-wants-to-build-pipeline-to-pump-gas-to-uganda-idUKKBN1KR1AB.

8 Article 8 of the 2012 addendum to the Block 2 PSA, www.resourcecontracts.org/contract/ocds-591adf-8344502322/view#/pdf.

9 United Republic of Tanzania, *Final Draft Natural Gas Utilisation Master Plan* (2016), 32, www.jamiiforums.com/attachments/oil-and-gas-masterplan-pdf.495398.

10 Jonathan Demierre, Morgan Bazilian, Jonathan Carbajal, Shaky Sherpa and Vijay Modi. *Potential for Regional Use of East Africa's Natural Gas* (Sustainable Development Solutions Network, 2014), 28, www.energypolicy.columbia.edu/sites/default/files/Potential-for-Regional-Use-of-East-Africas-Natural-Gas-SEL-SDSN.pdf.

Domestic demand for offshore gas will be affected by the amount of onshore gas production. In line with our assumption for offshore reserves, we were relatively conservative and only considered onshore reserves for which there are currently development plans. That is, reserves in the Kiliwani North, Mnazi Bay and Songo Songo blocks. We assumed that future annual production from these blocks is the same as 2018 and continues until the p2 reserves specified in company reports run out. We estimate that onshore reserves run out in 2034.

COSTS

There is significant uncertainty around capital expenditure requirements for the LNG project—both the total amount and the time profile. We assumed that total development expenditure is \$30 billion based on discussions with government and company officials. This is lower than the \$35 billion we assumed previously. We continued to assume that the LNG plant will cost \$1 billion per mmtpa, resulting in development expenditure for the LNG plant of \$14 billion.¹¹ We therefore assumed development expenditure for the upstream (the blocks and pipelines) of \$16 billion, with some of this expenditure used to construct new wells after production has commenced. We split upstream development expenditure across the three blocks in proportion to the reserves they are estimated to contain.

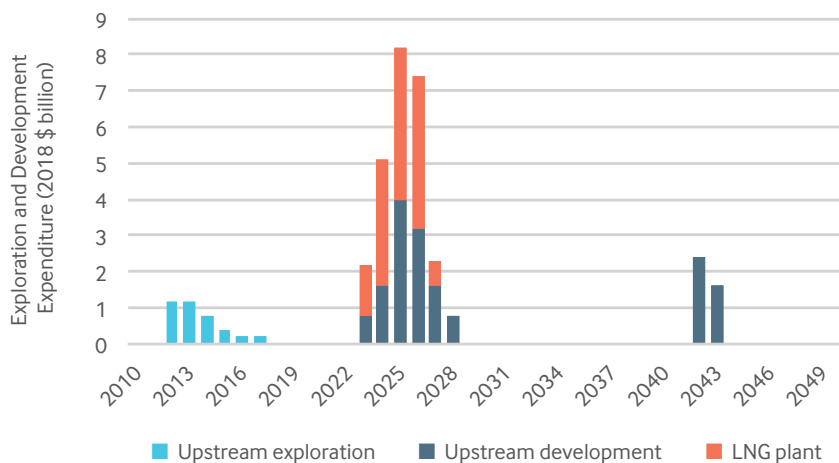


Figure 1. Assumed exploration and development costs

For operating expenditure, we maintained the same assumption for the upstream of \$0.60 per mmBtu as previously. However, we reduced our assumption for the LNG plant to bring it in line with the industry norm of annual operating expenditure (excluding fuel) being 2.5 percent of total capital expenditure.¹² This results in operating expenditure of \$0.50 per mmBtu.

11 According to recent analysis of LNG plant costs across the globe, a unit cost of \$1 billion per mmtpa would actually be relatively cheap given Tanzania’s LNG plant is greenfield, will process wet gas and is in a remote location. However, company officials suggest having fewer, larger trains should generate cost efficiencies that enable them to achieve a unit cost of around \$1 billion. Brian Songhurst, *LNG Plant Cost Reduction for 2014-18* (2018), 7, www.oxfordenergy.org/wpcms/wp-content/uploads/2018/10/LNG-Plant-Cost-Reduction-2014%E2%80%9318-NG137.pdf.

12 Songhurst, *LNG Plant Cost Reduction for 2014-18*, 28.

SALE PRICES

The target markets for Tanzanian LNG exports are expected to be in Asia, for which Japanese prices are a reliable metric. Given the inherent unpredictability, we did not assume a LNG price in our baseline. Instead, we look at the impact different prices are likely to have on the investment decision and government revenues in our analysis.

In the absence of gas imports and exports, and with the majority of gas being purchased by the government at a set price, there is currently little correlation between global price dynamics and the price of gas sold to the domestic market in Tanzania. Based on historical prices for onshore gas, we continued to assume an average price of \$4 per mmBtu for offshore gas sales to the domestic market.

TRANSPORT COSTS

We assumed shipping LNG to Asian markets costs \$1 per mmBtu, lower than our previous assumption of \$2 per mmBtu. This reduction is based on discussions with company officials and better takes into account the likelihood that oil prices are likely to be lower in the longer term due to the energy transition.

The planned location for the LNG plant is relatively close to the existing pipeline network that supplies the domestic market. Gas arriving from the offshore blocks should be able to be transferred to this network with minimal additional cost. On this basis, we continued to assume that the tariff for distributing gas to the domestic market from the onshore blocks and from the exit point of the offshore pipelines is the same. However, given changes to the weighted average of distribution costs for the onshore blocks in 2016-18, we assumed a tariff of \$0.25 per mmBtu rather than \$0.40 per mmBtu.

SEGMENTATION OF THE PROJECT VALUE CHAIN

We understand that both parties are likely to agree to a segmented value chain, and therefore continued to assume this structure in our baseline.

FISCAL REGIME

In a segmented structure, we expect the fiscal regimes provided in the current PSAs to be levied on the upstream (which will comprise both the blocks and pipelines), but a different fiscal regime to be agreed and levied on the LNG plant. The main components of these assumed regimes are presented in Table 4.

Fiscal term	Upstream (blocks and pipelines)	Midstream (LNG plant)
Royalty	5%	None
Cost gas limit	70%	None
Government share of profit gas	30-50%	None
Royalty paid from government profit gas?	Yes	No
Income tax	30%	30%
Royalty deductible from taxable income?	Yes	No
Depreciation of capital expenditure	20% per year across five years	20% per year across five years
Loss carry forward	Unlimited	Losses can be carried forward indefinitely but used against maximum of 70% of income per year
Additional profit tax	None	None
Dividend and interest withholding taxes	10% ¹³	10%
State equity share	10%; carried and repaid through TPDC's share of cost gas	10%; carried and repaid through TPDC's share of cost gas

Table 4. Main components of baseline fiscal regimes for the upstream and midstream

Because the government and companies have still not disclosed the PSAs, we continued to base our baseline fiscal terms on the contents of the leaked addendum to the Block 2 PSA, government statements in 2014, and an assumption that the terms approximate the model PSAs that the government has developed for the sector.¹⁴ We therefore also continued to assume that the fiscal regimes in the PSAs for blocks 1 and 4 are not significantly different from that in the Block 2 PSA. However, until they are disclosed, we will have a limited understanding of their contents.

As previously, we assumed that the LNG plant is taxed as a normal business entity (i.e., under the standard income tax regime) but subject to the rules set out in the Finance Act 2016 and Written Laws (Miscellaneous Amendments) Act 2017 for oil and gas projects. We assumed that TPDC also has 10 percent carried interest in the LNG plant so that incentives for TPDC and companies are aligned across the value chain.

PRICING BETWEEN PROJECT ENTITIES

In a segmented structure, any gas bought and sold between the upstream and midstream will need to be priced, as too will any services provided between these components. We continued to assume that the upstream will have a tolling arrangement with the LNG plant. That is, rather than selling its gas to the LNG plant, it will pay the LNG plant a tolling fee for processing the gas and then sell the LNG itself. We also continued to assume that this tolling fee will be regulated through capping the LNG plant's rate of return at 8 percent. However, we look at the impact different tolling fees are likely to have on the investment decision and government revenues in our analysis.

¹³ Depending on the multinational structure of a company, double taxation treaties between Tanzania and other jurisdictions may significantly reduce the effective rates of withholding taxes. However, the treaties I have viewed allow for the current rates of withholding tax on interest and dividends. Tanzania Revenue Authority, "Double Taxation Agreements," accessed 3 July 2019, www.tra.go.tz/index.php/double-taxation-agreements.

¹⁴ David Manley and Thomas Lassourd. *Tanzania and Statoil: What Does the Leaked Agreement Mean for Citizens?* (Natural Resource Governance Institute, 2014), 8. www.resourcegovernance.org/sites/default/files/Tanzania_Statoil_20140808.pdf.

PROJECT HURDLE RATE

As previously, we assumed a hurdle rate of return of 13 percent (in real terms). Wood Mackenzie surveys continue to find this to be the most common hurdle rate used for LNG projects across the globe as reported by companies.¹⁵

THE ECONOMY AND PUBLIC FINANCES

Our baseline for the wider economy and public finances starts with the most recent publically available IMF data for 2017/18 (treated here as the calendar year of 2018).¹⁶ We then build a picture of their future trajectory by focusing on the trends in key variables. Because our analysis covers a long-term, 50-year horizon, we overlook short-term fluctuations.

We continued to assume non-gas GDP growth of 5.5 percent a year (in real terms) based on the average growth rate of East African Community members over the last 20 years. We also continued to estimate gas GDP from the bottom-up based on the value added per unit of gas produced. This is derived as the difference between the realized price and the cost of imported goods and capital. Given the slack in the economy, we assumed that domestic inputs would not have been produced if not demanded by the gas sector, and therefore that they generate additional GDP.¹⁷

As previously, we assumed that non-gas, non-grant revenue will grow in line with the rest of the non-gas economy. On the one hand, the revenue to GDP ratio is rather low and would be expected to increase on a sustainable development path, but on the other hand, empirical evidence suggests that increases in resource revenues have an adverse effect on mobilizing other domestic revenue.¹⁸ We continued to expect grants to decline in the future. We modeled a linear decrease in grants down to zero as GDP per capita reaches upper middle income status.

We also continued to assume primary expenditure growth follows economic growth and stays fixed as a percentage of GDP. However, once the fiscal rules are applied, we modeled expenditure only growing to the extent that it does not break any of the rules.

We assumed any debt below 40 percent of the previous year's GDP is borrowed at a rate of 1.5 percent (in real terms). This is based on the current debt stock being around 40 percent of GDP and the vast majority of it being either concessional or borrowed domestically. However, as previously, we assumed that any debt beyond this threshold is borrowed at external commercial rates. The assumed interest rate for this debt of 4.5 percent (in real terms) is in line with the average Eurobond rates across Africa.¹⁹

15 Wood Mackenzie. Wood Mackenzie's Second 'State of the Upstream Industry' survey (2018), 5, go.woodmac.com/l/131501/2018-04-12/rppt9.

16 IMF. *United Republic of Tanzania: Seventh Review under the Policy Support Instrument* (2018), www.imf.org/~media/Files/Publications/CR/2018/cr1811.ashx.

17 The gas sector will have an additional impact on GDP beyond domestic value addition and the rents it generates. Improved power generation capacity could facilitate greater industrialization and economic diversification. Concurrently, a booming gas sector might divert resources from other sectors, undermining their competitiveness. Neither of these effects are modelled.

18 Ernesto Crivelli and Sanjeev Gupta. Resource Blessing, *Resource Curse? Domestic Revenue Effort in Resource-Rich Countries* (IMF, 2014), www.imf.org/~media/Websites/IMF/imported-full-text-pdf/external/pubs/ft/wp/2014/_wp1405.ashx.

19 Trevor Hambayi. *Africa Eurobond Financing: A Ticking 35 Billion Debt Bust* (2016), 3, www.academia.edu/24841059/Africa_Eurobond_Financing_A_Ticking_35_Billion_Debt_Bust.

REFERENCES

- Biryabarema, Elias. “Tanzania wants to build pipeline to pump gas to Uganda.” Reuters, 6 August 2018. uk.reuters.com/article/uk-tanzania-energy-uganda/tanzania-wants-to-build-pipeline-to-pump-gas-to-uganda-idUKKBN1KR1AB
- Crivelli, Ernesto and Sanjeev Gupta. *Resource Blessing, Resource Curse? Domestic Revenue Effort in Resource-Rich Countries*. International Monetary Fund, 2014. www.imf.org/-/media/Websites/IMF/imported-full-text-pdf/external/pubs/ft/wp/2014/_wp1405.ashx
- Demierre, Jonathan, Morgan Bazilian, Jonathan Carbajal, Shaky Sherpa and Vijay Modi. *Potential for Regional Use of East Africa’s Natural Gas*. Sustainable Development Solutions Network, 2014. www.energypolicy.columbia.edu/sites/default/files/Potential-for-Regional-Use-of-East-Africas-Natural-Gas-SEL-SDSN.pdf
- Equinor. *Block 2 Tanzania*. 2018. www.equinor.com/content/dam/statoil/documents/where-we-are/equinor-block-2-project-121018.pdf
- Government of the United Republic of Tanzania. *Addendum to Existing Production Sharing Agreement between Government of the United Republic of Tanzania and Tanzania Petroleum Development Corporation and Statoil Tanzania AS and ExxonMobil Exploration and Production Tanzania Limited, Block 2*. 2012. www.resourcecontracts.org/contract/ocds-591adf-8344502322/view#/pdf
- Hambayi, Trevor. *Africa Eurobond Financing A Ticking 35 Billion Debt Bust*. 2016. www.academia.edu/24841059/Africa_Eurobond_Financing_A_Ticking_35_Billion_Debt_Bust
- International Monetary Fund. *United Republic of Tanzania: Seventh Review under the Policy Support Instrument*. 2018. www.imf.org/-/media/Files/Publications/CR/2018/cr1811.ashx
- Manley, David and Thomas Lassourd. *Tanzania and Statoil: What Does the Leaked Agreement Mean for Citizens?* Natural Resource Governance Institute, 2014. www.resourcegovernance.org/sites/default/files/Tanzania_Statoil_20140808.pdf
- Ng’wanakilala, Fumbuka. “Tanzania to conclude talks for delayed LNG project in September.” Reuters, 23 March 2019. af.reuters.com/article/commoditiesNews/idAFL8N21A04P
- Ng’wanakilala, Fumbuka and Nuzulack Dausen. “Tanzania says construction of LNG plant to start in 2022.” Reuters, 28 May 2019. af.reuters.com/article/commoditiesNews/idAFL8N23459P
- Pearson, Natalie Obiko, Stephen Stapczynski, Elffie Chew, and Kelly Gilblom. “Shell, Partners Announce \$31 Billion LNG Canada Investment.” *Bloomberg*, 2 October 2018. www.bloomberg.com/news/articles/2018-10-02/shell-partners-announce-31-billion-lng-canada-investment
- Songhurst, Brian. *LNG Plant Cost Reduction for 2014-18*. 2018. www.oxfordenergy.org/wpcms/wp-content/uploads/2018/10/LNG-Plant-Cost-Reduction-2014%E2%80%9318-NG137.pdf

Tanzania Revenue Authority. “Double Taxation Agreements.” Accessed 3 July 2019. www.tra.go.tz/index.php/double-taxation-agreements

United Republic of Tanzania. *Final Draft Natural Gas Utilisation Master Plan*. 2016. www.jamiiforums.com/attachments/oil-and-gas-masterplan-pdf.495398/

Wood Mackenzie. *Tanzania Upstream Summary September 2016*. 2016.

Wood Mackenzie. *Wood Mackenzie’s Second ‘State of the Upstream Industry’ survey*. 2018. go.woodmac.com/1/131501/2018-04-12/rppt9

The Natural Resource Governance Institute, an independent, non-profit organization, helps people to realize the benefits of their countries’ oil, gas and mineral wealth through applied research, and innovative approaches to capacity development, technical advice and advocacy.
Learn more at www.resourcegovernance.org



Oil, gas and mining for development