THE AFRICAN CLIMATE FOUNDATION

Sustainable Energy Transitions for African Petroleum Producers

Summary

This paper evaluates the changing landscape and closing window of opportunity for African petro-states to take advantage of their gas resources caused by the growing global recognition of the urgent threat posed by climate change as well as the short-term demand for gas in Europe due to Russia's invasion of Ukraine. Greater commitment to climate action has led many countries and donor agencies to make plans to end financial support for petroleum extraction. At the same time, the European Union (EU) has been pursuing new sources of African natural gas to compensate for loss of supply from Russia. African countries face an unenviable dilemma of needing to foster economic development and industrial growth while mitigating the impacts they are likely to experience due to global climate change. To many policy makers, gas development and export is a bridge to achieving both of these aims. However, exploiting Africa's gas reserves involves multiple trade-offs, uncertainty and significant transition risk, particularly as the adoption of renewable energy (RE) and the low-carbon transition gains speed. Using models of two Paris-compliant scenarios developed for the African Climate[1] Foundation (ACF), we argue that limiting global warming to well below 2°C (WB2C) or achieving net zero emissions by 2050 (NZE2050), would lead to investments in African gas being ultimately value destructive. We find that current and aspiring African petro-states should be wary of accepting new risk associated with gas and gas infrastructure and are incentivised, whether or not they pursue gas exploitation, to embrace rapidly scaling up renewables in their energy technology mix.

Policy insights

- African petro-states face challenges and multiple trade-offs in utilising their gas resources due to uncertainty and the transition risk association with new investments in African natural gas.
- In Paris Agreement and Net Zero 2050 compliant scenarios, many such investments are value destructive. African governments could face billions of dollars in losses and set back their own transitions to green technologies.
- In total, liquefied natural gas (LNG) imports will fall 60 percent between 2020 and 2050 in the NZE2050 scenario. Impacts are more severe for emerging gas producers (Mozambique, Tanzania, Mauritania and Senegal) and countries currently exploring for gas (South Africa and Namibia).
- Renewable energy is an increasingly attractive investment for all African countries that offers greater promise not only for powering Africa but also for creating jobs and driving green industrialisation.
- Managed low-carbon transitions and the shift away from fossil fuels further Sustainable Development Goal (SDG) 7 as well as the African Union's (AU) Agenda 2063.

Introduction

African exploration and production have been crucial to new growth in the global natural gas industry, accounting for over 40 percent of global gas discoveries between 2011 and 2018. Mozambique and Tanzania alone accounted for 24 percent of global discoveries in that period (IEA 2019). These high-profile gas discoveries have led gas-rich African countries to develop new strategies and policies to take advantage of these resources (Graham & Ovadia 2019).

The gas discoveries of the past decade have also coincided with growing global recognition of the urgent threat posed by climate change. African governments are increasingly pinning their hopes on gas production to foster petro-development (Ovadia 2016). At the same time, an energy crisis is engulfing Europe, with an urgent short-term need for gas caused by the need to replace imports previously supplied by Russia due to the invasion of Ukraine.

With the increasing shift to cleaner technologies, gas has been positioned by the petroleum industry as a transition fuel that will pave the way for greater renewable energy (RE) deployment. As a result, some African policy makers continue to see the exploitation of gas, especially through liquid natural gas (LNG) exports, as an opportunity to address energy access, garner export revenues and foster economic development. However, there is considerable debate as to whether gas can really be considered an environmentally friendly source of energy and to what extent investments in new gas extraction make economic sense for African governments.

Overall, global action to mitigate the negative impacts of climate change creates considerable economic uncertainty and risk for development based on gas development and export. Despite Europe's short-term need for gas, the European Union's (EU) medium- and long-term strategy is to transition to RE. The speed of this transition, as well as East Asia's green transition, will be crucial for the profitability of African gas projects that are being developed now as well as those already under production. Based on research done by our team for the African Climate Foundation (ACF), we argue that African countries that invest in gas may find their investments ultimately to be value destructive, particularly in scenarios where global warming is limited to well below 2°C (WB2C) in compliance with the Paris Agreement and in net zero emissions by 2050 (NZE2050) scenarios that provide the greatest chance of limiting warming to 1.5°C. In a situation where both meeting and failing to achieve Paris commitments raises new challenges for African development, more attention must be paid to what is required and owed to Africa in order to realise sustainable and just energy transitions.

Climate change inequity: Africa's unenviable dilemma

Transitioning away from fossil fuel dependence and bolstering economic diversification in the longer term is necessary to drive inclusive and sustainable structural transformation as well as increase systemic resilience. Sachs et al. (2021) suggest that scaling up electrification in line with Sustainable Development Goal (SDG) 7, the United Nations (UN) Secretary-General's Roadmap for Digital Cooperation, the African Union's (AU) Digitization Transformation Strategy, and the AU Agenda 2063, especially if accomplished through zero-carbon electricity, would provide numerous opportunities for positive feedback loops between energy, mining and industrialisation in Africa (Sachs et al. 2021, 5). As a recent report by the International Renewable Energy Agency (IRENA) and the African Development Bank (AfDB) suggests, investing instead in RE will help to achieve these goals given RE's benefits in terms of economic growth, cost effectiveness and potential for industrial development and local job creation (IRENA & AfDB 2022, 13).

Africa's energy deficit is a critical constraint to inclusive and sustainable structural transformation. It is estimated that about 45 percent of the African population (600 million people) lack access to electricity and almost 70 percent (over 900 million) lack access to clean cooking fuel (IEA 2019, 14). Within the continent, gas to power contributes to the electricity mix (to varying degrees) in 24 out of 54 African countries.2 Natural gas has the potential to provide large-scale and reliable electricity to address the energy deficit that would allow countries to grow their economies and develop industrially (Andrews & Nwapi 2018; Nalule 2018; Nalule & Acheampong 2021; Sachs et al. 2021). Gas is also an important upstream industry for production of fertilisers, hence a key input for increasing productivity in downstream agricultural and food sectors.

Energy transitions are generally a twofold process that involve both phasing out emissions from fossil fuels (high-carbon energy transitions) and adopting RE and other low-carbon technologies (low-carbon energy transitions)

(Blondeel et al. 2021). African energy transitions are twofold in a different sense in that they involve a massive expansion of energy production while at the same time needing to mitigate the climate and environmental impacts experienced by African countries.

Despite having contributed the least to climate change, Africa is the most vulnerable continent to its impacts (Carabine et al. 2014; Adenle et al. 2017). A recent World Bank study has suggested that as many as 86 million Africans will be forced to migrate within their own countries by 2050 because of changing weather patterns (World Bank 2022). A study by the AfDB, UN Environment Programme, and UN Economic Commission for Africa found that western and eastern Africa could lose up to about 15 percent of their gross domestic product (GDP) by 2050 due to climate inaction. However, in scenarios compliant for the Paris Agreement, the most serious macroeconomic and development consequences for Africa could be averted (Baarsch & Schaeffer 2019, 11).

For some it is difficult to see why greenhouse gas (GHG) emissions should be a priority in the drive to power Africa and why short-term benefits from gas development might be lower than medium-long term costs and associated risks for African countries. Moreover, given that Africa will bear the brunt of climate change impacts, African countries cannot ignore the need for sustainable energy transitions. Globally, emissions from the energy sector account for almost three-quarters of all GHG emissions.3 Given the need to increase energy production in Africa to improve access to electricity, clean cooking and industrial development, the choices made about energy systems today have major implications for the world of tomorrow. Doubling down on gas will also negatively impact the ability of African states to achieve all 17 of the SDGs (see Daley & Lawrie 2022, 7). While African states must carefully weigh the question of how to extract value from their gas resources, the actions of wealthy countries are a key variable in their decision-making about energy transitions, hence contributing uncertainty and further risks.

The risk of natural gas development in Africa

The speed with which energy transitions may unfold globally is a major question mark. A faster global transition poses more risk for fossil fuel producers in Africa; however, country-specific transition risks remain regardless of the speed of the global transition. If low-carbon transitions gain speed towards the targets for WB2C or NZE2050, the danger of stranded assets becomes real for many African petroleum producers.

In modeling the cost of delayed action on transitioning to NZE, IRENA (2017) concludes that the total value of stranded assets across the upstream energy, power generation, industry and buildings sectors will be US$20 trillion under the delayed action scenario, compared with only US$10 trillion in the scenarios with accelerated adoption of RE by 2050. Mercure et al. (2021) similarly model the impact of achieving NZE2050, finding that over US$350 billion in African oil and gas assets would be stranded, with over US$90.3 billion in stranded assets in Nigeria alone. This analysis demonstrates not only the cost of delayed action, but also the cost of proceeding with new fossil fuel projects when the likelihood of transition is high and failure to transition would also involve extraordinary costs in terms of loss and damage caused by climate change.

Noting the risk of the growing number of coal and gas projects in Africa becoming stranded assets as renewable-based power becomes increasingly competitive, IRENA and AfDB observe:

> Plans to develop new extraction projects in Africa – investments of USD 230 billion by 2030 and USD 1.4 trillion by 2050 – risk leaving Africans behind in the energy transition... In terms of job creation and energy access, these oil and gas projects fail to deliver the benefits that renewables bring. For each dollar invested, renewable energy creates two to five times more jobs than fossil fuels do. Other investments for a green economy – like climate adaptation, conservation agriculture, public transport and energy-efficient building retrofits – provide up to 25 times more jobs than those created by fossil fuels. (IRENA & AfDB 2022, 148 citing OCI 2021)

African countries with large oil and gas reserves have argued that the world should see gas as the cleanest fossil fuel and support it as part of the path to net zero (Mbaga Obiang Lima 2021). It has also been proposed that natural gas is an important intermediate fuel, being less emissions intensive than coal (Osinbajo 2021). While these arguments have already been shown to have flaws,4 Mbaga is correct to note the importance of oil and gas to his country's GDP and makes some salient points in arguing against a blanket ban given the

context of his proposal to use gas-to-power to make energy poverty history, create jobs and expand the tax base.

There are important questions raised by Mbaga and Osinbajo about African development. Osinbajo is obviously correct that continued poverty is not a humane solution to climate change. However, given Equatorial Guinea and Nigeria's histories as prime examples of the 'resource curse' (Gelb 1988; Auty 1993; Sachs & Warner 2001; Ovadia 2020), we must go beyond arguments by these state representatives, which can be viewed as self-serving, and do a deeper dive into whether or not gas can provide a clean alternative in Africa, under which conditions such resources could be exploited in a development way, and who would be served by such an approach to Africa's energy needs.

The likely speed of energy transitions and the risk of stranded assets

Many gas and LNG projects currently under development in Africa are only economically feasible with most or all of the gas destined for export, given the lack of effective domestic demand. However, these large capital investments need decades of production to recoup costs and meet different financial commitments of both private investors and government, especially when they involve major infrastructure development such as in the case of piped gas. In a managed transition in which policy is designed to encourage and incentivise low- and high-carbon transitions to stem emissions of carbon dioxide (C02), the speed with which transitions unfold will inevitably lead to unburnable carbon and stranded assets. Therefore, fossil fuels are increasingly being understood as a liability as the banking and insurance sectors hedge against what are now called 'transition risks' (Carney 2015; van de Graaf and Bradshaw 2018; Fattouh et al. 2019; Blondeel et al. 2021; Eicke & Goldthau 2021).

The pace of energy transitions, and particularly the pace of transitions over the period of 2020–2030, is critical for achieving NZE in 2050 (Grubler et al. 2016; Sovacool 2016; Sovacool & Geels 2016; Blondeel et al. 2021). In recent years, a great deal of scholarly attention has been paid to the question of whether rapid energy transitions are possible. Historically, such transitions – the switch from wood to coal or coal to oil – have been long, protracted processes. However, rapid energy transitions are possible due to the accelerated adoption of renewable technologies and their increasing installed capacity. Sovacool (2016) provides compelling evidence of 10 cases of energy transitions that, in aggregate, affected almost one billion people and needed only 1–16 years to unfold.

The price of RE, especially solar and wind energy, has fallen dramatically in recent years leading to accelerated estimates for how quickly RE will replace other sources of energy (IEA 2022). Carbon Tracker estimates that new solar and onshore wind farms with battery storage installed are already competitive and will be cheaper to run than most gas plants by 2030 (Sims et al. 2021). While costs for RE in many African countries may not be as low as the global average, the trend toward lower costs for RE is clear. According to IRENA and AfDB, between 2011 and 2020, 'solar capacity grew at an average compound annual growth rate (CAGR) of 54%, two and a half times that of wind (22.5%), almost four times that of geothermal (14.7%) and almost 17 times that of hydropower (3.2%)' (IRENA & AfDB 2022, 41). The speed with which solar in particular and RE in general are growing is perhaps one of the best indications of progress toward sustainable development objectives.

Unfortunately, there is a completely different political economy to RE (Baker et al. 2014; Power et al. 2016) and a broad range of actors (Newell & Bulkeley 2016). While the price has come down considerably and may already be lower than competing fuels (depending on specific country conditions), there are limited rents to be made for host governments in RE that is not meant for export. In countries where petroleum is already the main export and petroleum revenues sustain the existing regime, the overall political economy is locked in. The shift to RE is also not seen as an alternative option because RE technologies are not domestically owned or produced. This constrains growth globally and incentivises countries with hydrocarbon resources to continue pursuing rents from petroleum resources.

Undoubtedly, transition risks and stranded assets create both winners and losers – not just among private companies but also among states. This has been an important topic for scholars of the geopolitics of energy in recent years (Overland 2019; Overland et al. 2019; Bazilian et al. 2020; Vakulchuk et al. 2020). Across African countries, transition risks become even more significant if we consider governance risks associated with energy investments and mega-projects. For example, there is evidence of corruption vulnerabilities associated with

the allocation of energy rents to power plants in Tanzania, with costly and polluting plants receiving a larger share of subsidies (Andreoni et al. 2021). In South Africa, long-term financial commitment in coal-based and highly centralised energy projects resulted in powerful incumbents' interests and strong resistance to change generating a lock-in effect (Pye et al. 2021), despite load shedding and energy crises (Andreoni et al. 2022).

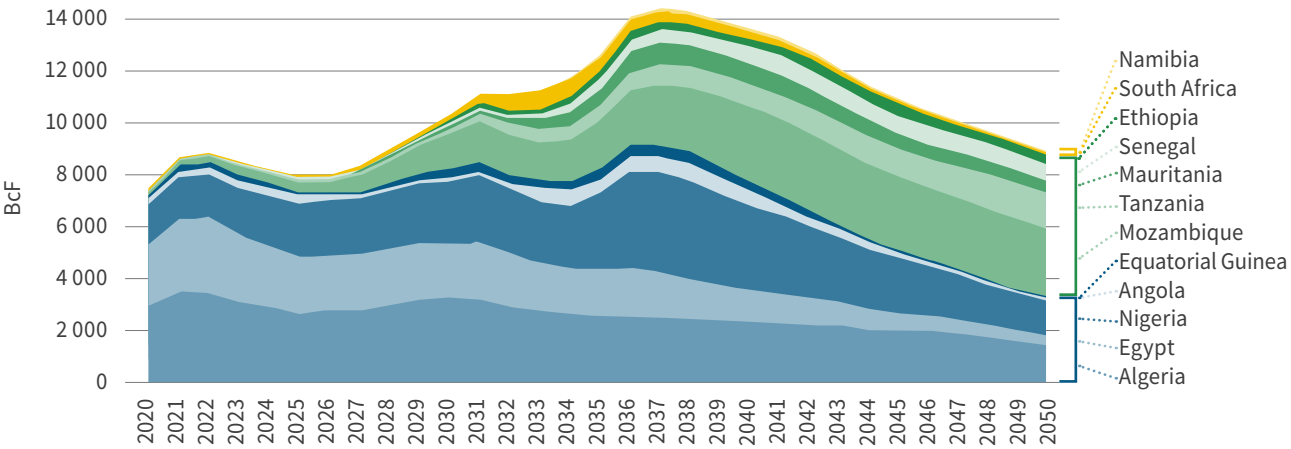
When it comes to who may lose out, Manley and Heller (2021) estimate that more than US$400 billion in investments by national oil companies (NOCs) will only break even if humanity exceeds its emissions targets and allows the global temperature to rise more than 2°C. There are several paradoxes in this 'lose-lose' situation. Manley and Heller write that even though these are 'risky bets with public money', NOCs may still be incentivised to continue spending on major new petroleum extraction projects. Rather than invest in projects that are unlikely to make a substantial return, especially given the higher costs many African NOCs have, public money could be invested elsewhere for lower risk and higher reward (both financially and in terms of economic growth and employment generation). Therefore, there is also an opportunity cost in pursuing such investments in addition to the risk of financial loss (Manley & Heller 2021, 7).

Two scenarios for African natural gas[5]

In formulating their approaches to the extraction of natural gas, African states will have to hedge their bets to some extent and balance not only their climate change and socio-economic development goals, but also their assessment of the financial gain from gas revenues in a business as usual (BAU) scenario with the risk of stranded assets in the NZE2050. Their strategies are likely to reflect their confidence in both global progress toward NZE and in wealthy nations providing the climate finance necessary for transitioning.

Working for the ACF, technical partners at Willis Towers Watson created a model of how meeting climate objectives would impact African natural gas supply and demand in the WB2C and NZE2050 scenarios. The model is based on determining the optimal global trade flow between LNG assets and importing regions to create LNG demand scenarios. These scenarios assess the amount of available African production that would be economic given a particular level of global LNG demand. The African 'petro-states' we examine have either existing or emerging gas production or are exploring for gas. Therefore, we categorise countries as being either: 1) mature producers, 2) emerging producers, or 3) in the exploratory phase (Figure 1).

FIGURE 1: CATEGORISATION OF COUNTRIES IN THE STUDY BY AVAILABLE GAS PRODUCTION



Exploration phase

Characterised by countries with new developments beyond the current decade, often dependent on successful exploration activity.

Emerging producers

Characterised by countries with major developments undergoing appraisal/FID in the coming years.

Mature producers

Characterised by countries with established gas markets, looking to avoid expected declines in order to maintain exports/meet domestic consumption.

Source: Willis Towers Watson (2022)

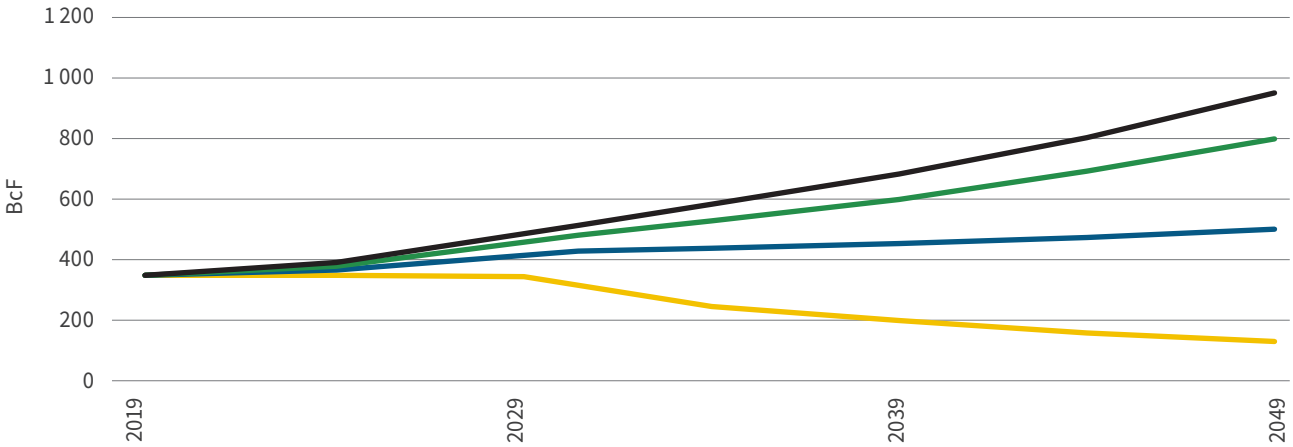
Taking their cue from the International Energy Agency (IEA), numerous studies of climate change impacts involve similar scenario-based approaches. Just since 2021, there have been numerous examples of this approach (IEA 2021a; IRENA 2021; Fulwood 2021; McKinsey 2021; Mercure et al. 2021; SEI 2021; IRENA & AfDB 2022). Our own approach begins by modelling LNG demand in each of the main IEA scenarios (Figure 2). However, few scenario-based reports pay significant attention to African states and even fewer to the possibility of doing in-depth analysis based on the empirical material generated. We therefore go on to discuss specific contexts for mature, emerging and exploratory gas industries in Africa.

In using scenarios and modelling to analyse the possibilities for mature, emerging and exploring countries in Africa to utilise their gas resources, our goal is not to make predictions about which global energy transition scenario is most likely to occur. Given that Africa is not a major source of climate change, but will be greatly impacted by it, the analysis of each scenario is not about lowering Africa's emissions but rather seeking to understand the limits on how African countries can be successful in realising value in each scenario, achieving their development objectives and bringing about structural transformation.

LNG seems like a good bet for most African countries in the BAU scenario; however, this changes with a more concerted global energy transition. The BAU scenario involves a 14 percent rise in global LNG demand from 2020 to 2025, with Europe the biggest driver of growth. As mentioned above, it is unclear at this time how Russia's invasion of Ukraine will change the incentives for European countries to transition away from gas faster, even as it raises gas prices in the short term. In 2021, natural gas experienced even sharper price increases than oil. However, the IEA argues 'the immediate period of higher prices is expected to be temporary, not least because of the planned expansion of LNG export capacity following a record year for project final investment decisions in 2019, but the potential for supply-demand imbalances and price volatility in the coming years remains strong' (IEA 2021b, 101).

In the NZE scenario we modelled just prior to the Ukraine conflict, LNG imports between 2020 and 2050 fall by 60 percent, reaffirming the findings of the IEA's NZE2050 report. This is a reversal, even from the WB2C scenario. What happens depends to a large degree on the strategies adopted by resource-rich governments and their national petroleum companies. In the NZE it is assumed that, despite having lower cost resources at their disposal, investments in

FIGURE 2: LNG DEMAND SCENARIOS



No Holds Barred (NHB), shows what happens if the world continues along its present path, without any additional changes in policy – Our best estimate of a NHB scenario.

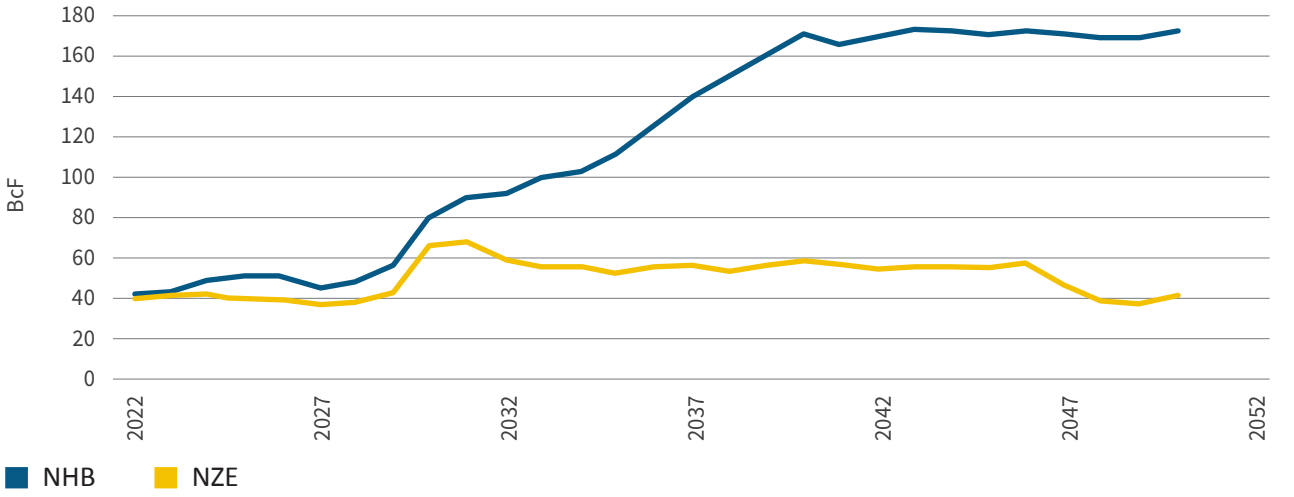
Business as Usual (BAU), reflects all of today's announcement policy intentions and targets, insofar as they are backed up by detailed measures for their realisation – Our market expectations scenario used in Part 1 analysis.

Well below 2 Degrees Centigrade (WB2C), maps out a way to meet sustainable energy goals in full, requiring rapid and widespread changes across all parts of the energy system. This scenario charts a path fully aligned with the Paris Agreement by holding the rise in global temperatures to 'well below 2 °C.

Net Zero Emissions by 2050 Scenario (NZE), sets out a narrow but achievable pathway for the global energy sector to achieve net zero CO_2 emissions by 2050 – Our best estimate of a 1.5 degree scenario.

Source: Willis Towers Watson (2022)

FIGURE 3: REVENUES FROM GAS IN THE NHB AND NZE SCENARIOS, ASSUMING NO DOMESTIC TRANSITION



Source: Willis Towers Watson (2022)

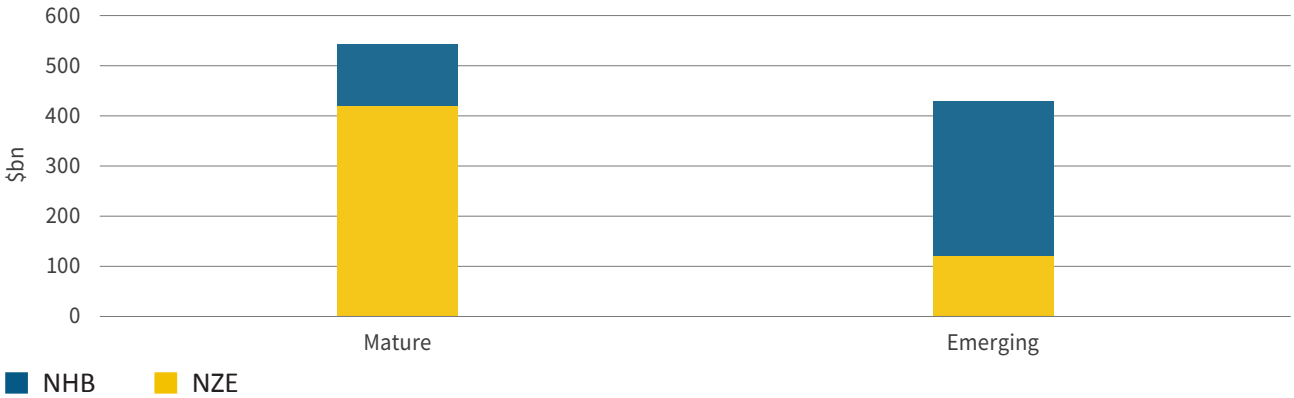
new fields are restricted. What is clear is that falling global consumption in the NZE scenario does not provide room for new projects to viably enter the supply mix as demand is met by more competitively placed existing projects.

More concerningly, revenues for all gas producers, especially emerging producers, fall dramatically in the NZE scenario as compared to the NHB scenario (Figure 3). When looked at in terms of mature and emerging producers in Africa, it is clear that emerging producers are hit much harder by the quicker transition (Figure 4). In such a scenario, numerous LNG projects currently approaching or beyond their final investment decisions (FID) would no longer be economical. These results should give pause to all countries contemplating new investments in fossil fuel infrastructure.

Should African countries invest in RE and/or gas?

In this section, we review the investment calculus for mature, emerging and exploring countries in the BAU scenario and the specific context for Mozambique, the emerging gas producer with the greatest potential in Africa. The decision to invest in RE or gas is not a straightforward dichotomy. Given the competitive pricing of RE, all African countries have a strong incentive to invest in renewables – even those continuing to pursue gas for domestic consumption (especially as a baseload source of energy) or export (as a source of finance to support investments in RE). While noting what Sovacool et al. (2020) have called the 'decarbonization divide', RE

FIGURE 4: TOTAL VALUE OF GAS REVENUES 2021–2050 (8% DISCOUNT), ASSUMING NO DOMESTIC TRANSITION



Source: UN Comtrade data

is still preferable to fossil energy. However, the economics of using gas as a 'bridge' to renewables in power sectors continues to be challenged by the falling cost of renewables and rising LNG prices. Additionally, increased international recognition of the critical importance of reducing methane emissions (coupled with increasing availability of data to track methane emissions) could point towards a future paradigm shift in the structure of the LNG market, which may also concern investors.

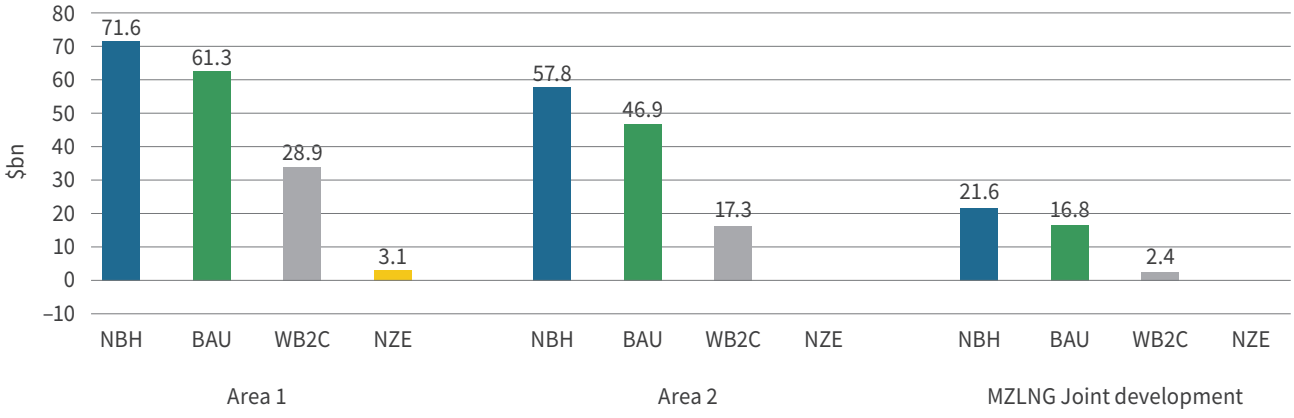
Amongst the mature gas producers, the largest producers all have a strong incentive to invest in RE and diversify their technology mix. In Nigeria, for example, the lack of sufficient incentive from the regulated price structure to bring on required levels of production to meet domestic demand means the country will be at risk of failing to meet growing domestic demand. This in turn would erode pipeline exports, suggesting an incentive for all countries involved in the West African Gas Pipeline (WAGP) to invest in RE. Given that RE is already cheaper than gas in Nigeria and offers a cost-effective solution for powering more remote locations through mini-grids or off-grid RE, the business case for renewables in Nigeria is very strong.

Investing in RE also makes sense for Africa's emerging gas producers and countries currently in the exploratory LNG phase. Mozambique has declining production in its Pande and Temane fields and may need increased domestic power if the projects in the Rovuma Basin end up primarily as LNG projects and gas from the projects is not used for domestic power generation. Additionally, pipeline exports to South Africa may have to be curtailed within 10 years. LNG volumes from Rovuma cannot be redirected to fill this void in Mozambique's power grid because of infrastructure constraints between the north and south of the country.

Tanzania's LNG projects are largely envisioned as being for export. While the government still hopes to maintain a domestic supply obligation, the more that is consumed domestically, the lower the project revenues. Therefore, even if Mozambique's and Tanzania's LNG projects go ahead, there is still a strong incentive to invest in RE for domestic consumption. Evidence of a feasible energy transition whereby remote fossil fuel plants are incrementally replaced by RE has been shown for Tanzania (Andreoni et al. 2021). When it comes to South Africa and Namibia, both exploratory producers are incentivised to invest in RE, even under a BAU scenario, due to the high level of domestic demand in South Africa and the fact that their electricity grids are connected.

When it comes to investing in gas, the decision largely depends on what scenario comes to pass. Global uncertainty remains a key factor that African countries have little influence on. Even for Mozambique, the emerging gas producer with the greatest potential, the value of its gas would be greatly reduced in a WB2C scenario and value destructive in a NZE2050 in the sense that the project as a whole will not generate revenues greater than the initial capital expenditure (CAPEX). Assuming that LNG exports from Mozambique

FIGURE 5: TOTAL PROJECT NET PRESENT VALUE FOR MOZAMBIQUE (8% DISCOUNT), ASSUMING DECOUPLED PRICING REGIME



Source: UN Comtrade data

will decouple from oil-linkage and depend on LNG market fundamentals instead, LNG demand will still be significantly affected by a global low-carbon energy transition (Figure 5). Lower global demand will reduce forecasts for LNG clearing prices across the world, but not to the degree of oil markets. Across the entire industry, a transition from NHB to WB2C would eliminate 70 percent of total value, but the projects would still be economic. In the NZE scenario, only Area 1 would still be economic. The risk for both the Mozambican government and investors would be the NZE scenario playing out after a FID with development completed and CAPEX already sunk into the project. While Area 1 would have some level of resilience, no amount of renegotiation of fiscal terms for Area 4 or the MZLNG Joint Development would allow the projects to become viable as they would be value destructive (or have negligible value) from the outset. Where projects are developed, the risk to government value could reach 92 percent of the expected value of revenues in the NZE scenario. Peak revenues in 2041 in a WB2C scenario would account for just over a third of possible NHB revenues.

Conclusion

Modelling the value of African natural gas under different scenarios for energy transitions shows that gas resources on the whole and LNG projects in particular lose significant amounts of their value in the WB2C scenario (consistent with the Paris Agreement) and are largely value destructive in a NZE2050 outcome. With little benefit, significant risk, and the opportunity cost of missing out on the benefits of early adoption of renewable technologies (including green hydrogen), African states should consider forgoing new LNG investments and instead ramp up their support for green transformations.

Even those planning to continue exploiting gas should be investing now in renewables and factoring in the potential inter-temporal trade-offs associated with different energy technology mixes. These trade-offs are technical as well as political, that is, choices around different technologies lock investments and incumbents' interests in the future. A whole range of domestic and international factors stand in the way of such moves happening organically – including a whole host of financial and capacity-related constraints to state-led development. In any scenario, including NHB, there will be winners and losers.

In proposing and encouraging alternatives to gas production, Africa's development goals must be addressed, including universal access to electricity, clean cooking, economic diversification and inclusive structural transformation. Achieving these goals will require a massive low-carbon transition and embrace of RE for both consumption and production uses. Max Ajl has argued that, based on Intergovernmental Panel on Climate Change (IPCC) data and an IPCC estimate of the carbon price per ton needed to keep global warming below 1.5°C, the climate debt owed by the Global North to the Global South could be anywhere from US$37.325 trillion (assuming a price of $50/ton) to as large as US$447.9 trillion (using the IPCC's upper estimate of $600/ton) (Ajl 2021, 232–233). From a justice perspective, encouraging any investment in climate change mitigation let alone the embrace of green transitions and NZEs, will necessarily mean coming to the negotiating table with humility, and stepping up with climate finance.

Scaling up climate finance could be achieved through an African green new deal, or a 'green deal' tailored to the African context that would 'combine the objectives of achieving climate goals, fostering economic development and jobs creation, and guaranteeing social equity and welfare for society as a whole' (IRENA & AfDB 2022, 289; see also Ovadia 2021). In promoting this vision, IRENA and AfDB imagine an 'African Green Deal with renewable energy at the heart of economic transformation', which they suggest 'holds the potential to produce positive effects across a wide array of social, economic and sustainability imperatives', including 'economic diversification and value creation; inclusive and decent jobs; environmental stewardship and climate resilience; and universal access to affordable, reliable, sustainable and modern energy' (IRENA & AfDB 2022, 293).

Envisioning such a deal from an African perspective involves clarifying desirable outcomes, including industrial development, improved livelihoods, gender equality, poverty reduction, and increased education and welfare. While finance is necessary, it is not a sufficient condition to drive sustainable structural transformation. Directing finance towards an appropriate energy mix for Africa that serves its developmental purpose calls for a renewed role of integrated industrial and energy policies for structural transformation. These policies can only be implemented within an entrepreneurial-regulatory state framework (Andreoni et al. 2023) aligning the investments and

regulatory changes in energy markets within a broader structural transformation agenda.

This deal and renewed role of the state also involves knowing what outcomes must be avoided, including a lack of development, conflict, corruption, and losses and damages from global climate change. Effective utilisation of revenues from fossil fuels, local content in both petroleum and renewables, transparency and accountability in petroleum and energy management, democratisation of policy making, and engagement of civil society organisations can help bring about desirable outcomes. However, in scenarios compatible with the Paris Agreement (WB2C) or achieving NZE2050, the window for petro-development may already have closed. Therefore, African countries that have not already committed to new fossil fuel investments should be wary of new investments that involve risk to the government while those that have already committed should take precautions to reduce transition risks and prepare for a future based on renewable energy.

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Endnotes

1 Author's calculation based on 2019 data from Our World in Data (https://ourworldindata.org/grapher/share-elec-by-source).

2 Author's calculation based on 2019 data from Our World in Data (https://ourworldindata.org/grapher/share-elec-by-source).

3 See https://ourworldindata.org/emissions-by-sector.

4 See, for example, Sims et al. (2021).[I would remove the note and embed this in the body text as: see, e.g., Sims et al. 2021]

5 The data and preliminary analysis in this section was put together by Matt Huxham and Muhammed Anwar of Willis Towers Watson for the ACF and was used by the authors to produce a scoping study for the ACF. Data is presented in this paper with the permission of the ACF; however, the argument and analysis are entirely that of the authors and may not necessarily reflect the views of the ACF.

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ABOUT THE AFRICAN CLIMATE FOUNDATION

The African Climate Foundation (ACF) is the first and only African-led and fully African-run climate change re-granting organisation on the continent. Through its grant making and thought leadership, the ACF seeks to support interventions at the nexus of climate change and development that have the greatest potential to deliver long-term socio-economic transformation and inclusive development in Africa.

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