SADC REGIONAL GAS MASTER PLAN

2023 - 2038

2022

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LIST OF ABBREVIATIONS AND ACRONYMS

Acronym	Definition
°C	Degree Celsius
2P	Proven plus Probable Gas Reserves
4IR	The Fourth Industrial Revolution
AfCFTA	African Continental Free Trade Area
AfDB	African Development Bank
AIA	Africa International Advisors
AU	African Union
BAU	Business As Usual
bbl	Barrel of Oil
BBOE	Billion Barrel of Oil Equivalent
bcf	Billion cubic feet
bcf/d	Billion cubic feet per day
bcm	Billion cubic metres
bcm/a	Billion cubic metres per annum
BP	British Petroleum
Bscf	Billions of cubic standard feet
Btu	British thermal unit
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditures
CBM	Coal Bed Methane
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Capture and Storage
CMI	Corridor Management Institutions
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO2	Carbon Dioxide
CoE(s)	Centre(s) of Excellence
COMESA	Common Market for Eastern and Southern Africa
Covid-19	Coronavirus Disease
CTL	Coal-to-Liquids
DBSA	Development Bank of Southern Africa
DFI	Development finance institutions
DMRE	Department of Mineral Resources and Energy (South Africa)
Domgas	Domestic Gas
DRC	Democratic Republic of Congo
Dx	Delivery Tariffs
EAPP	Eastern Africa Power Pool
EA-SA-IO	East African, Southern African and Indian Ocean Regions

Acronym	Definition
EC	Economic Corridor
ECGs	Export Credit Guarantees
ECOWAS	Economic Community of West African States
ECREEE	ECOWAS Centre for Renewable and Energy Efficiency
EE	Energy Efficient/Energy Efficiency
EIA	Environmental Impact Assessment
EIA	U.S Energy Information Administration
ENH	Mozambican National Oil Company [Empresa Nacional de Hidrocarbonetos]
EOI	Expression of Interest
EPCC	Exploration and Production Concession Contract
ERERA	The ECOWAS Regional Electricity Regulatory Authority
ESI	Electricity Supply Industry
ESREM	Enhancement of a Sustainable Regional Energy Market
ESREM EA-SA-IO	Enhancement of a Sustainable Regional Energy Market in the Eastern Africa, Southern Africa, and the Indian Ocean Region
EU	European Union
FDI	Foreign Direct Investment
FID	Final Investment Decision
FLNG	Floating Liquefied Natural Gas
FOB	Free on Board
FSRU	Floating, Storage and Regasification Unit
GDP	Gross Domestic Product
Gg CO2eq.	Gigagrams of CO2 Equivalent
GHG	Greenhouse Gas
GJ	Gigajoules
GJ/a	Gigajoules per annum
GPBRS	Gas, Petroleum and Biofuels Regulation Sub-Committee of the Regional Energy Regulators Association of Southern Africa
GSA	Gas Sales Agreement
GT	Gigatonnes
GTL	Gas-to-Liquids
GTP	Gas-to-Power
GUMP	Gas Utilisation Master Plan
GW	Gigawatt
GWh	Gigawatt hours
H2	Hydrogen
HFO	Heavy Fuel Oil
ICP	International Cooperating Partner
ICPs	International Cooperating Partners
ICT	Information and Communications Technology

Acronym	Definition
IDC	Industrial Development Corporation
IDPF	Industrial Development Policy Framework
IEA	International Energy Agency
IEP(s)	Integrated Energy Plan(s)
IFC	International Finance Corporation
IFI	International Financial Institutions
IGAD	Intergovernmental Authority on Development
IGMOU	Inter-Governmental Memorandum of Understanding
IO	Indian Ocean
IOC	International Oil Companies
IOGP	International Organisation of Oil & Gas Producers
IPP(s)	Independent Power Producer(s)
IRENA	International Renewable Energy Agency
IRP(s)	Integrated Resource Plan(s)
J/a	Joules per annum
JCC	Japan Custom-Cleared Crude Price
KGRTC	Kafue Gorge Regional Training Centre
km	Kilometre
KPI(s)	Key Performance Indicator(s)
kt	Kilotonnes
ktCO2eq.	Kilotonnes of CO2 Equivalent
kV	Kilovolts
LCOE	Levelised Cost of Energy
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
M&E	Monitoring and Evaluation
m3	Cubic Metre
MMBtu	Million British Thermal Units
MMscf	Million standard cubic foot
MMscf/d	Million standard cubic foot per day
MMt	Million Metric Tonnes
MMt/a	Million Metric Tonnes per annum
MOU	Memorandum of Understanding
MRG	Methane Rich Gas
MSB	Modified Single Buyer
Mt	Metric Tonne
MT	Megatonne
MtCO2eq.	Million tonnes of CO2 equivalent

Acronym	Definition
MTO	Methanol-to-Olefins
MTPA	Million tonnes per annum
MVA	Mega Volt-Amp
MW	Megawatt
MWac	Megawatts of AC power
MWh	Megawatt-hour
NBF	The NEPAD Business Foundation
NDCs	Nationally Determined Contributions
NEP	National Energy Policy
NEPAD	New Partnership for Africa's Development
NERSA	National Energy Regulator of South Africa
NGL	Natural Gas Liquid
NGO	Non-governmental Organisation
NGUMP	Natural Gas Utilisation Master Plan of Tanzania
NOC	National Oil Company
NOCs	National Oil Companies
NPV	Net Present Value
OCGT	Open Cycle Gas Turbine
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
OPEX	Operating Expenditures
p.a.	Per annum
PCGs	Partial Credit Guarantees
PCI	Projects of Common Interest
PetroSA	Petroleum Oil and Gas Corporation of South Africa
PJ	Petajoule (Million GJ)
PJ/a	Petajoule per annum
PPA(s)	Power Purchase Agreements
PPDU	ECOWAS Infrastructure Projects Preparation and Development Unit
ppm	Parts Per Million
PPP(s)	Public-Private Partnerships
PPPPIF	Public-Private Partnership Policy and Implementation Framework
PRGs	Partial Risk Guarantees
PSA	Production Sharing Agreement
PV	Photovoltaic

Acronym	Definition
RAERESA	Regional Association of Energy Regulators for Eastern and Southern Africa
RE	Renewable Energy
RECs	Regional Economic Communities
REEESAP	Renewable Energy and Energy Efficiency Strategy and Action Plan
REEESAP EA-SA-IO	Renewable Energy and Energy Efficiency Strategy and Action Plan for Eastern Africa, Southern Africa, and Indian Ocean region
RERA	Regional Energy Regulators Association of Southern Africa
RFI	Request for Information
RFP	Request for Proposal
RGMP	Regional Gas Master Plan
RGMP I	Regional Gas Master Plan Phase I
RGMP II	Regional Gas Master Plan Phase II
RIDMP	Regional Infrastructure Development Master Plan
RISDP	Regional Indicative Strategic Development Plan
RMCs	Regional Member Countries
RMIPPP	Risk Mitigation Independent Power Producer Procurement Programme
ROMPCO	Republic of Mozambique Pipeline Company
RoR	Revenue Requirements
RoW	Rest of the World
RSC	Risk Service Contract
SACREEE	The Southern African Development Community (SADC) Centre for Renewable Energy and Energy Efficiency
SADC	Southern African Development Community
SAGP	Southern African Regional Gas Aggregator
SAPP	Southern African Power Pool
SARERA	SADC Regional Energy Regulatory Authority
SDG	Sustainable Development Goals
SDG 7	Sustainable Development Goal 7
SDIs	Spatial Development Initiative(s)
SEA	Strategic Environmental Assessment
SMEs	Small and Medium-Sized Enterprises
SOE(s)	State-Owned Enterprise(s)
SPA(s)	Sale and Purchase Agreements
SPS(s)	Sustainable Power Solution(s)

Acronym	Definition
SSA	Sub-Saharan Africa
ssLNG	Small-scale Liquefied Natural Gas
Syngas	Synthetic Gas
TCF	Trillion cubic feet
tCO2eq.	Tonnes of CO2 equivalent
TGUMP	Tanzanian Gas Master Plan
ToR	Terms of Reference
TPA	Third-Party Access
TSO(s)	Transmission System Operators
TTF	Dutch title transfer facility
TWh	Terawatt hour
Tx	Transmission Tariffs
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNSD	United Nations Statistics Division
US	United States
US$	United States dollar
USAID	United States Agency for International Development
WAGP	West Africa Gas Pipeline
WAPP	West African Power Pool
WBC	Walvis Bay Corridor
WBCG	Walvis Bay Corridor Group
WEC	World Energy Council
WEF	World Economic Forum
WHO	World Health Organisation

FOREWORD FROM THE EXECUTIVE SECRETARY OF SADC

It is important that we adequately outline our strategy for the implementation of the RGMP, taking into consideration that the Plan serves as a mechanism that will facilitate development of gas infrastructure, industries and markets.

The 43rd Ordinary SADC Summit of Heads of State and Government held in Luanda, Republic of Angola, in August 2023, adopted the SADC Regional Gas Master Plan (RGMP) 2023-2038. The SADC RGMP 2023-2038 is a comprehensive gas infrastructure investment blueprint for the Region. In adopting this Plan, the SADC Heads of State and Government recognised that energy infrastructure development is pivotal in accelerating the attainment of the collective aspiration of regional integration and development. At the same time, energy infrastructure development meets the objectives outlined in the SADC Industrialisation Strategy and Roadmap 2015-2063.

The formulation of the SADC RGMP 2023-2038 opens opportunities for the SADC region to develop gas infrastructure projects, which would constitute the basis for gas-to-power infrastructure and promote industrialisation in the SADC region while in the long term, contributing to energy security, job creation and economic growth. The development of the Plan is in line with our unwavering commitment to the Just Energy Transition at both regional and global levels which calls for a shift towards the use of renewable energy sources.

This Plan which contains projects to be implemented over a 15-year period until 2038, has identified actions that encompass regional policy convergence, creation of an enabling regulatory framework and clustered SADC Member States into the proposed six corridors. In addition, the Plan has put in place institutional arrangements that will be implemented to empower existing regional entities with oversight responsibilities for regional gas programmes and projects, recognising that the sector requires a highly skilled, specialised, and innovative manpower.

The RGMP 2023-2038 recognises that SADC Member States are at different levels of gas infrastructure development. Some Member States have developed gas-to-power plants, pipelines and liquefaction facilities which are used to convert liquefied natural gas (LNG) through gas-to-liquids (GTL) processes for ease of transportation as well as LNG storage and regasification terminals. Other Member States are actively promoting gas-based industrialisation through petrochemical industries for production of fertilisers that are scheduled to be commissioned prior to 2038. The programmes and projects in their initial phases will be packaged through funding from the regional and continental Project Preparation Facilities (PPFs) which provide initial capital for project preparation to make them bankable. Moreover, existing global mechanisms will be utilised to ensure the development of a pipeline of bankable projects in the region, which will, in turn, attract funding from both public and private investors.

It is important that we adequately outline our strategy for the implementation of the RGMP, taking into consideration that the Plan serves as a mechanism that will facilitate development of gas infrastructure, industries and markets.

This Plan reinforces our collective recognition of infrastructure development as the bedrock for deepening regional integration and economic development. In that spirit, we express our sincere gratitude for the support received from the Government of the Republic of South Africa, particularly the Industrial Development Corporation (IDC) and the Development Bank of Southern Africa (DBSA) who have been the primary sponsors of the RGMP development process. I urge Member States and International Cooperating Partners to render support towards the development of the identified regional gas projects outlined in this Plan to complement our on-going efforts in enhancing energy security and driving the regional industrialisation agenda**.**

H.E. Mr. Elias Mpedi Magosi
Executive Secretary of Southern African Development Community

PREFACE FROM THE DEPUTY EXECUTIVE SECRETARY FOR REGIONAL INTEGRATION

"The development of natural gas in the energy sector reflect the unwavering commitment of the SADC region towards the attainment of the United Nations (UN) Sustainable Development Goal (SDG) numbers 7 and 9."

Robust infrastructure has long been identified as a necessary enabler of the SADC regional industrialisation agenda. The SADC Industrialisation Strategy and Roadmap 2015-2063 which guides the SADC regional industrialisation agenda has identified various forms of energy as a crucial factor for enabling industrialisation and economic growth.

SADC recognises that ensuring the security of energy supply, which manifests through energy availability, reliability, accessibility and affordability contributes to economic growth, poverty alleviation, and general livelihoods improvement. By ensuring energy security, the SADC region is well poised to achieve regional integration aspirations espoused in the SADC Regional Indicative Strategic Development Plan 2020-2030 and the SADC Vision 2050.

It is worth noting that the SADC region has made significant progress in energy transition, through the implementation of various legal and policy frameworks, which include amended SADC Protocol on Energy and strategic documents such as the Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP) 2016-2030, the Southern African Power Generation and Transmission Master plan (SAPP Pool Plan) 2018 and the Regional Energy Access Strategy and Action Plan (REASAP) 2020-2030. This success in energy transition is attributable to the commendable commitment of SADC Member States.

Considering the access to electricity and modern energy services, the Region currently has a weighted average access rate of 55 percent, indicating the need for further efforts to increase access rate across Sub-Saharan Africa. For a long time, the SADC region has traditionally been reliant on coal, hydropower, nuclear power, and distillate fuels, despite being endowed with alternate energy sources such as natural gas, solar, wind and bioenergy. However, the Region is actively working towards diversifying its power generation mix while striving to reduce the dominance of coal, hydropower, nuclear power, and distillate fuels.

The discovery of natural gas in the SADC region, particularly in Angola, Mozambique, Namibia and the United Republic of Tanzania, has proven to be a significant "game changer" in the regional energy sector and

the entire petrochemical industry. Some Member States like Botswana, South Africa, Zambia and Zimbabwe have reported substantial reserves of coal bed methane (CBM) gas that is yet to be exploited. It is important to note that natural gas is categorised as a low-carbon energy source. Unlike other hydrocarbons, natural gas can be directly used for heating purposes, and through petrochemical industry processes, it can be converted to produce fertilisers and other applications.

The development of natural gas in the energy sector reflect the unwavering commitment of the SADC region towards the attainment of the United Nations (UN) Sustainable Development Goal (SDG) numbers 7 and 9. SDG number 7 focuses on ensuring reliable access to affordable, reliable and sustainable and modern form of energy; SDG number 9 emphasises on building resilient infrastructure, promoting inclusive and sustainable industrialisation, and fostering of innovation, while at the same time working towards a shift in energy sources as stipulated in the Glasgow Climate Pact 2021.

This energy transition will entail the adoption of low emission technologies, aimed at reducing reliance on fossil fuels, especially in power generation, through implementation of gas-to-power projects. Furthermore, the utilisation of gas in smaller quantities will be facilitated by establishing liquefaction facilities, enabling its conversion into liquefied natural gas (through gas-to-liquids processes along the projected six (6) main corridors. These initiatives are aligned with identified energy requirements, industrialisation plans, existing infrastructure.

The implementation plan of this RGMP 2023–2038, outlines the timebound activities, institutional arrangements for overseeing the infrastructure implementation and the roles of Member States and regional organisations. The SADC Secretariat will be responsible for the coordination and reporting of the progress in the implementation of this Plan.

The RGMP 2023–2038 complements the implementation of the ongoing prioritised projects derived from the RISDP 2020-2030 under Pillar II on Infrastructure Development in support of Regional Integration, as well as the second short-term action plan of the Regional Infrastructure Development Master Plan (RIDMP STAP II) 2023 – 2027. By promoting energy security and enhancing access to cleaner energy sources, we are confident that the successful implementation of this RGMP 2023 – 2038 will contribute to the realisation of the SADC Vision 2050 of a peaceful, inclusive, competitive, middle-to-high income industrialised Region.

Ms. Angela Makombo N'Tumba
Deputy Executive Secretary of Southern African Development Community - Regional Integration

EXECUTIVE SUMMARY

The global energy transition, driven by our shared need to decarbonise, and the increased and sustained deployment of renewables, has led to a profound change in energy systems. This change, not limited to the variability introduced with renewables within utility scale power systems, but also within the domains of mobility, small-scale and embedded generation, the Fourth Industrial Revolution (4IR) and the underlying shifts of digitisation, amongst others, is fundamentally altering the supply, demand, and management of energy carried to end-users.

Member States of the Southern African Development Community (SADC) are having to contend with this transition within the backdrop of an urgent need to secure reliable and economically viable sources of energy to drive development, economic growth, and prosperity for all within the region.

The Member States, with significant indigenous gas resources, recognised natural gas as a key transitionary fuel, contributing towards greenhouse gas emission reductions, while providing dispatchable power cost-effectively and reliably to energy systems. Furthermore, natural gas can facilitate longer term industrialisation as a petrochemical feedstock, and as a reliable and cost-effective industrial heating source.

The 37th SADC Summit of the Heads of State and Government held in Pretoria, South Africa in August 2017 thus directed the SADC Secretariat to coordinate and constitute an Inter-State (Regional) Gas Committee to promote the inclusion of gas in the regional energy mix and for industrial development. In addition, at the meeting hosted virtually by Mozambique on 30 October 2020, the SADC Ministers responsible for Energy received and considered reports on the high-level implementation plan of Phase I of the Regional Gas Master Plan (RGMP I) and urged Member States to develop gas infrastructure and markets in the region. The Ministers also endorsed the roadmap for Phase II of the Regional Gas Master Plan (RGMP II). The RGMP considers the optimal balance of gas supply (domestic, regional, international), gas demand (power, heating, petrochemicals, mobility) and the infrastructure development required. Infrastructure development, specifically within the gas value chain requires guaranteed off-take at scale necessary for bankability and investment. The fundamental implication is that the power sector must anchor investment, thereby facilitating secondary demand and industrialisation.

Historically, gas in the region has been produced from a (now depleted) offshore field in South Africa, associated gas in Angola and onshore fields in southern Mozambique and Tanzania. In the absence of further discoveries near the onshore fields, supply from these resources is due to start declining within the next 10 years. At the same time, the region has seen the discovery of very substantial gas resources in northern Mozambique and Tanzania, and lately off the coast of South Africa and Namibia. These discoveries have placed the region at the forefront of the global Liquefied Natural Gas (LNG) and natural gas landscape. Despite these discoveries, the region remains mired in energy poverty, emphasising the need for competitive and sustainable energy supply. Due to this energy poverty, there is a large dependence on biomass (wood fuel) to meet energy needs, which has direct socio-economic and environmental consequences. Industrialisation is also low with limited petrochemical and fertiliser production. SADC Member States have growing populations and an urgent need to drive inclusive economic growth, reduce poverty and income inequality, and create prosperity and well-being for all.

In parallel, there is a need to address global warming and the region has committed to attaining the United Nations Sustainability Development Goals (SDGs), through Nationally Determined Contributions (NDCs), to ensure access to affordable, reliable, sustainable, and modern energy for all and therefore to substantially increase the share of renewable energy in the region's energy mix. This, against a backdrop of having some of the best solar and wind power potential in the world. Indigenous natural gas can play a key role in achieving these goals by providing a complementary dispatchable source of energy and expediting the development of the power grid in renewable resource rich areas. In this way, gas can accelerate the energy transition to a lower carbon future for the region.

Therefore, the decisions made within the region must balance the needs of economic growth with environmental sustainability. The energy systems must decarbonise while ensuring energy access, security, stability, and affordability and thereby enabling sustainable, equitable, and inclusive economic growth.

There is large opportunity for the region, by unlocking its domestic gas resources and, in so doing, meeting the energy needs of its citizens whilst accelerating the path to a low carbon future for the region.

The Regional Gas Master Plan was therefore premised on the following Vision and Strategic Framework:

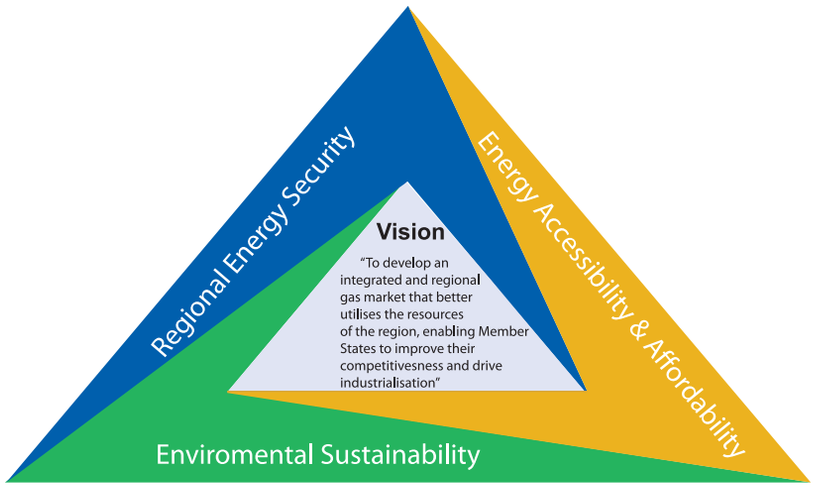


Figure 1: RGMP Vision and Strategic Framework Plan

To attain this Vision there are several strategic goals which must be achieved:

Adopt a regional energy security focus within SADC
All countries in the region need to commit to including a consideration of regional resources in their energy planning and wherever possible to prioritise the least cost energy mix on this basis. This will best be implemented through Integrated Energy Planning.

Expedite LNG export projects
Many of the region's large gas resources are ideally suited for the production of LNG into global export markets. This provides a key baseload demand for the region to begin monetising its large gas resources. It also acts as an important source of export for many countries. It is critical therefore that these large LNG projects proceed.

Utilise domestic and regional gas to meet regional mid-merit power demand
Domestic supply and royalty gas commitments incorporated in concession agreements, field development plans and contracts associated with these LNG developments are an important tool for governments to ensure supply of gas to the local market. It is however important that demand, of a sufficient scale and value, is created to ensure that such supply of domestic gas is economically viable. Gas-to-Power (GTP) is the most viable monetisation alternative to anchor such economically viable demand.

GTP projects should be developed utilising domestic offshore and onshore resources and the Southern African Power Pool (SAPP) grid should be reinforced such that power can be wheeled to the main energy demand centres. Gas producing countries should provide a clear estimate of the volumes, timing and price range of gas resources that will be made available for domestic and regional consumption. SADC countries also need to make firm commitments regarding the (GTP) volumes that they would be willing to off-take. While this must be done via a competitive bidding process, it should be done in a way that can underpin long term investment in power distribution and generation infrastructure in the region. As such, Independent Power Producer (IPP) programmes should be opened to regional bidders.

Utilise imported LNG to meet current industrial demand and substitute diesel in peaking plants
LNG terminals should initially be developed to replace gas volumes for current industrial demand, utilising existing infrastructure as far as possible. Once this demand has anchored the development of the necessary infrastructure, the LNG can be utilised to substitute diesel usage in peaking plants, on an aggregated basis.

Develop pipeline infrastructure to create integrated gas supply/demand systems where gas resources are close to demand

Pipelines should be considered to link gas resources with current demand. This is particularly relevant for areas where current gas resources are depleting such as Tanzania or where there is a large demand node in fair proximity to the source such as from the Orange Basin to the Western Cape.

Facilitate regional industrialisation through the development of petrochemical facilities close to gas resources

The development of GTP facilities in the region should contribute to overall industrial competitiveness by improving energy reliability and reducing the overall cost of power. However, the role that natural gas can play extends beyond the integrated energy sector (power, transport, and heating), with the effective utilisation of cost-competitive gas resources as a petrochemical feedstock. These facilities will be competing with world scale global facilities, utilising low-cost gas and established facilities, and therefore require very cost competitive gas and infrastructure to enable them. As such, they should be established at locations close to the large-scale gas resources, but in areas with good port and infrastructure potential, such as Nacala, Soro or Mtwara.

Access commercial and domestic markets through LPG and CNG

As a result of the lack of access to clean cooking, most people in sub-Saharan Africa rely on biomass for cooking, especially in rural areas. This impacts health dramatically and impairs productivity, with the burden falling disproportionately on women. The unsustainable harvesting of firewood also contributes to climate change. A long-term goal of the region is to provide affordable energy to all citizens including those in rural areas which may not be accessible through a power grid. These areas rely heavily on biomass for their energy needs and this should be substituted over time utilising Liquefied Petroleum Gas (LPG) and Compressed Natural Gas (CNG). The other advantage of developing an LPG sector in SADC is that can act as a “seed market” for natural gas.

Increase momentum of energy transition through facilitation of renewable energy and hydrogen economy

Ultimately the use of regional natural gas resources should unlock additional investment in renewable energy by strengthening grid infrastructure in the region, particularly in areas with high renewable energy potential such as Namibia and the Northern Cape. The development of blue hydrogen projects can also be an enabler of green hydrogen.

Should this strategy be followed, investment to the value of ~US$17 billion in much needed power and gas distribution infrastructure and power generation can be unlocked as per the following Infrastructure Investment Blueprint:

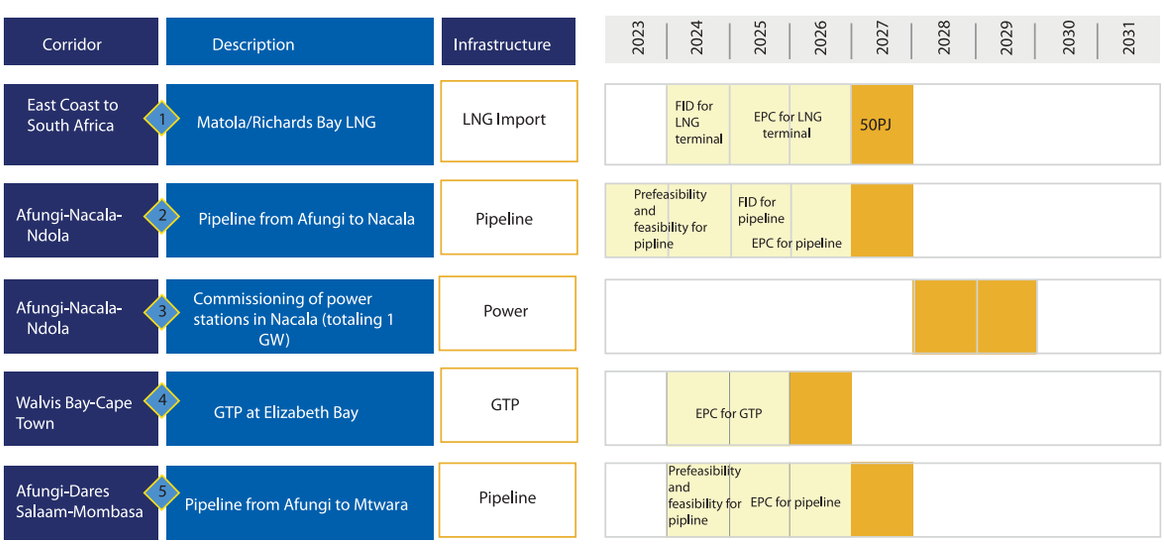


Figure 2: Prioritised Proposed Regional Infrastructure Projects

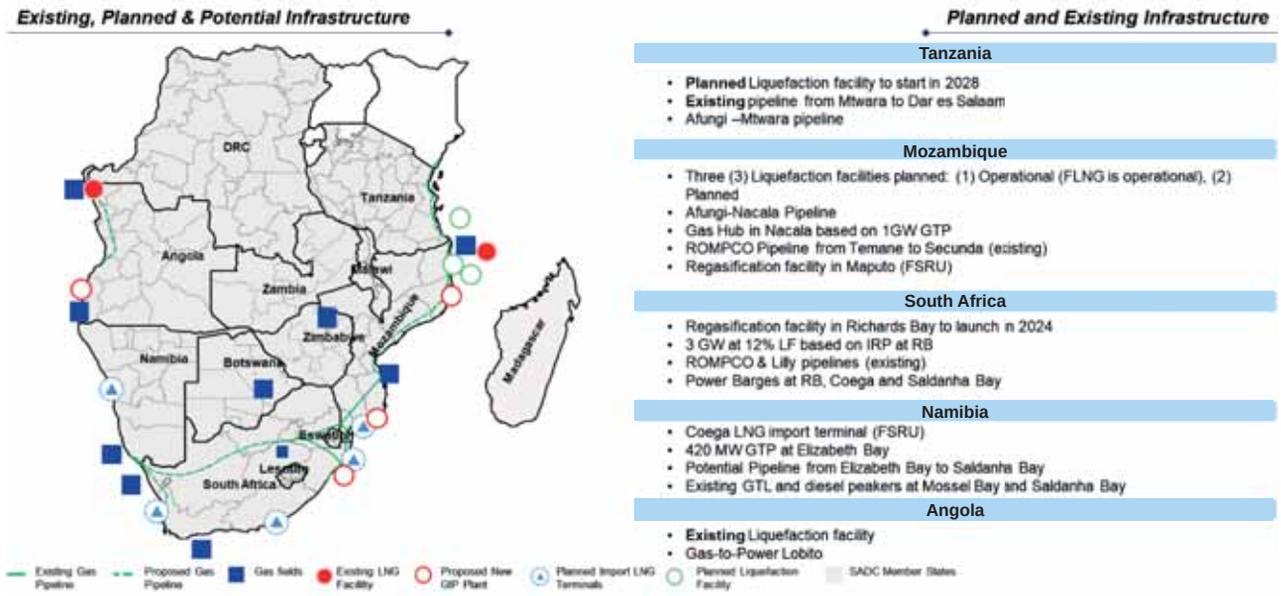


Figure 3: Existing, Planned and Potential Infrastructure Mapped

There are also a number of key enabling dimensions which must be addressed in order to realise this Vision and Infrastructure Blueprint.

Table 1: Key Enabling Dimensions to realise the RGMP Vision and Infrastructure Blueprint

Goal	Outcomes	Rationale
A. Policy Convergence	• Promotion of regional integration • Regional energy security • Diversification of the regional energy mix • Promotion of industrial development within SADC • Encouraging participation of the private sector in the gas supply industry value chain • Ensuring a Just Transition	As a region, the single biggest obstacle to development of a regional gas market is the lack of a coherent policy environment on a national level integrating regional gas into the energy mix. Policy development and regional policy alignment should be prioritised and ensure a careful balance between the needs of Member States to protect national resources and security of energy supply with environmental imperatives and a drive to net zero carbon energy supply, whilst attracting investors into the gas value chain and ensuring competition. Integrated Energy Planning, on a national and regional level, is a critical tool for SADC Member States to manage the energy trilemma and make timely, informed
B. An Enabling Regulatory Framework	• Ensuring security of regional supply • Protecting end user interest through transparent and fair pricing • Promoting investment by reducing barriers to entry, enhancing competition and enabling easy entry for new players • Facilitating cross border trade through harmonised gas network codes and clear licensing requirements, • Addressing dominancy in the vertical value chain • Ensuring safety and environmental sustainability in the industry	The regulatory framework and mechanisms should facilitate competition and ensure easy access to the market through an investor friendly regulatory framework which also addresses national needs. The current fragmented regulatory landscape could make the prospects of regional integration and regulatory harmonisation difficult to achieve and so it is recommended that it be approached in a phased manner, starting with bilateral cooperation between countries with existing gas markets and aligned with the clusters and economic corridors. Member States with existing gas markets should lead the way in terms of regulatory harmonisation (both technical and economic) following convergence on a policy level. Thereafter multilateral and then regional harmonisation can take place.

Goal	Outcomes	Rationale
C. Market Development	• Fair and transparent pricing which addresses national and regional needs and currency risk • Harmonised and transparent wheeling tariffs • Bankable contracts that are aligned across the value chain	Market development cannot occur without demand being anchored, supply secured, and infrastructure developed. Immediate and comprehensive regional integration is unlikely and a phased approach to market development and integration should be taken. A critical aspect of the gas market development is therefore ensuring anchor demand from potential large-scale national gas markets and bankable signed off-take agreements with anchor tenants (either electron or molecule). This is likely to be conducted on a national basis and facilitated through national aggregators.
D. Capital and Investment	• Integrating physical infrastructure is both a precursor to, and an enabler for deeper economic integration, thereby allowing countries to benefit from scale economies. • Capital is required to develop the energy infrastructure of SADC, particularly where individual Member States might not be able to fund such ventures	Regional institutions must facilitate agreements and compensation to ensure that the region invests in energy distribution infrastructure. This has two components: - Ensuring that the SAPP grid is strengthened and expanded to improve energy integration and allow for the development of large scale GTP close to gas sources - Development of gas pipeline networks that can create integrated supply/demand systems by joining multiple points of demand and supply. There should be consideration for setting up an Energy Fund for the SADC.
E. Facilitating gas-based industrialisation through petrochemicals and industrial development	• Industrial sites established with access to secure & affordable energy • Gas-based petrochemicals sector developed utilising affordable indigenous gas	Regional industrialisation should take place through access to secure and affordable energy. Thereafter gas-based petrochemical facilities should be established at industrial hubs with access to affordable gas. Private Partnerships (PPPs) should be employed to establish the hubs (utilities, services etc). Regional cooperation in terms of the downstream product markets (fertilisers etc) should also be encouraged.
F. Development of a Highly Skilled and Innovative Workforce	• Sharing knowledge and experience • Skills Development Framework • Technical Skills Development	The SADC region can benefit from Member States with more mature education systems, and those with established gas industries and therefore sharing of knowledge and experience becomes a tangible enabler. The objective of the RGMP Skills Development Framework, is to provide a blueprint for which Member States can align skills development initiatives, ensuring the skills needed for gas market development are considered and met.

1. INTRODUCTION

1.1 Background to the Regional Gas Master Plan (RGMP)

The Southern African Development Community (SADC) Vision 2050 is determined to achieve a common future, within a regional community that will ensure socio-economic well-being, improvements of the standards of living and quality of life, freedom and social justice, peace, and security for the people of southern Africa. The SADC Heads of State and Government further resolved to move towards Vision 2050 by leveraging areas of excellence and implementing priorities to achieve inclusive and sustainable socio-economic development through the removal of all barriers to deeper integration and guided by the purposes and principles of the SADC Treaty and Agenda.

The SADC Regional Indicative Strategic Development Plan (RISDP) 2020-2030, pronounced regional integration as its core objective, as part of its role in the building blocks for the African Union (AU) integration. SADC RISDP 2020-2030 also established Pillar 2 to focus on development of infrastructure including different forms of energy to support regional integration. Similarly, the SADC Industrialisation Strategy and Roadmap 2015-2063 identified agro-processing, mineral beneficiation as well as manufacturing value chain development as three key growth paths for industrialisation of the region, with removal of non-tariff barriers to enable and promote intra-regional trading.

Development of the enormous natural gas resources in the SADC region can provide energy security and industrial development, support economic growth, foster development and contribute to fiscal revenue generation. However, the supply potential exceeds short-term opportunities for domestic consumption due to the national economies still being relatively under-industrialised. There is, therefore, a need to determine the potential value chains associated with gas, evaluate opportunities for regional gas trade, as well as domestic gas monetisation opportunities. Given that these are interdependent, the development of a Regional Gas Master Plan (RGMP) was required. It is important for the region to look beyond national borders and identify potential demand and uses for natural gas regionally and throughout the rest of Africa. Given the regional interdependencies and the substantial investments required to unlock and bridge supply and demand, a regional view on natural gas monetisation is needed. As such, the RGMP intends to provide decision-makers with a tangible roadmap to unlock the development of SADC's regional gas potential.

1.2 Strategic and Policy Linkages

The SADC Regional Gas Master Plan is rooted in global, continental, regional and national policies, and strategies, focusing on regional integration, industrialisation, and sustainable development. All SADC Member States have adopted 17 ambitious policy goals to end poverty, protect the planet, promote gender equality, and ensure prosperity, as part of the United Nations Sustainable Development Agenda, and are committed to achieving specific targets by 2030.

The SADC region has a specific set of key issues that requires focus and intervention which, in turn, means that different Sustainable Development Goals (SDGs) will be prioritised over others. The SDG 7 seeks to ensure access to affordable, reliable, sustainable, and modern energy for all. This is a critical need in the SADC region, which aims to substantially increase the share of renewable energy in the global energy mix, and to double the improvement of energy efficiency. Progress on this goal translates to progress on all the above listed priorities. The RGMP advocates for the use of natural gas to assist the region to provide affordable and reliable energy to its citizens while enabling the advancement of renewable energy by providing a complementary dispatchable source of energy.

The African Union (AU) Agenda 2063 is Africa's blueprint and master plan for transforming Africa into the global powerhouse of the future. It is the strategic framework that aims to deliver on inclusive and sustainable development and has seven key aspirations[1]. The SADC RGMP aims to support the AU Agenda 2063 by ensuring that the region's natural gas resources enable the energy transition and thereby sustainable development of the region. It also aims to ensure an integrated continent through the development of regional infrastructure, policy convergence, regulatory harmonisation, and market integration.

[1] African Union (AU), 2013, Agenda 2063: The Africa We Want

Finally, the focus that every country has placed on achieving the SDGs, and their NDCs to the Paris Agreement, has led to a concerted regional effort to bridge the energy gap in the SADC region over the last ten years. SADC Member States have strengthened energy policy and regulations, advanced infrastructure, expanded grid connections, increased knowledge of off-grid energy solutions, and more. This study sought to ensure that the relevant strategic and policy decisions taken by SADC on a regional level and Member States on a national level were considered and integrated, ensuring alignment and consistency in planning, as illustrated in the figure below.

Figure 4: Alignment of Regional Gas Master Plan

2. THE APPROACH AND METHODOLOGY

A defined approach was undertaken incorporating two distinct delivery Phases for the RGMP (i.e., RGMP I and RGMP II). Phase I of the RGMP commenced in January 2020 and concluded with the development of the RGMP Conceptual Framework. At a meeting hosted virtually by Mozambique on the 30th of October 2020, the SADC Ministers responsible for Energy received and considered reports on the high-level implementation plan of RGMP I and urged Member States to develop gas infrastructure and markets in the region.

The Ministers endorsed the roadmap for Phase II of the RGMP and commended the Development Bank of Southern Africa (DBSA) for supporting the development of RGMP I. They also commended DBSA and the Industrial Development Corporation (IDC) for offering to support RGMP II.

Phase II, which commenced in December 2021, incorporated the development of the RGMP Vision & Strategy and concluded with the Infrastructure and Market Development Blueprint and Implementation Plan.

This overall methodology is further described in the figure below, with the work packages being the key deliverables undertaken during each stage

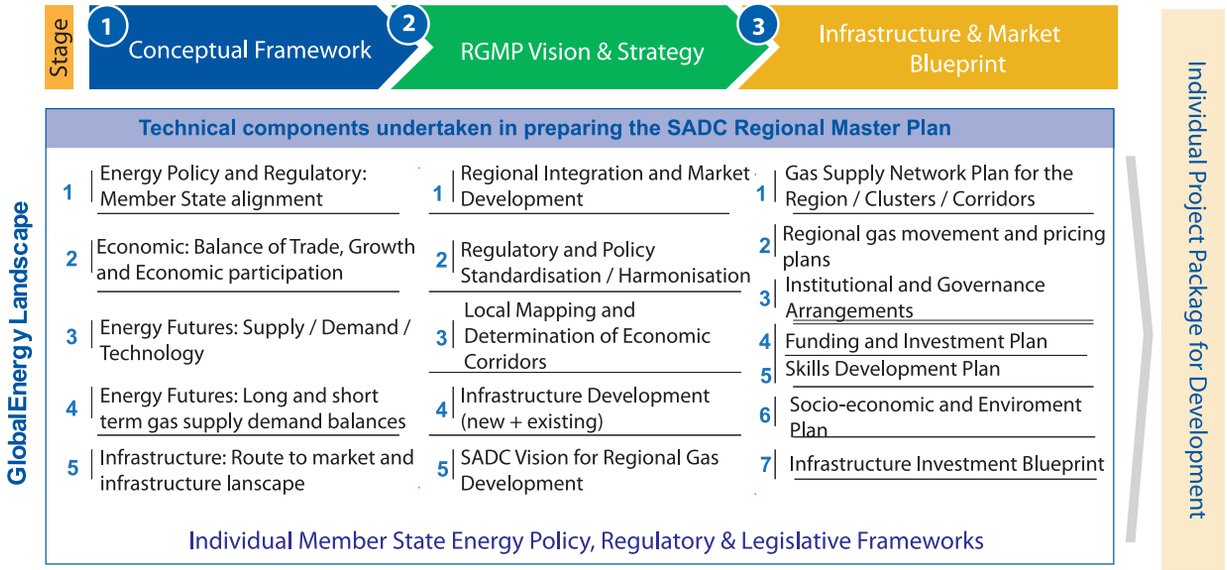


Figure 5: RGMP Approach and Methodology

In developing the RGMP, two boundary conditions exist, namely:

1. the 'Global Energy Landscape' that is characterised by the drive to decarbonise and the energy transition to a new global energy system structure, and

2. the individual Member States' Energy Policy, Regulatory & Legislative Frameworks as defined by the stated policy of said Member States.

The boundary conditions define the scope within which the analyses of the RGMP were undertaken. This includes likely technology development paths and cost-curves, changes in the energy system structure and the opportunities and challenges that must be overcome in such changes. Furthermore, the stated policy context provided the defined policy environment within which energy and infrastructure development is planned for Member States. Where deviation from stated policy occurred, the rationale is clearly articulated and is substantiated through techno-economic considerations.

The following Phases were undertaken:

- Phase I: Conceptual Framework,
- Phase II: RGMP Vision & Strategy, and
- Phase II: Infrastructure & Market Development Blueprint and Implementation Plan.

2.1 Phase I: The Conceptual Framework

To achieve the outcome of creating a viable blueprint for regional integration and development over a 30-year horizon, several key analyses across the supply, demand, policy & regulatory environments were conducted as inputs towards developing the long-term outlook. Due to the levels of uncertainty, especially in relation to the energy transition and the time horizon specified, a scenario-based approach was utilised and modelled across supply and demand towards achieving equilibrium.

The long-term forecasting approach was demand focused, considering key segments, base developments per segment and impacts of industry-specific trends on demand. Gas supply requirements considered stated policy intentions (e.g., the country specific Integrated Resource Plans (IRPs)) and was escalated/deflated in line with demand growth projections and industry trends.

These provided the key focus areas for country integration, sector development and infrastructure development.

2.2 Phase II: RGMP Vision and the Infrastructure Development Blueprint

Phase II of the RGMP process included the development of the RGMP Vision and Strategy as well as the development of the Infrastructure and Market Development Blueprint and Implementation Plan.

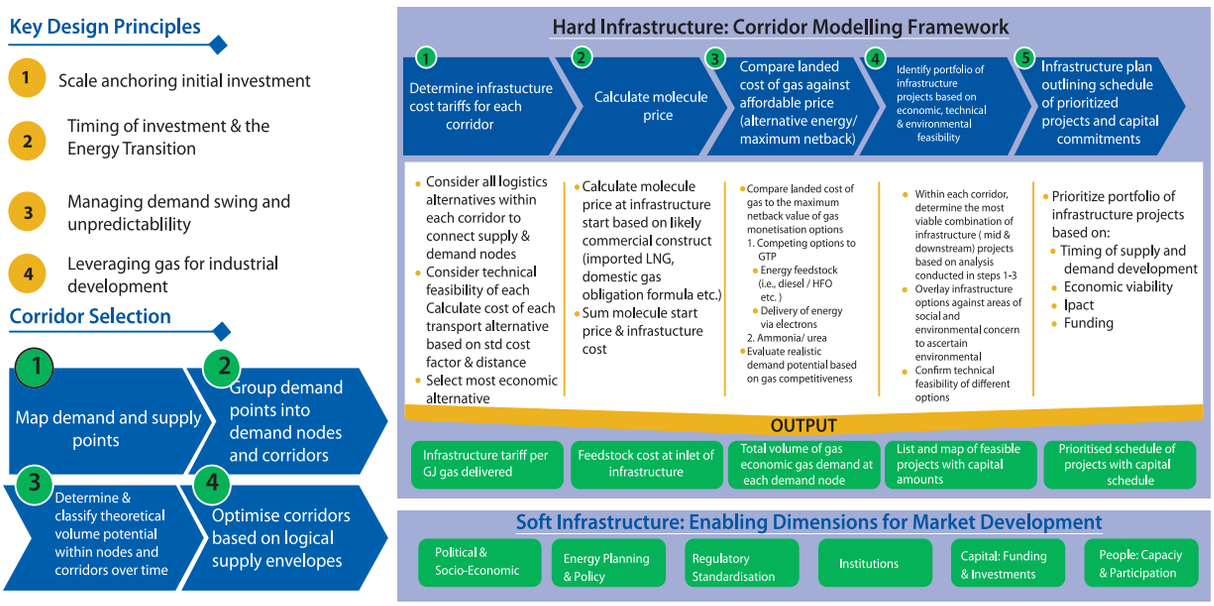


Figure 6: Framework for Developing Phase II of the RGMP and the Infrastructure Blueprint

The following key dimensions were considered for the development of the regional gas market:

- supply envelope and access to natural gas molecules either via imported LNG or domestically/ regionally produced gas,
- route to market options and regional infrastructure that will allow the transport and trading of molecules, electrons (from GTP), or petrochemical products, and
- demand from downstream off-takers and end-users.

Enabling conditions are required to facilitate investment across the value chain. This includes investment in:

- supply options, including gas field exploration, development and production, and LNG liquefaction;
- infrastructure to connect supply and demand, including ports, LNG regasification and storage facilities, pipelines, rail, and road networks; and
- industrial demand applications, including power generation, petrochemicals, and heavy industry.

Market development does not happen in isolation. Enabling factors must be present to attract investment and catalyse the required development. The enabling dimensions considered included:

- **Political, Socio-economic & Environmental**. Geopolitics of energy, and the Just Energy Transition.
- **Capital and Investment**. The availability of capital and the macro-economic and fiscal conditions for investment.
- **Policy, Legislative & Regulatory.** Policy direction, legislative and regulatory frameworks, with maturity, certainty, and consistency in application.
- **Institutional Arrangements.** Roles and responsibilities of key governance entities within the regulatory, public, and private domains.
- **Infrastructure & Market Structure.** Quality of infrastructure, market size and third-party access.
- **People: Capacity & Participation.** The necessary skills, competencies, and talent in developing technical value chains and thereby providing the human capital.

2.3 Regional Integration

African countries have historically ranked low when it comes to competing in the global economy, held back by fragmented markets that inhibit efficiency and constrain economic growth[2]. Regional market integration, and further to that economic integration, can drive greater competitiveness for Member States within the global economy through leveraging comparative advantages in an integrated manner.

The scale of infrastructure investment needed within the energy sector requires markets that are sufficiently large in securing off-take for bankability, and this is not often the case in the SADC region. Key markets such as South Africa can unlock regional domestic gas opportunities for the benefit of all. Such collective integration allows for the access of potentially lower cost energy than what would be achieved through individual efforts.

That is, integration can be of mutual benefit for both the energy importing Member State, as well as the energy exporting Member State. The mechanisms of integration will depend on balancing sovereign requirements with the benefits that integration can unlock.

Regional integration for Member States within the gas sector can be achieved through value chain integration, across several inter-related value chains as reflected below.

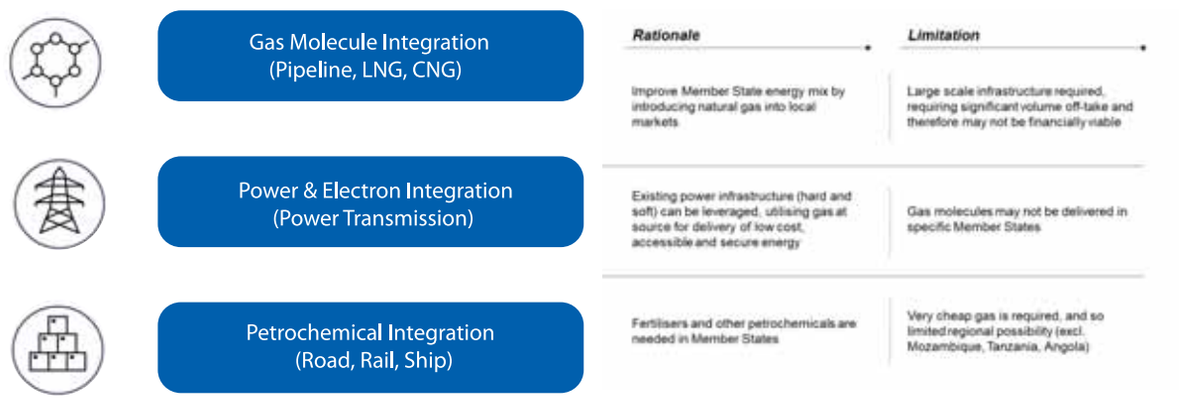


Figure 7: Integration Options and Opportunities

Techno-economic considerations, as well as long-term sustainability should guide decisions in this regard. Therefore, the following underpinned the RGMP considerations:

- short-term: lowest cost option with viable technology delivery mechanisms that enable energy security, accessibility, affordability, and sustainability; and
- long-term: mitigate risks associated with stranded assets.

Furthermore, investment in infrastructure creates value chains that have broader economic benefits, requiring an integrated and value chain approach to market development.

2.4 Industrial Development and Private Sector Participation

The supply potential of gas in the region exceeds the short-term demand owing to the relatively unindustrialised economies of SADC Member States. The availability of gas can drive industrialisation in the region, potentially through large-scale projects which anchor demand e.g., GTP, petrochemical complexes, gas-to-liquids (GTL) facilities, ammonia production for fertiliser or blue hydrogen projects.

SADC Member States have obligations to meet several developmental and socio-economic needs of their citizens, which must be enabled by the industrialisation of the region. However, large financial, human, and technological gaps exist in this sector, necessitating private sector support. The Member States therefore advocate for partnership with the private sector in the provision, maintenance, operation, management and ownership of infrastructure, systems, services, and facilities based on different modalities, including public private partnerships.

The purpose of the RGMP will be to serve as a fact base for the sector and will inform and support stakeholder discussions and public policy decision-making processes.

[2] International Monetary Fund, 2021, https://www.imf.org/external/pubs/ft/fandd/2018/12/afcfta-economic-integration-in-africa-fofack.htm

3. EVOLVING MACRO CONTEXT

3.1 The (Just) Energy Transition

The current global energy system transition is a structural one. Yet unlike much of the rest of the world, SADC Member States must contend with, and address, historical challenges of energy poverty, lack of equitable energy access, and poor energy security with persistent power shortages. This acts as a constraint on SADC's regional economic and social development.

However, it is evident that very significant increases in climate change mitigation ambitions will be required urgently, to avert significant climate change impacts and increasing political pressure will be brought on countries to increase their ambitions. How rapid and severe this increase in ambition may be, along with the subsequent impact on regional and country level energy policies, is unclear. Providing reliable forecasts for global energy, including gas demand, is significantly complicated by these policy and technology uncertainties.

Balancing the needs to address energy poverty, increase energy access and affordability while committing to, and achieving, the net-zero targets require a balanced and nuanced approach. Within the SADC context, one must consider the unconscionable state of access to modern energy systems, and the urgent and immediate need for the region to create prosperity for its people. Further to this, the role that SADC Member States have played and continues to play in in global CO2 emissions is negligible.

As renewables become more cost effective and contribute to greater generation capacity in the region, structural challenges of grid stability, due to variable supply from renewables, must be mitigated. Gas can play a meaningful role in the energy transition, due to it facilitating increased renewable uptake, securing energy supply, and diversifying the regional energy mix. The need for a diversified energy mix is an important one. It is unlikely that any new coal projects will be approved due to funding constraints; nuclear is considered a costly option requiring long-term commitments, while climate change is affecting the region's hydro resources[3]. Much of the region is dependent on biomass (wood fuel) for heating and cooking purposes which has environmental and socio-economic concerns, affecting the most vulnerable members of society[4]. This leaves few options for Member States to increase the energy supply and improve energy security in an environmentally sustainable manner.

The large gas discoveries, if adequately integrated through the appropriate route to market options, could create a balanced generation mix while improving system flexibility. The infrastructure investment required can unlock economic development, reduce energy poverty, enhance energy access, and meaningfully address the energy challenges the region faces. However, the opportunity to utilise the region's natural gas resources in addressing its energy transition is one with a defined horizon to action.

3.1.1. Energy Poverty

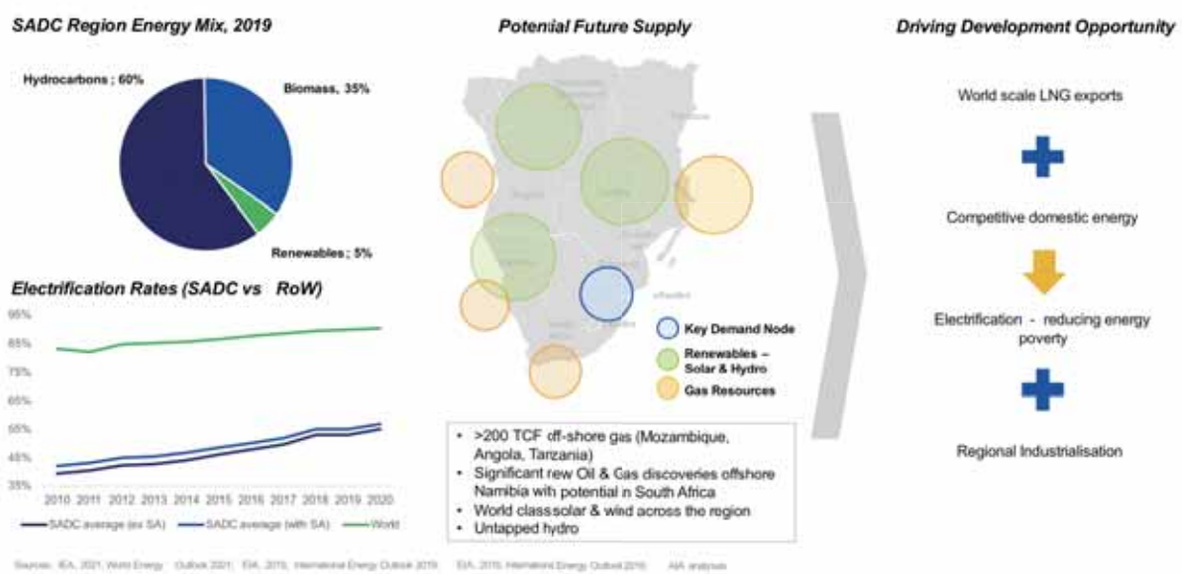


Figure 8: The SADC Energy Landscape

[3] Brooks, C., 2019, EEG Energy Insight: Will climate change undermine the potential for hydropower in Africa?
[4] Clean Cooking Alliance, The Issues, https://cleancooking.org/the-issues/, Accessed March 2022,

According to the SADC Renewable Energy and Energy Efficiency Status Report 2018, 48% of the region's residents have access to electricity[5]. This is comparable with data published by the World Bank, which indicated that sub-Saharan Africa (SSA) had the lowest energy access rates in the world, with 48% of the population having access to electricity in 2020[6]. As shown in Figure 8, even though SADC is endowed with world-class renewable energy potential (particularly solar and hydro) and abundant hydrocarbon resources (especially gas), it remains an energy poor region in which many people must grapple with the challenges linked to energy poverty. The Covid-19 pandemic has adversely affected progress regarding energy access across SSA, which has been illustrated by the decline in the rate of access to electricity across the region in recent years. It is estimated that the current rate of access to electricity in SSA must improve threefold to combat the effects of the pandemic and achieve SDG Target 7.1 by 2030[7].

The lack of access to clean cooking fuels and technologies in sub-Saharan Africa is significant, the rate of population growth continues to outpace the rate of access to clean cooking for many countries within the region[8]. In addition to the difficulties brought on by the pandemic, the lack of access to clean cooking fuels and technologies has been intensified by the recent fuel price spikes resulting from the war in Ukraine. Of the global population that lacked access to electricity in 2021, more than one-third lived within the SSA region. Limited access to clean cooking infrastructure and technology, along with affordable fuels has prompted a heavy reliance on biomass for cooking in Sub-Saharan Africa, especially in rural areas. This impacts health dramatically, impairs productivity, results in air pollution, exacerbates deforestation and compounds the negative effects of climate change[9].

The collection, purchasing and use of biomass can be onerous and, in some instances dangerous. Premature deaths due to household air pollution is a serious consequence of the unsustainable harvesting of fuelwood, a burden falling disproportionately on women and children, who are more likely to spend time near open fires and traditional cook stoves[10].

SADC has the opportunity to utilise its abundant gas resources for LNG exports, thereby bringing in much needed foreign revenue. In parallel, the gas can be used to leverage the more widespread development of the SAPP distribution grid and expedite access to electricity. This, in turn, can incentivise the development of renewable energy projects in areas where gas resources coincide with renewable energy potential. LPG can facilitate improvements in cleaner energy access in residential and commercial sectors, where its ease of transportation and handling can help drive developments in less mature markets within SADC[11]. As such, the LPG sector also represents a significant opportunity for private sector investment to bring clean cooking fuels to the several hundred million consumers in sub-Saharan Africa.

3.1.2. Renewable Energy Landscape

The cost of renewable power has declined significantly over the last decade with the cost of solar and wind power generation all falling dramatically. While robust data on the cost of utility scale battery storage is not readily available, indications are that these costs have declined at a similar pace.

These rapid declines in renewable power generation and storage costs naturally call into question the long-term viability of gas demand. However, sustaining this rapid decrease in costs is likely to become more challenging, particularly as raw material costs are becoming a greater part of the cost base of renewables. The recent rapid increases in the prices of many minerals and key inputs has begun putting pressure on the cost of renewable energy.

To address the uncertainty of the outlook for renewable energy and energy storage, we have used a set of scenarios, shown below, for the future of renewable energy prices. These scenarios have been used in our modelling of gas and GTP projects.

[5] REN21, 2018, SADC Renewable Energy and Energy Efficiency Status Report 2018
[6] IEA, IRENA, UNSD, World Bank, WHO. 2022, Tracking SDG 7: The Energy Progress Report 2022
[7] IEA, 2022, Africa Energy Outlook 2022
[8] IEA, 2022, SDG 7: Data and Projections – Access to clean cooking, https://www.iea.org/reports/sdg7-data-and-projections/access-to-clean-cooking, Accessed November 2022
[9] IEA, 2022, Africa Energy Outlook 2022
[10] IEA, IRENA, UNSD, World Bank, WHO. 2022, Tracking SDG 7: The Energy Progress Report 2022
[11] EA, IRENA, UNSD, World Bank, WHO. 2022, Tracking SDG 7: The Energy Progress Report 2022

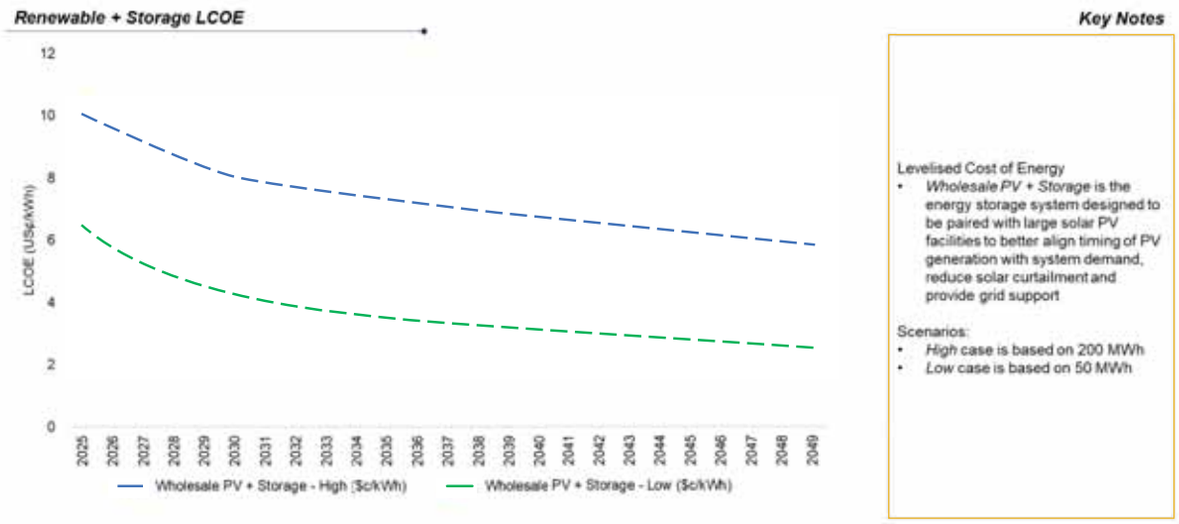


Figure 9: Renewable and Storage Levelised Cost of Energy (LCOE)

3.1.3. Green Hydrogen and Energy Storage

The second important area in which gas is impacted by the energy transition is in its use as a heating fuel and chemical feedstock. Increasing investment is being made to enable the production of hydrogen through the electrolysis of water and using renewable energy, i.e., green hydrogen. These developments could have an impact on the development of a regional gas market as there is the potential threat of displacement of natural gas in key industrial and chemical processes and as an energy source in residential, commercial, and industrial applications by green hydrogen.

There are challenges to the development of a regional green hydrogen market including the scale of renewable energy deployment that would be required in addition to renewable power generation targets; the fact that many projects are export focused and the significant lack of existing infrastructure. This will all impact on the timeframe in which a green hydrogen economy could be developed in the region.

In this study, we have sought to ensure that the regional gas market is developed in a “no regret” manner as far as possible. Therefore, consideration was given to the potential for gas pipeline infrastructure to be used for the transport of hydrogen in future. This also included giving due consideration to where major green hydrogen and renewable power projects are being developed and how the development of regional gas infrastructure can enable such projects in future, through grid enhancements etc.

3.2 Global LNG Market Trends

The global gas market can be divided into an Atlantic Ocean market and an Indian/Pacific Ocean market. The Atlantic Ocean is dominated by the United States (US) and Europe and the Pacific by a combination of large existing importers such as Japan and South Korea and emerging importers such as China, India, Pakistan, and Bangladesh. Prices between the different markets can also vary significantly as they can be driven by very localised dynamics as illustrated in the Figure 10.

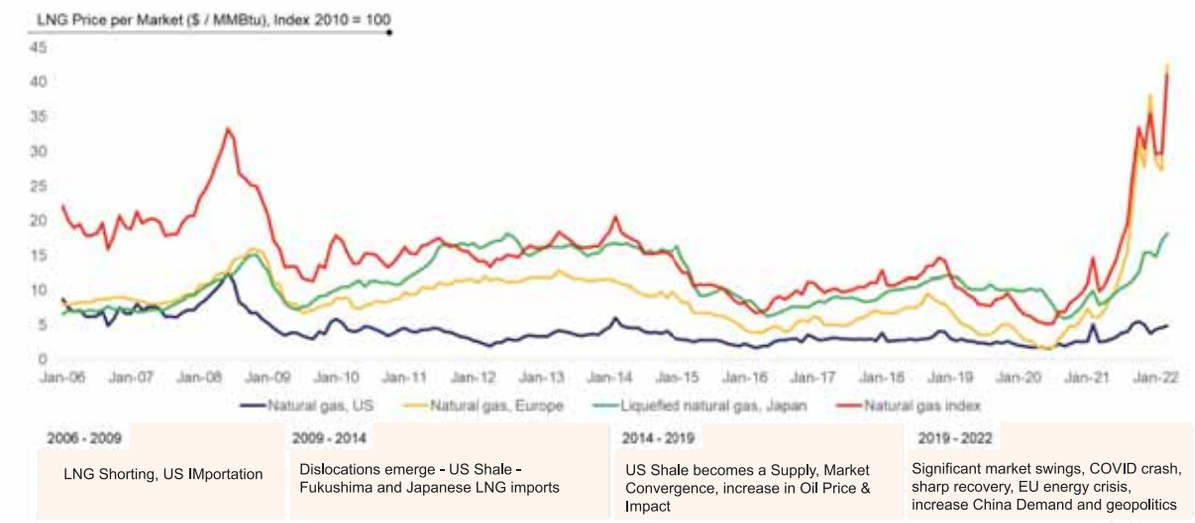


Figure 10: LNG Pricing Outlook

Over the last decade-and-a-half the big driver of global LNG markets has been:
• The shortage of gas in North America for much of the 2000s, leading to a spike in prices as North America had to secure imports. The advent of shale gas and oil production in North America revolutionised the United States market, making it largely self-sufficient in oil (although heavier crudes are still imported) and turned the continent into a major LNG export player.

• In more recent years, the market has been driven by a combination of the economic impacts of Covid 19 and the world's subsequent recovery and then the recent war in Ukraine with the spill-over of those tensions into global energy markets.

In the short-to-medium term, we believe that the plans for Europe to rapidly decrease its gas imports from Russia will be the dominant driver of the global LNG market. Imports from Russia currently account for 40% of total European Union (EU) gas consumption, with some countries like Germany even more reliant on Russia [12]. The EU have announced ambitious plans to reduce these imports by a third by the end of 2022. In the short-term we see these moves having a significantly disruptive impact on global LNG markets.

In the short term therefore, this unexpected volume of LNG imports flowing to Europe will help support LNG prices, not just due to the gas but also much of the associated import and regasification infrastructure (such as Floating Storage Regasification Units (FSRUs) etc). This particularly, as Russia will not be able to easily switch the gas it currently produces from its western Siberian fields to other markets in Asia in the short-term due to infrastructure constraints.

However, plans are currently afoot to develop a pipeline, the "Power of Siberia-2", to link Russia's western Siberian pipelines to China. This is likely to be expanded considering the evolving challenges of energy supply to Europe. It can be expected therefore that as this Russian gas begins to enter markets in Asia, together with a potentially more rapid decline in overall gas demand in Europe, it will constrain gas prices in the medium-to- long term.

The longer-term course of gas demand and prices will likely be heavily influenced by the pace and scale of the energy transition.

[12] International Monetary Fund, 2021, https://www.imf.org/external/pubs/ft/fandd/2018/12/afcfta-economic-integration-in-africa-fofack.htm

4. GAS-BASED INDUSTRIALISATION

Energy is required for economic production and therefore economic growth. Depending on the requirements, energy can come in various forms including Electricity and Heat. Natural gas, through combustion and the generation of heat, can contribute both towards power generation (i.e., electricity) and heating energy (i.e., heat) for industrial applications. Furthermore, natural gas can be used as a petrochemicals feedstock thereby contributing towards industrialisation in various potential ways. For SADC Member States, industrialisation requires the following:

- Accessible and affordable feedstocks and/or energy required for industrial applications, and
- Security of tenure and security of pricing.

For continuous and competitive production of products, energy (and/or feedstock) sources need to be accessible, affordable and secure. That is, it needs to be available as and when production requires it, at a price that allows for competitive production of products.

For SADC Member States it is important to recognise that value is only created when the energy is used as a driver for production. The transformation of energy (i.e., from heat to electricity) provides little in the form of value creation, and instead it is necessary to transform the energy into a more usable form. Priority should then be given to ensuring the energy is available, accessible, cheap and secure for end-users than focusing on local energy transformation projects.

4.1 Gas-based Industrialisation: Petrochemicals

The nature of petrochemicals from natural gas is predicated on two factors, namely the composition as well as the cost of gas. The shale gas developments, for instance, in North America has tended to be very rich in the heavier hydrocarbons such as ethane and propane. These commodities are ideal to produce the key chemical building blocks such as ethylene and propylene. Consequently, a large petrochemical industry has developed off the back of gas developments in the USA. By contrast, the large gas finds off the east coast of southern Africa particularly have tended to be much more heavily weighted to methane with very little of the heavier hydrocarbons. This restricts the options for development of petrochemicals to the production of ammonia and its derivatives, the production of methanol and subsequent derivatisation of that methanol into other chemical products as well as the production of fuel and chemicals using the Fischer-Tropsch process (GTL).

These applications are highlighted in the figure below.

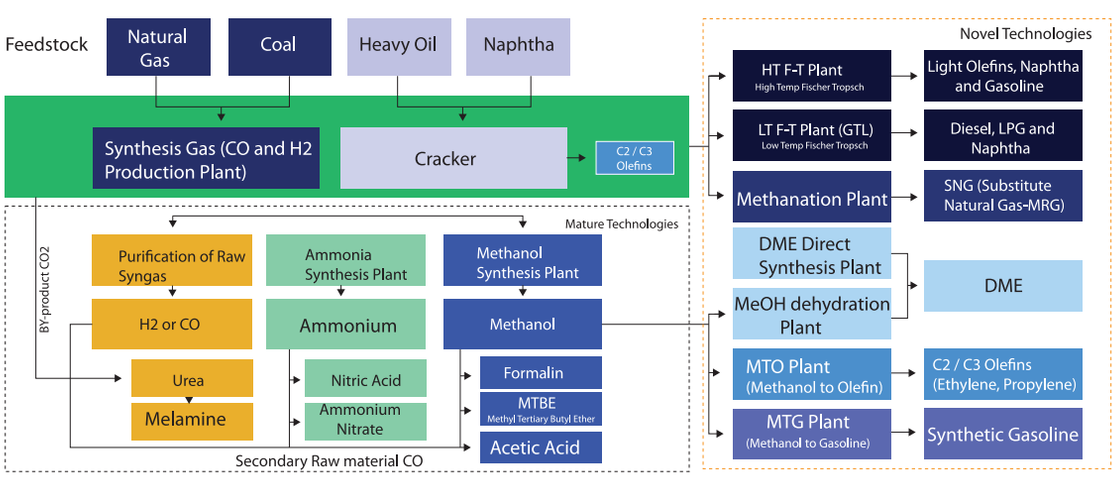


Figure 11: Petrochemical Production from Various Input Sources

AIA conducted a techno-economic analysis of the mature gas monetisation options outlined above. Our findings are summarised in the graphs below. In both the cases of ammonia and methanol, it was found that a combination of gas prices below US$3 and substantial tax incentives will be required to yield a reasonable prospect of a return on capital of ~10%. In the case of GTL, a maximum gas price of US$2 will be required for a similar return prospect.

Methanol

The techno-economic analysis of Methanol is displayed in the graphs below.

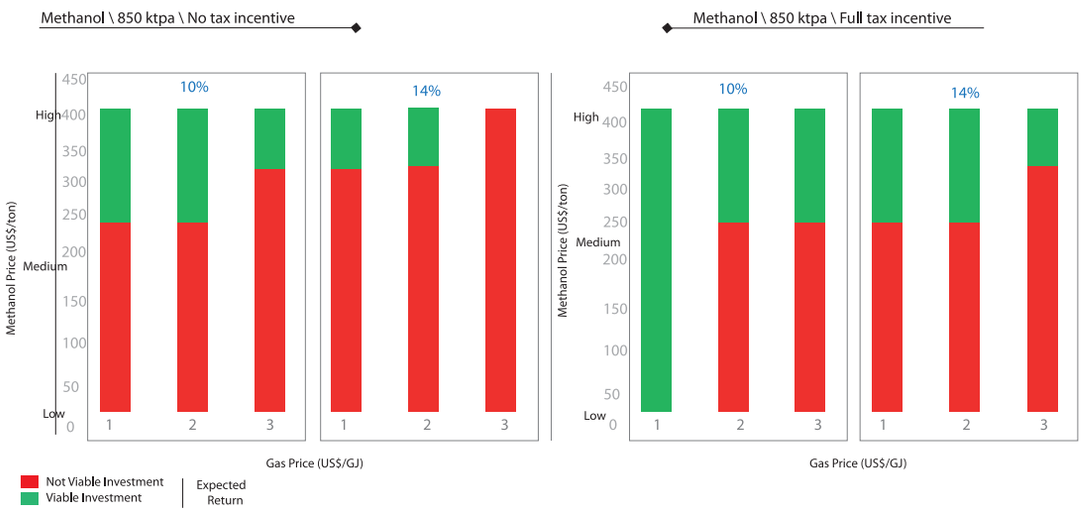


Figure 12: Techno-Economic Analysis of Methanol (MeOH)

Ammonia

The techno-economic analysis of Ammonia/Urea is displayed in the graphs below.

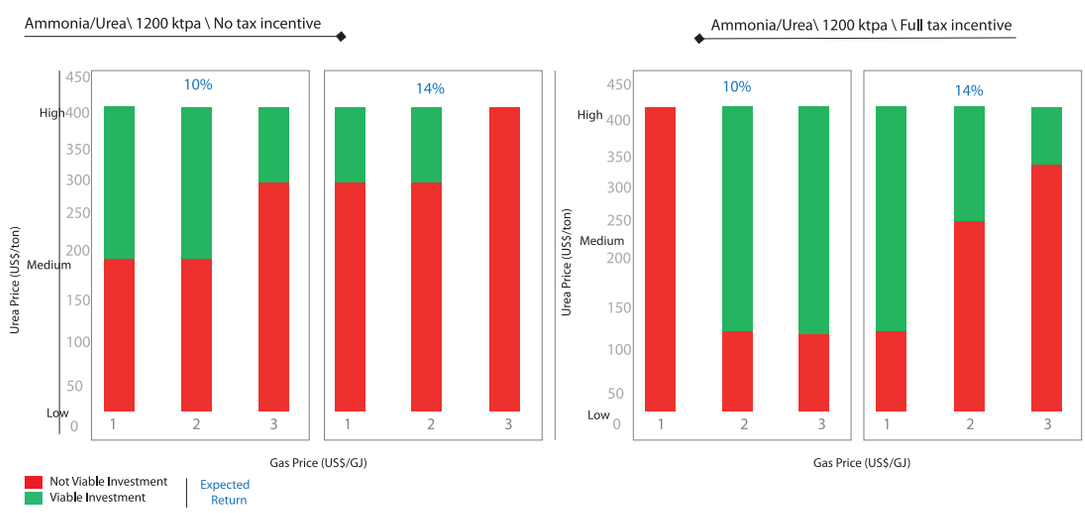


Figure 13: Techno-Economic Analysis of Ammonia/Urea (NH3)

GTL

The techno-economic analysis of GTL is displayed in the graphs below.

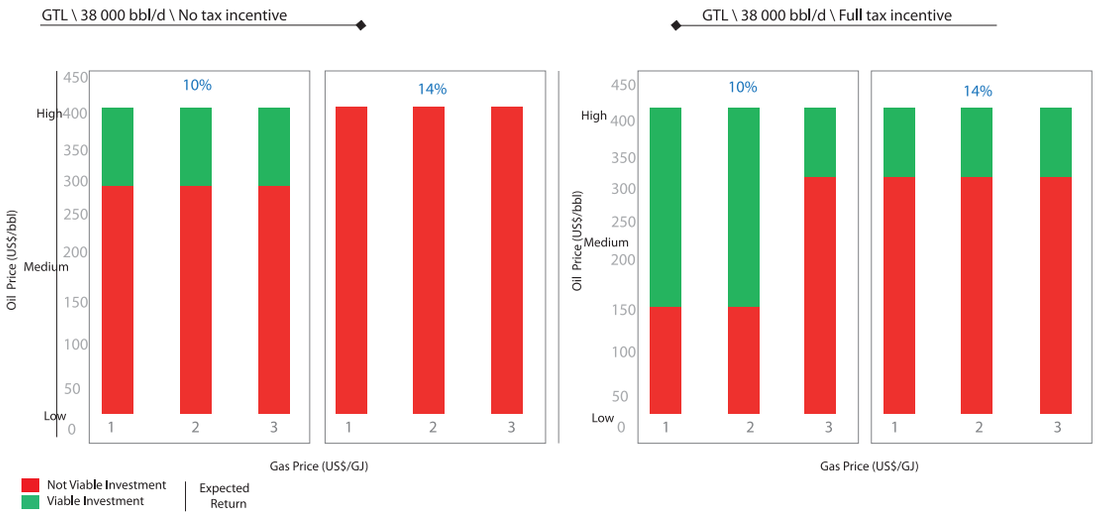


Figure 14: Techno-Economic Analysis of GTL

Should governments in the region wish to prioritise fertiliser production from natural gas, there will need to be serious consideration given to a combination of government interventions. These measures would need to focus on reducing the cost of gas and capital as well as tax incentives to facilitate the development of fertiliser production. These interventions would need to be weighed up against the value of utilising the gas for power production or LNG export.

Longer term, the drive to net zero can however provide an opportunity for countries in this region to position themselves as producers of zero carbon ammonia from natural gas. The chart below shows the relative cost of hydrogen produced through steam methane reforming, with the sequestration of CO2, and water electrolysis using renewable electricity.

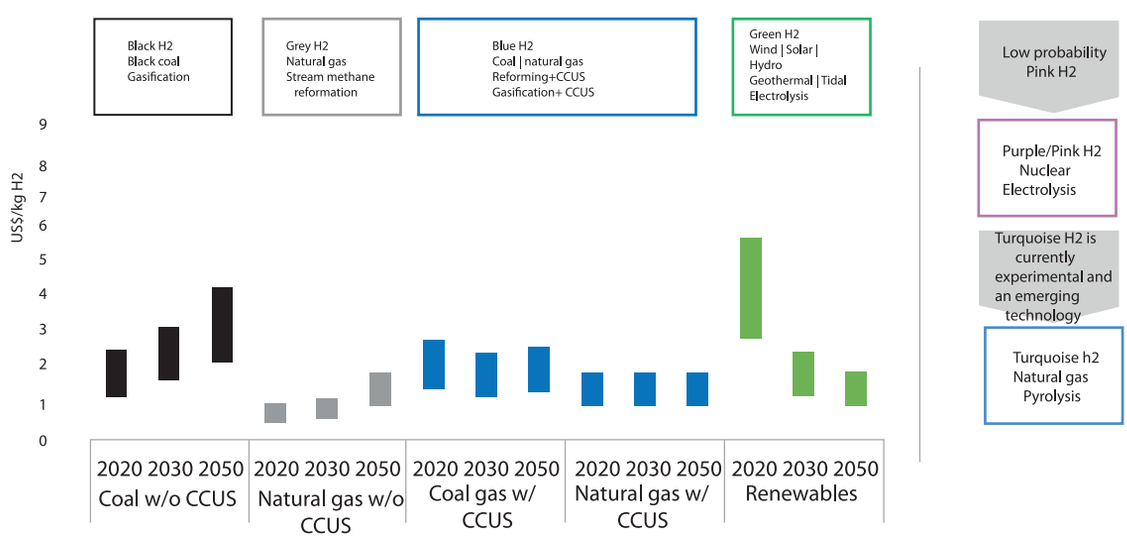


Figure 15: Levelised Cost of Hydrogen Production by Technology In 2020, and in the Net Zero Emissions Scenario, 2030 And 2050 [13].

[13] International Energy Agency, 2021, Global Hydrogen Review 2021

It is evident from this analysis that the production of hydrogen from steam methane reforming and CCUS will have to play a key role in the transition to net zero. Hence, in areas of gas production with suitable depleted gas wells, the production of zero carbon (so-called blue ammonia) can provide an avenue for development of fertiliser production in the longer term.

4.2 Gas-based Industrialisation: Heating Energy

For general industrialisation purposes, gas, as indicated can be used in two ways, namely for primary heating purposes or through the production of electricity which is then used in industrial applications. The industrial sector consumes 46% of all heat generated globally, followed by the residential sector (38%) and the commercial sector (13%). Typical industries which require significant primary heating inputs include:

- Brick and ceramic tile,
- Cement,
- Steel,
- Mining and metallurgical,
- Ferrous Alloys,
- Manufacturing,
- Glass,
- Brewery,
- Food Processing and FMCG, and
- Packaging, Paper, and Pulp.

As gas would play a role in providing a cost-effective energy input source, it is not primarily responsible for creating industrialisation through heating, it rather enables greater competitiveness in industrial applications through cost effective and available energy inputs. Therefore, due to the volumes of gas required and its indirect role in industrialisation, it should be considered as secondary demand in this regard. That is, industrial heating will not anchor gas and related infrastructure, rather will develop around existing pockets of infrastructure.

4.3 Industrialisation Roadmap

The RGMP considers a phased approach to infrastructure development, through critical anchor projects. This roadmap includes:

- Phase 1: Power sector to anchor demand and unlock initial infrastructure development through building out electricity and gas transmission networks, underpinned by sovereign off-take.
- Phase 2: Through effective corridors, build out distribution infrastructure enabling the secondary demand of industrial users, developed through private sector participants.
- Phase 3: Where indigenous sources of gas exist, develop downstream petrochemical industries, including fertilisers, methanol, blue hydrogen production by incentivising investment through favourable fiscal terms and an enabled environment. This would be developed by private capital and requires significant de-risking through appropriate Member State support.

The figure below demonstrates this phased approach, along with clearly indicating the related activities, outcomes, and rationale.

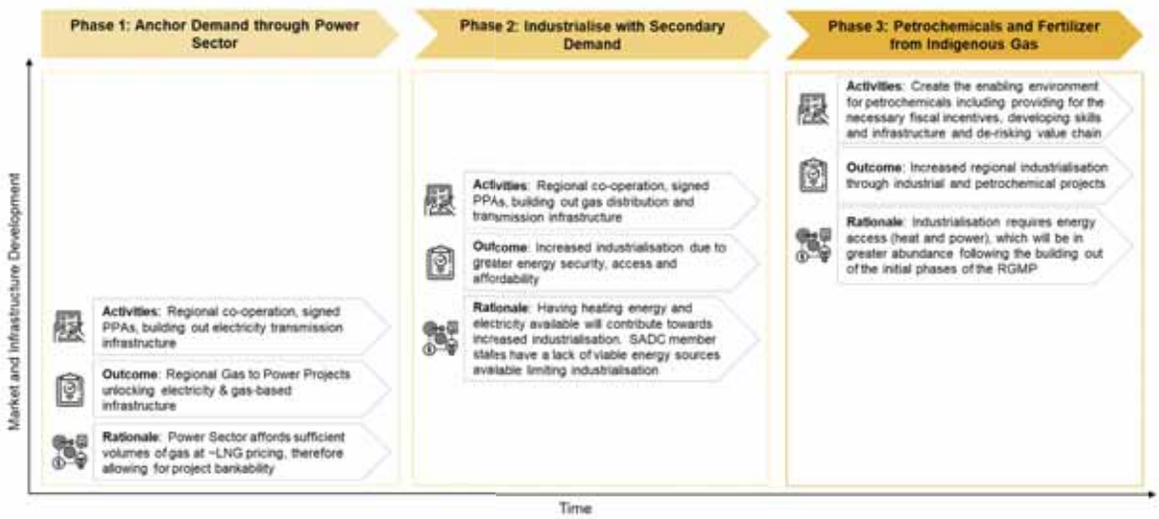


Figure 16: Developmental Process for Building Out the Gas Market

5. INFRASTRUCTURE BLUEPRINT

Implementation of the RGMP must take place in a sequenced manner to put in place the required hard and soft infrastructure in a logical and financially prudent manner.

The infrastructure blueprint is focused on connecting sources of gas supply to key demand centres within different market corridors within the region. AIA defined the following key gas supply/demand corridors as illustrated in the map below.

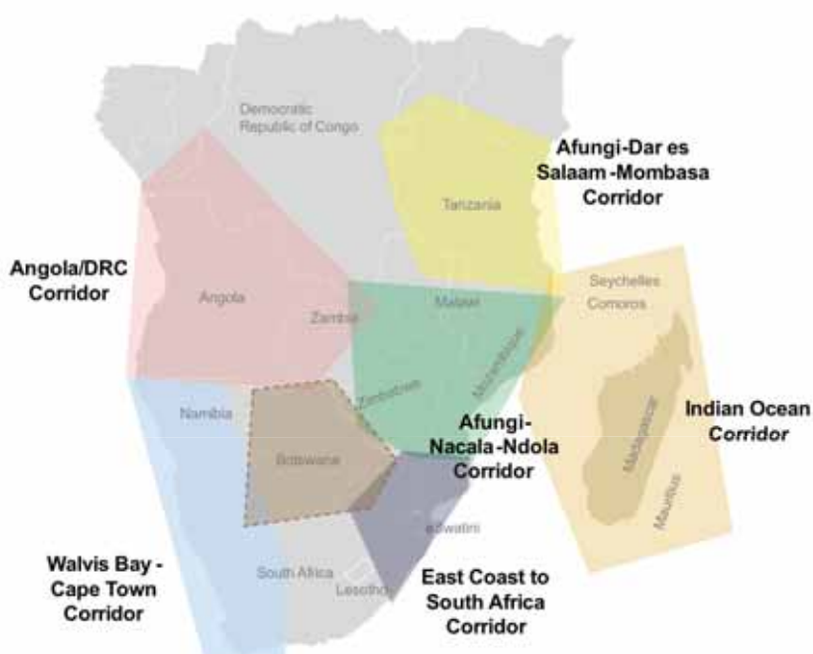


Figure 17: Gas Supply/Demand Corridors

Within each corridor, priority infrastructure projects were identified that can unlock the development of a gas economy. In line with the philosophy discussed above, the focus was to identify projects that can unlock the scale of demand required to economically finance the required infrastructure. Thus, the initial phase of development in most of the corridors is focused on GTP with other industrial demand forecast to come later.

The key priority projects identified as well as their potential timing are shown in the figure below:

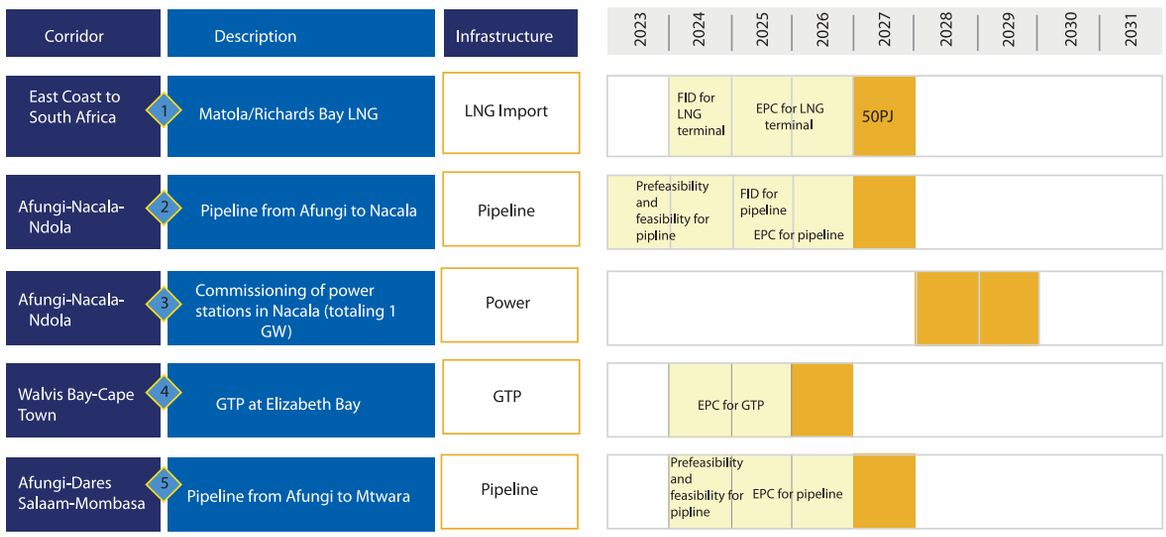


Figure 18: Prioritised Infrastructure Projects for all Corridors

The figure below provides a breakdown of the capital expenditure (CAPEX) requirement to execute this roadmap within each corridor.

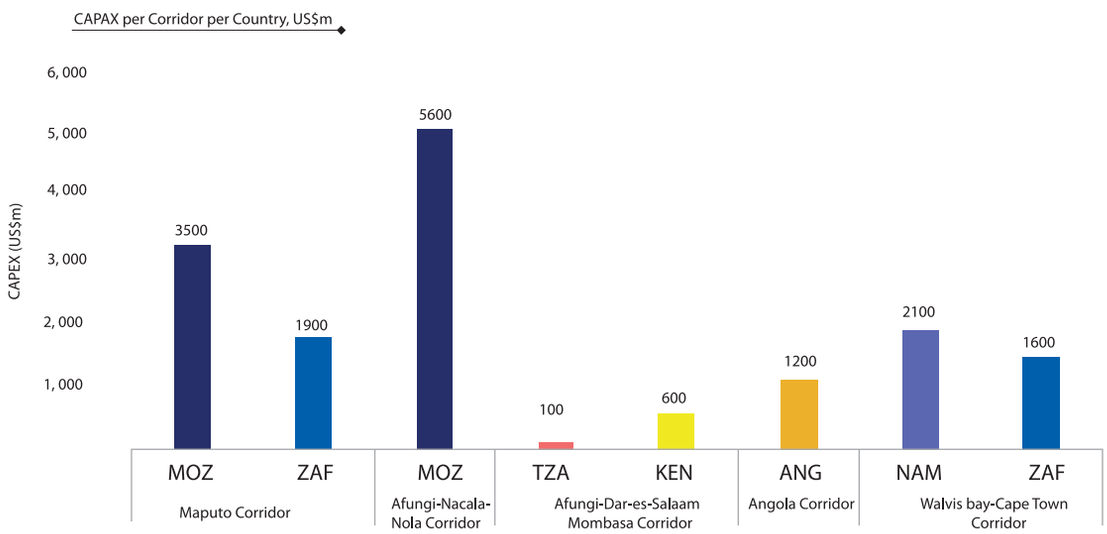


Figure 19: Capital expenditure (CAPEX) Requirement for Execution of Infrastructure Blueprint

The table below provides greater detail regarding the size and cost of each of the projects.

Table 2: Size and Cost of Proposed Projects

Priority	Project	Description	Corridor	SADC Countries Impacted	Infrastructure Type	Capacity MW/Kta/km	Stage and Timeline	Start to Finish Cost	US$ million KPIs/ Outcomes
1	Matola LNG terminal / Richards Bay LNG Terminal	LNG import, storage and regasification terminal	East Coast to South Africa	Mozambique and South Africa	FSRU with associated port & pipeline infrastructure. 2000 MW GTP,	Initially – 1 MMtpa possibility to expand to 3 MMtpa	Feasibility FSRU- Start Q4 2022 – end Q4 2025 Power Start Q1 2023 – end Q1 2036	Maputo FSRU: 466 Pipeline (Maputo to Ressano Garcia): 60 GTP (Beluluane): 2334 Mozambique power projects: 356	South Africa opens power market to new regional supply.
2	Nacala gas hub	~900 MW mid-merit GTP at Nacala supported by pipeline from Rovuma	Afungi-Nacala-Ndola Corridor	Mozambique, Malawi, Zimbabwe & Zambia, DRC	Pipeline, GTP & associated transmission, small-scale LNG (ssLNG) and CNG loading & transport infrastructure	GtP 900 MW Pipeline ~85 PJ	Concept development Pipeline & GTP commence 2023 – 2027	Pipeline (Afungi-to-Nacala): 1015 GTP (+650 MW): 759 GTP (GLAE): 292 Mozambique power projects: 212	• South Africa & Mozambique conclude cross-border energy agreement • Successful placement of 250 MMscf/d of domestic gas from land-based LNG facilities • 900 MW GTP at Nacala to anchor gas hub Pipeline from Afungi to Nacala developed • Reinforced transmission line from Nacala to Namialo • Successful development of ssLNG and CNG market serving Malawi, Zambia, DRC Copperbelt and Zimbabwe
3	Betty's Bay GTP & Cape Town pipeline	Potential 420 MW to 1250 MW GTP supported by gas from Orange Basin	Walvis Bay – Cape Town Corridor	Namibia, South Africa	GTP and associated transmission infrastructure	GTP 420 – 1250 MW	Concept development	GTP (Elizabeth Bay): 1 459 Namibia power projects: 126	• Cross-border energy treaty between Namibia and South Africa to facilitate the flow of power and gas between countries. • Successful development of new gas finds (Graff, Venus) and existing fields (Ibubhesi, Kudu) and landing of gas for domestic use • South Africa opens gas IPP programme to regional supply Development of GTP at Betty's Bay • Strengthening of power transmission grid between Namibia and South Africa

Priority	Project	Description	Corridor	SADC Countries Impacted	Infrastructure Type	Capacity MW/Kta/km	Stage and Timeline	Start to Finish Cost	US$ million KPIs/ Outcomes
4	Afungi to Madimba pipeline	Gas pipeline linking Afungi in Mozambique	Afungi – Dar-es-Salaam – Mombasa	Mozambique – Tanzania	Gas pipeline ~224 PJ	Initially – 1 MMtpa possibility to expand to 3 MMtpa		Pipeline (Afungi-to-Madimba): 93 Tanzania power projects: 15	• Energy treaty between Tanzania and Mozambique governing transfer of energy • Integration of northern Mozambique and Tanzanian gas supply system.
5	Lobito GTP	GTP to act as anchor to support development of gas fields in Kwanza Basin	Angola/DRC Corridor	Angola, DRC, Zambia, Namibia, Botswana, South Africa	GTP with associated transmission infrastructure	1200 MW GtP	Concept development Pipeline & GTP commence 2023 – 2027	GTP (Soyo II): 840 Angola power projects: 362	• Successful development of gas fields in the Kwanza basin • Successful development of GTP facility at Lobito • Integration of Angolan power grid into the SAPP network
TOTAL								**US$ 8 389m**	

6. IMPLEMENTATION PLAN

We recommend that the following actions be implemented in order to implement the Regional Gas Master Plan.

Table 3: RGMP Implementation Plan

Strategic Goal	Outcomes	Objective	Strategic Interventions	Target/KPI	Timeframe	Responsibility
Regional Policy Convergence	• Promotion of regional integration • Regional energy security • Diversification of the regional energy mix • Promotion of industrial development within SADC • Encouraging participation of the private sector in the gas supply industry value chain • Ensuring a Just Transition • Integrated Energy Planning	1. Adoption of Regional Vision and Master Plan for natural gas in the Region by all Member States	1.Facilitate the review and adoption of the SADC Regional Gas Master Plan – Phase II by all Member States	RGMP adopted by the Inter-State (Regional) Gas Committee and SADC Ministers responsible for Energy	2022/ 2023	• SADC Secretariat
			2. Establish a Programme Management Office (PMO) to coordinate implementation of the SADC RGMP	PMO established and fully operational	2023 (establishment) 2024 (Fully operational)	• SADC Secretariat
		2. Alignment of Member State policies and plans within the SADC Region	1. Facilitate the integration of the SADC Regional Gas Master Plan into Member State Development Policies and Plans	Discussions and workshops have been held with all of the major gas exporting (producing) and gas importing Member States	2024 - onwards	• SADC Secretariat
			2. Update National Development Policies and Plans to unlock developmental opportunities enabled by natural gas corridors 3. Align Spatial Development Policies and Frameworks with regional natural gas corridors 4. Develop "Just Transition" policies that leverage natural gas within the energy mix	All of the major gas exporting (producing), and gas importing Member States have included regional integration and natural gas within the energy mix of their development policies	2026	• Member States

Table 3: RGMP Implementation Plan (Continued)

Strategic Goal	Outcomes	Objective	Strategic Interventions	Target/KPI	Timeframe	Responsibility
Regional Policy Convergence	• Promotion of regional integration • Regional energy security • Diversification of the regional energy mix • Promotion of industrial development within SADC • Encouraging participation of the private sector in the gas supply industry value chain • Ensuring a Just Transition • Integrated Energy Planning	3. Integrated Energy Planning by Member States of the SADC Region	1. Drive adoption of the Integrated Energy Planning Cycle and Guidelines for Regional and National Plans in the region 2.Member States to develop Integrated Energy Plans and Integrated Resource Plans along these guidelines	Workshops have been held with Member States on the Integrated Energy Planning Cycle and Guidelines for Regional and National Plans Member States have begun the process of introducing integrated energy planning	2023 - 2024	• SADC Secretariat
		4. Natural Gas Master planning by Member States of the SADC Region	1. Develop National Natural Gas Master Plans in line with the SADC Regional Gas Master Plan 2. Implement monitoring and evaluation mechanisms to enable realignment and knowledge sharing among Member States	National Natural Gas Master Plans are in place in the major gas exporting (producing) and gas importing Member States. These Master Plans are aligned with the RGMP	2025	• Member States
An Enabling Regulatory Framework	• Ensuring security of regional supply • Protecting end-user interest through transparent and fair pricing • Promoting investment by reducing barriers to entry, enhancing competition, and enabling easy entry for new players • Facilitating cross-border trade through harmonised gas network codes and clear licensing requirements, • Addressing dominancy in the vertical value chain • Ensuring safety and environmental sustainability in the industry	1. Establish a Regional Cross border regulator	1.Ensure the establishment of the SADC Regional Energy Regalatory Authority (SARERA) as per the RISDP 2020 - 2030	(SARERA) is fully operational as per the RISDP 2020 - 2030.	2026	• SADC Secretariat • Regional Energy Regulators Association of Southern Africa (RERA)
		2. End-user Protection	1. Aggregators and Regulators 2. Apply Develop Regional Natural Gas Pricing and Tariff Guidelines for adoption by National Regional Natural Gas Pricing and Tariff Guidelines and update Member State Energy Regulations 3.Ensure transparent & fair pricing regulations are in place.	Regional Natural Gas Pricing and Tariff Guidelines are developed Regional Natural Gas Pricing and Tariff Guidelines are included in the corridor development.	2025 2026 - onwards	• RERA • National Regulators
			4. Develop a Regional Natural Gas Quality Standard to standardise the trade of natural gas and derived products 5. Develop National Gas quality regulations in line with the Regional Natural Gas Quality Standard	Regional Natural Gas Quality Standard developed Regional Natural Gas Quality Regulations developed	2024 2026 - onwards	• RERA • National Regulators

Table 3: RGMP Implementation Plan (Continued)

Strategic Goal	Outcomes	Objective	Strategic Interventions	Target/KPI	Timeframe	Responsibility
An Enabling Regulatory Framework	• Ensuring security of regional supply • Protecting end-user interest through transparent and fair pricing • Promoting investment by reducing barriers to entry, enhancing competition, and enabling easy entry for new players • Facilitating cross-border trade through harmonised gas network codes and clear licensing requirements, • Addressing dominancy in the vertical value chain • Ensuring safety and environmental sustainability in the industry	3. Industry Growth and Investmen	1. Develop and/or review Local Content Regulations to unlock socio-economic development opportunities across the natural gas value chain	Local content regulations have been reviewed with a view to unlock socioeconomic development opportunities across the natural gas value chain	2026 - onwards	National Regulators
			2. Establish a Regional Regulatory framework for the Third-Party Access to mid-stream infrastructure 3. Facilitate Third-Party Access at a regional level 4. Develop National regulations for third-party access and off-take along regional natural gas corridors	A Regional Regulatory framework for Third-Party Access to mid-stream infrastructure has been established This framework has been adopted at national level within Member States	2025 2027 - onwards	• RERA • National Regulators
		4. Cross-border Trade Enablement	1. Develop Regional Network Codes and Standards for cross-border Natural Gas trade. 2. Develop a Model Transmission Agreement and an Interconnection Agreement Template for National Regulators to utilise 3. Develop guidelines for Dispute Resolution	Regional Network Codes and Standards for cross-border natural gas trade have been developed Model Transmission Agreement and an Interconnection Agreement Template have been developed Guidelines for dispute resolution have been established	2026 - onwards	• RERA
			4. Develop and/or update national licensing rules and harmonised gas network codes and standards in adherence to relevant market rules. 5. Develop procedures for dispute resolution	National licensing rules and harmonised gas network codes have been established Guidelines for dispute resolution have been established.	2027 - onwards	National Regulators
			6. Develop Regional Gas Market Maturity Model 7. Track Regional Gas Market Maturity 8. Investigate and propose mechanisms for unbundling of vertically integrated market players 9. Facilitate adoption of proposal by Member States	Gas Market Maturity Model has been established The regional gas market is being tracked annually Mechanisms for unbundling of vertically integrated market players have been established, where appropriate, and this has been discussed and agreed with Member States	2026 – onwards 2035 - onwards	• RERA • National Regulator

Table 3: RGMP Implementation Plan (Continued)

Strategic Goal	Outcomes	Objective	Strategic Interventions	Target/KPI	Timeframe	Responsibility
An Enabling Regulatory Framework	• Ensuring security of regional supply • Protecting end-user interest through transparent and fair pricing • Promoting investment by reducing barriers to entry, enhancing competition, and enabling easy entry for new players • Facilitating cross-border trade through harmonised gas network codes and clear licensing requirements, • Addressing dominancy in the vertical value chain • Ensuring safety and environmental sustainability in the industry	5. Ensuring Safety and Environmental Protection	1. Develop a Regional Environmental Management Framework for adoption by Member States 2. Encourage Member States to undertake Strategic Environmental Assessments (SEA) and use these to streamline the environmental authorisation process	Regional Environmental Management Framework is developed Regional Environmental Management Framework is adopted by Member States The majority of Member States are utilising Strategic Environmental Assessments (SEA) to streamline the process	2026 2027 – onwards 2027 - onwards	• RERA • National Regulators
		6. Improve Regional Energy Security	Develop regional guidelines and regulations for: 1. Risk management and reporting 2. Gas storage 3. Early warning on the diversion of gas from the SADC market as per the approved SADC RGMP 4. Development of various gas supply options and supply competition upstream	Regional guidelines for energy security are developed	2026 - onwards	RERA • National Regulators
A Regionally Integrated Gas Market	Fair and transparent pricing which addresses national and regional needs and currency risk • Harmonised and transparent wheeling tariffs • Bankable contracts that are aligned across the value chain	1. Natural Gas Aggregation	1. Develop and/or prepare National Gas Aggregators for natural gas trade across corridors 2. Enable trade with international markets through aggregation 3. Conduct brokerage functions for bilateral gas trade across the region	National Gas Aggregators have been established for the majority of the Corridors	2027	• Member States and Private Sector Players • National Aggregators
		2. Regional Gas Trade	1. Provide analysis and recommendations for future development of the SADC Natural Gas market 2. Provide Research and proposals for local gas pricing mechanism and indices	Local gas pricing mechanisms and indices proposal completed and workshopped with relevant stakeholders	2026 - onwards	• RERA • National Aggregators
			3. Encourage the use of domestic gas obligations to drive regional gas market development	Bilateral and multilateral discussions take place between relevant stakeholders in each corridor	2027 - onwards	• Member States

Table 3: RGMP Implementation Plan (Continued)

Strategic Goal	Outcomes	Objective	Strategic Interventions	Target/KPI	Timeframe	Responsibility
A Regionally Integrated Gas Market	Fair and transparent pricing which addresses national and regional needs and currency risk • Harmonised and transparent wheeling tariffs • Bankable contracts that are aligned across the value chain	2. Regional Gas Trade	4. Establish Regional Corridor Management Institutions (CMIs)/ Groups to facilitate corridor development across SADC as per the SADC RGMP corridors 5. Facilitate corridor development with all relevant stakeholders	Each corridor has an established Corridor Management Institution/Group Corridor establishment has been discussed with all relevant stakeholders	2026	SADC Secretariat • CMIs
		3. Harmonised and transparent wheeling tariffs	1. Development of easily accessible, consistent, and transparent wheeling tariffs across different utility electricity grids	Standardised and transparent wheeling tariffs established across the region alongside a harmonised grid code.	2026	• RERA • National Regulators
Driving capital investment through bankable infrastructure projects	Scale economies due to regional integration • Accessible Infrastructure Finance	1. Building out SAPP grid and pipeline networks where there are multiple nodes and supply network 2. Funding for SADC Energy and Gas Infrastructure	1. Strengthen the SAPP grid and pipeline networks as per the Investment Blueprint 2. Set up a SADC Energy Fund to help fund the energy infrastructure of SADC Member States where individually, Member States might not be able to fund such ventures	SADC Energy Fund set up and capacitated.	2025	SADC Secretariat • African Development Bank (AfDB) DBSA
Facilitating gas-based industrialisation through petrochemicals and industrial development	• Increased regional industrialisation projects • Developed petrochemicals sector	• Increase energy access, affordability and security to drive industrialisation • Utilise indigenous gas to develop petrochemical hubs	1. Ensure affordable & secure energy access for industrial sites 2. Identify potential petrochemical hub sites and develop PublicPrivate Partnerships (PPPs) to establish them (utilities, services etc) 3. Ensure regional cooperation in terms of the downstream product markets (fertilisers etc)	Industrial sites established with affordable & secure energy access One to two petrochemical hub sites established (utilities, services etc)	2030	Member States
A highly skilled and innovative workforce	Sharing knowledge and experience • Skills Development Framework • Technical Skills Development	1. Regional Standardisation and Harmonisation with the establishment of Centres of Excellence	1. Establish a body to be accountable for regional skills development	Regional Natural Gas Skills Development Body established or a SADC Institution has accountability	2023	SADC Secretariat
			1. Develop Regional standards for skills development across gas and related industry programmes,	Regional standards for skills development established and recognised regionally SADC Centres of Excellence established guidelines for employer and employee	2026	• SADC Secretariat • Regional Natural Gas Skills Development Body / Kafue Gorge Regional Training Centre (KGRTC)

Table 3: RGMP Implementation Plan (Continued)

Strategic Goal	Outcomes	Objective	Strategic Interventions	Target/KPI	Timeframe	Responsibility
A highly skilled and innovative workforce	Sharing knowledge and experience • Skills Development Framework • Technical Skills Development	1. Regional Standardisation and Harmonisation with the establishment of Centres of Excellence	2. Establish SADC Centres of Excellence that will coordinate skills development for specialised vocational, technical, policy, regulatory, and managerial skills, Establish guidelines for employer and employee engagement, and monitoring & evaluation of training outcomes	engagement, and monitoring & evaluation of training outcomes	2026	• SADC Secretariat • Regional Natural Gas Skills Development Body / Kafue Gorge Regional Training Centre (KGRTC)
	Sharing knowledge and experience • Skills Development Framework • Technical Skills Development	2. System and Policy Alignment	1. Facilitate the determination of skills demand for the SADC Natural Gas value chain 2. Establish Member State skills development priorities	Skills Audit completed	2025	• SADC Secretariat • Member States
	Sharing knowledge and experience • Skills Development Framework • Technical Skills Development	3. Developing sector skills supply	1. Align skills development initiatives and supply with demand based on planned gas sector developments 2. Utilise available SADC and African Continental Free Trade Area (AfCFTA) treaties to ensure specialised and skilled labour are freely transferable between Member States 3. Leverage regional and international expertise to build in-country competency	There is a marked improvement in the availability of labour skilled in natural gas in the region	2030	• SADC Secretariat • Member States • SADC Centres of Excellence (CoEs)

7. SOFT INFRASTRUCTURE: MARKET DEVELOPMENT

7.1 Developing the Gas Market

Regional integration is an underlying objective of the RGMP and could be achieved through developing a regional downstream gas market. For this to occur, at a minimum the following must be in place:

- access to natural gas molecules either via LNG or domestically/regionally produced gas,
- regional infrastructure that will allow the transport and trading of natural gas molecules, electrons (from gas-to-power), or petrochemical products, and
- demand from downstream off-takers and end-users.

The ideal would be to develop the full value chain as outlined in the figure below, but this is capital intensive and contractual agreements between suppliers and off-takers are necessary for bankability. Customer demand drives the development process with affordable gas prices required for the end-user, and different end-users affording different gas prices. The actual future demand will therefore need to be secured through signed offtake agreements for bankable projects and will be dependent on the price of the gas molecule to the end-user.

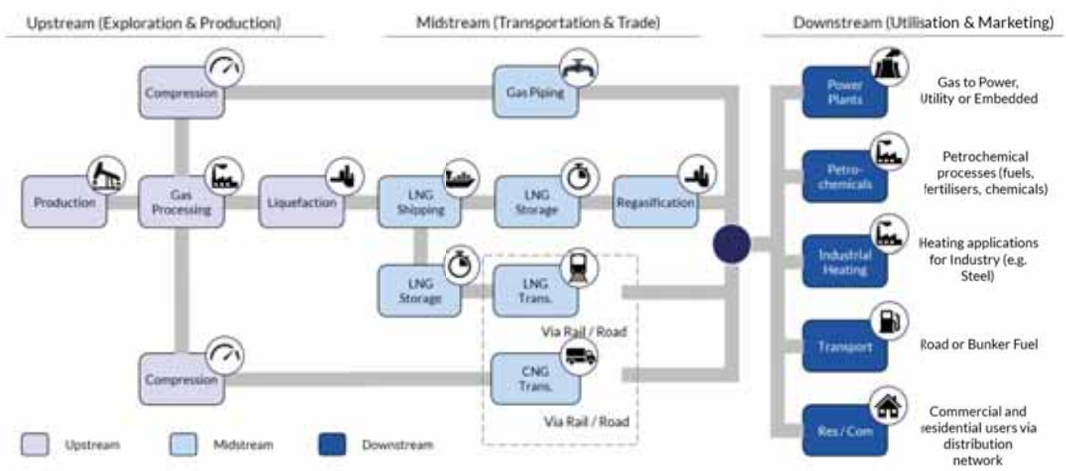


Figure 20: Natural Gas Value Chain

End-user gas pricing is dependent upon several factors that contribute to the build-up, as well as several risks which must be mitigated, and will influence long-term off-take. This is reflected below:

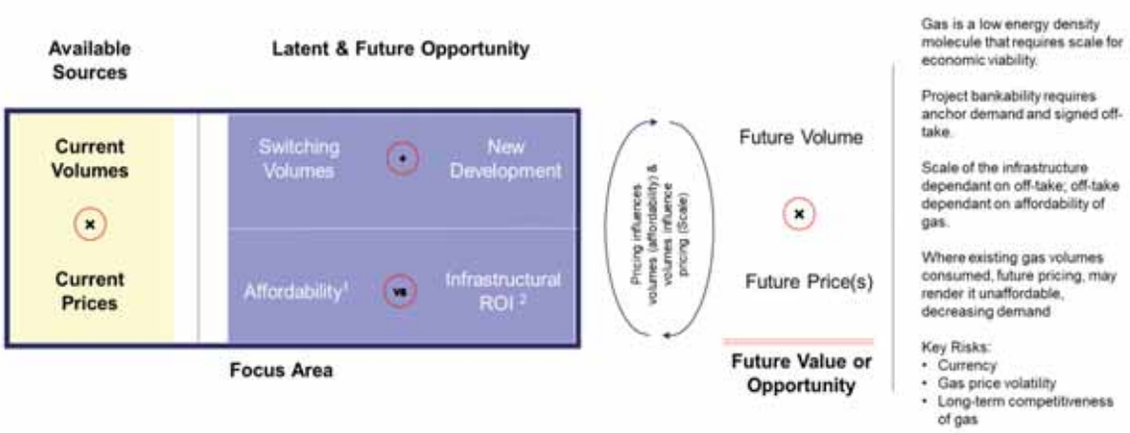


Figure 21: Key Factors Influencing Gas Demand and the Value of the Market

The issue of pricing therefore presents a key feature that must be resolved to ensure competitiveness of gas as an energy carrier. Existing gas markets in SADC (South Africa, Mozambique, Tanzania, Angola) have developed through domestic and regional gas sources, with reflective pricing. Introduction of LNG into the supply mix will alter the price structure to the end-user and therefore impact downstream demand. The region needs to take cognisance of this and find innovative ways of supplying regional gas at prices which can encourage substantive volume uptake.

7.1.1. Market Structuring

The pricing of gas is dependent upon various factors, one of which includes the structure of the market. Full vertical integration (e.g., Sasol through Pande and Temane, ROMPCO and Secunda Synfuels) is reflective of early-stage markets, characterised by limited flexibility or market dynamics and requires strong regulation to effect broader market participation. Due to the depletion of the Pande and Temane gas fields, this market structure will change. However, due to the nascency of the broader market, and mid-stream infrastructure itself being naturally monopolistic, some variation of a bundled structure is likely to remain present. This would create more competition on the supply side and may impact on pricing, but it is likely that there will be limited cost/savings pass-through to the end-user.

In order to move to wholesale competition and unbundled regional and national markets, there would need to be a marked increase in gas distribution infrastructure and third-party open access would be critical. National and regional aggregators could also play a significant role in transitioning to these market structures.

7.1.2. Aggregation and Aggregator Models

A key outcome of Phase I of the RGMP was the adoption of the concept of regional aggregation. By aggregating demand, increased volumes of gas are secured, allowing for greater bargaining power of buyers (in this instance SADC Member States). By facilitating route to market options through LNG and ssLNG delivery options, broader market participation can be achieved. It should be noted that the practical application of such a model, as with the entirety of the RGMP must be undertaken in a phased manner. That is, the regional aggregator should evolve as the market develops and matures through the introduction and utilisation of gas in the energy mix.

Due to the complexity of contractually aggregating regionally, and the potential requirements for multi-lateral commitments in a regional set-up, the initial phases of market development will likely occur on a bi-lateral basis. As each Member State will potentially have its own national aggregator, they will play a key role in setting up these bilateral agreements and will be the entity with whom the Sale and Purchase Agreements (SPAs) are contracted.

The role of the regional aggregator will initially be limited to that of a brokerage function but should be expanded upon as the regional market develops. It is recommended that this role be undertaken initially by one of the existing SADC Regional Organisations such as SAPP and a separate organisation be considered at a later stage if the role expands sufficiently.

7.2 Gas Pricing and Contracting

7.2.1. Pricing

7.2.1.1 Price Formation Mechanisms

The volume demanded and price paid are key in determining market feasibility as contracting and pricing will be influenced by both supply availability and demand requirements. Unlike oil, gas resources cannot be placed or sold in an international market unless processed further through liquefaction. If the scale is unsuitable for conventional LNG these assets may become stranded. There is also the risk of stranded assets if the larger resources are not developed expeditiously, and the pace of the energy transition accelerates. Developing, producing, and marketing such assets must then be done within the local markets (domestic or regional) that are available. As such the price formation mechanisms used will be dependent upon both the sellers' and buyers' alternatives.

From an import LNG perspective, prevailing market conditions (i.e., buyers' or sellers' market) will influence contracting. If the market is over-supplied, short-term contracts may be possible on coal and electricity linked pricing. Conversely, if the market is tight then the pricing will be at a premium to oil. Another important consideration is the reliability of the gas demand. A high predictability for the LNG cargoes can result in a reduced spot exposure and a lower need for storage.

Price formulation mechanisms are necessary in developing and evolving the SADC gas market and there are several mechanisms that can be used, depending upon the source of the gas, the cost of production and the alternate monetisation or utilisation options available. Certain formation mechanisms are more market friendly than others, however the interplay and balance between suppliers, off-takers and alternatives must

be carefully considered when designing a pricing regime. Regulators within the SADC context must, as such, ensure that the mechanisms adopted allow for the benefits of gas use to be passed on to industries and the consumers, but be efficient in terms of driving competitiveness of the market.

7.2.1.2 Gas Supply Options: Upstream Molecule Pricing

Market development within SADC should be considered across three supply scenarios, namely:

1. Domestic based gas-market development,
2. Import LNG based gas-market development, and
3. Hybrid domestic/import LNG based gas-market development.

In this regard the following options exist for upstream gas developments:

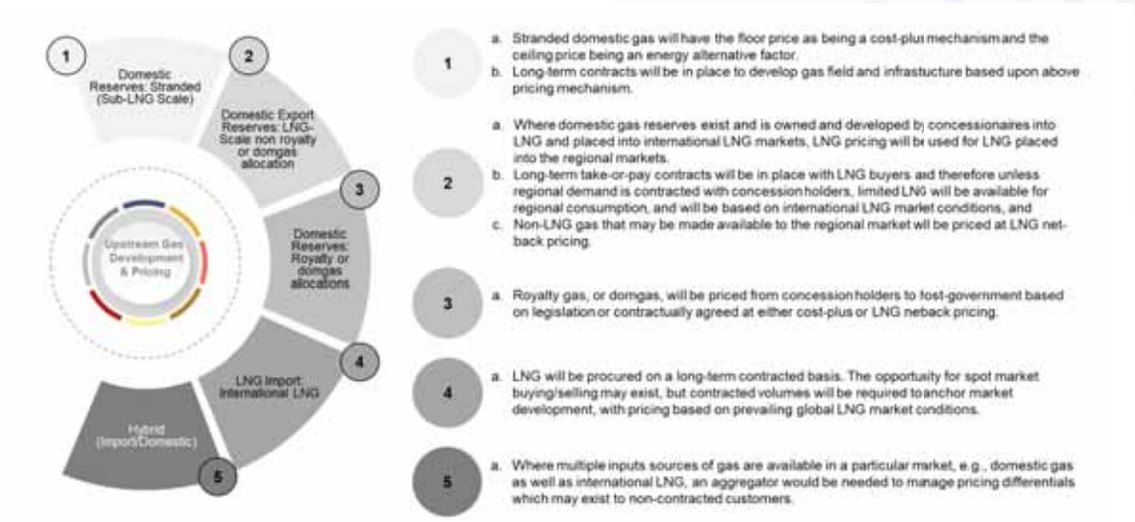


Figure 22: Upstream Gas Development and Pricing

The SADC region currently enjoys domestic-based pricing in the existing gas markets in Tanzania and South Africa/southern Mozambique. As these gas sources decline, there is a high likelihood that they will need to be replaced by imported LNG and supplemented by domestic gas. Aggregators will be required in these markets to aggregate demand from bankable projects to increase reliability of demand and to manage the pricing differential and currency risk.

LNG spot pricing should normally make up around 20% of the total imported volumes. While the pricing of Spot cargoes will often fluctuate, the long-term supply contracts are priced differently on a basis which allows for there to be price moderation. Therefore, price determination is very much based on how much is imported and how much of the imports are based on spot and term supply. There are good case studies to consider - Japan which is primarily long-term supply based as it has no natural gas of its own and Pakistan which is entirely spot based as it produces close on to 75 - 80% of its gas consumed. Spot cargoes work while there is liquidity in the market but when there is no liquidity, as is the case currently, countries such as Pakistan find it difficult to compete with Europe and other developed economies for spot LNG.

In order to ensure that the large gas finds elsewhere in the region are fully utilised and assets are not stranded, there are advantages to developing gas markets and projects close to the gas source at gas prices based on cost-plus mechanisms.

The SADC region is therefore likely to have a hybrid pricing formation with an element of import-based LNG pricing in the existing gas markets and domestic based gas pricing at the source. This is an important consideration as molecule pricing would contribute most significantly to the overall price of the gas to the end-user

7.2.1.3 Regulatory Price Build-up: Mid-stream Tariffs

As indicated, the input gas price has a significant role to play in determining overall end-user pricing. However, mid-stream infrastructure returns must be priced into the overall end-user pricing. This is reflected figure 23..

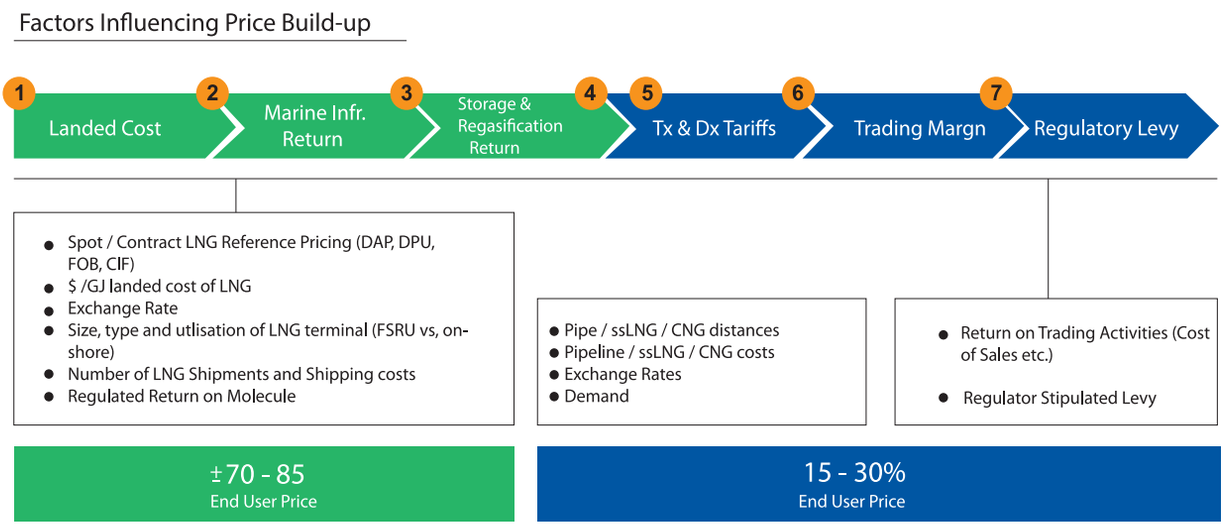


Figure 23: Typical Price Build-up for LNG Distributed to End-Users

Different infrastructure choices will have different CAPEX and operating expenditure (OPEX) outlays, with different jurisdictions having differing costs of capital due to the risk premiums that may be present. These would need to be accounted for in the overall tariff methodology adopted. Pass-through mechanisms should be employed and is reflected in the price calculation section of the report.

These tariffs would also need to be harmonised for regional infrastructure such as cross-border pipelines, which is expanded upon in section 7.5.

7.2.1.4 Gas Demand Options: Gas Price Affordability

When considering the overall value chain development, as indicated, end-user gas pricing must be less than the affordable gas price for economic value to be created. This is indicated in the figure below.

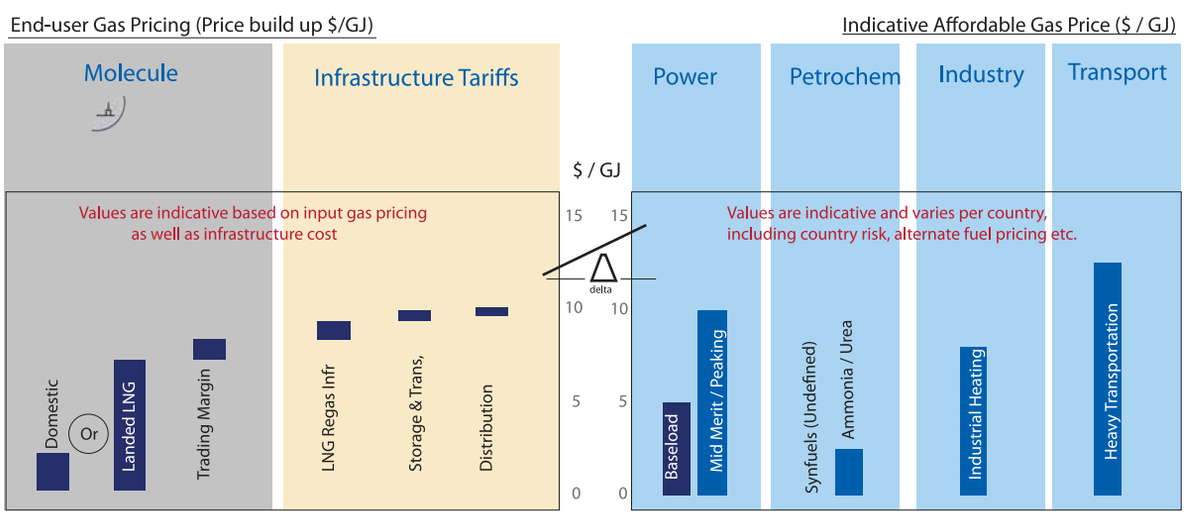


Figure 24: Creating Economic Value

Mid-merit power and existing industrial demand (with sunken capital) will tend to afford the higher gas prices, while greenfield petrochemical industries tend to afford the lowest gas price. This implies that power projects will anchor LNG import infrastructure, while petrochemical industries must be developed in-situ of upstream gas production facilities. Therefore, SADC gas importing countries must consider how gas optimally integrates with the power sector, while gas exporting counties should consider petrochemical production close to the gas source.

Changing the source of gas from domestic/regionally produced to international LNG (including LNG netback pricing) will structurally alter the market, decreasing competitiveness of certain industries. In the absence of sufficient quantities of domestic/regional gas, there are still however economic and environmental reasons for pursuing such a course as certain anchor market segments will still afford LNG pricing through displacing diesel and serving as peak-power and/or load following capacity. However, for LNG to be viable, contracting with LNG suppliers will generally require ~1 million tonnes per annum of LNG being imported. The economics of such a requirement means that aggregated and signed off-take must exceed this, which can only be achieved through such provisions within national Integrated Energy Plans and/or Integrated Resource Plans.

7.2.2. Contracting

The significant capital outlay that is required across the gas and downstream value chains, requires clear contracting between parties that set out the following:

1. Security of off-take
2. Predictability of off-take, in terms of volume and price, and
3. Alignment of timing of infrastructure build across the value chain

When considering the role of gas, as it requires development of its own system (i.e., gas production and transportation system) but must similarly integrate simultaneously with separate downstream systems (including e.g., the power system). This makes contracting complex. Further to this, the nature of the gas source, i.e., domestic vs. import LNG influences this greatly and therefore it will be useful to separate out these elements accordingly as demonstrated in the earlier chapters.

7.2.1.5 Domestic Gas

The natural gas industry, even within a domestic context, will have a monopolistic nature, require regulation, include high sunk costs and be somewhat opaque around the contracting that would occur between parties. This necessitates specialised protections in commercial transactions within the space. A Gas Sales Agreement (GSA) underpins bankable investment and is any agreement documenting the sale and purchase of a quantity of natural gas [14, 15].

Such agreements should cover the technical issues around the stakeholders, committed volumes, commercial considerations (gas/petroleum economics), policy and regulatory limitations, macroeconomic issues in the jurisdiction, financing options (corporate, banking & project financing), as well as exogenic events (geopolitics/ natural disasters/global macroeconomics).

7.2.1.6 LNG

Commercial and economic viability drives individual structuring of LNG Sale and Purchase Agreements (SPAs)[16]. Buyers, i.e., destination market(s) as well as sellers, i.e., supply source(s) are the critical determinants and must align contractually.

The seller of the LNG can be [17] :

- The upstream gas developers or one of their wholly owned affiliates,
- a 'Project Company' comprised of and owned by some combination of the upstream gas developers and third parties (including possibly LNG buyers) (a merchant LNG project structure) or just by third parties (a tolling LNG project structure), or
- an aggregator.

The buyer may be:

- A large utility or industrial company, buying LNG primarily for its own uses,
- a marketing company or natural gas aggregator buying LNG to on sell onto a given market, or
- as the spot market for LNG evolves, a trading company or portfolio LNG buyer buying LNG to arbitrage the LNG to other buyers based on market conditions.

[14] Practical Law Energy, 2019, Gas Sale Agreement
[15] Peter Roberts, 2019, Cross Keys Energy
[16] Sullivan, H.W., 2012, LNG Sale and Purchase Agreements
[17] Sullivan, H.W., 2012, LNG Sale and Purchase Agreements

In all cases the technical competence and creditworthiness of the seller to bear its performance and financial obligations under an LNG sale and purchase agreement and the creditworthiness of the buyer to bear the very significant financial obligations associated with performance and/or payment under an LNG sale and purchase agreement are of critical importance. Therefore, not all SADC Member States are likely to enter LNG SPAs, requiring key markets to provide bankable off-take volumes that will underpin the SPA in question.

7.2.1.7 Power Sector Integration

Power purchase agreements (PPAs) are entered into between a power producer (independent or utility) and the party who is purchasing the power (off-taker) and incorporate the commercial terms of sale and purchase of electricity for a project.

Such agreements provide a route to market for the power generated by the producer. The agreements also provide an opportunity for sale of green benefits to the electricity suppliers (wherein renewable energy generating stations receive benefits for renewable energy production and have the option to transfer such benefits). As a result of the nature of the agreement (revenue generating contract), it underpins the economics of power projects.

The investment in the LNG infrastructure and power generation and the structuring of the GSA and PPA will be determined by whether the project is considered baseload, or mid-merit as the dispatch of power will determine the economics of such a venture.

It should be stressed, for the gas sector to be unlocked, it must be anchored by the power sector, requiring policy certainty on an IRP basis, which makes provision for defined and contracted off-take volumes that can secure required gas infrastructure.

7.3 Political and Socio-economic

7.3.1. Political Drivers

In geopolitics, 'power' is the ability of one nation to influence the behaviour of other nations. A nation's command of physical power, notably through its control over primary energy resources such as gas, not only shapes its economic development but also its national security and military strength. As such, the international relations of nations are profoundly influenced by the distributions of energy resources and the technologies for their utilisation[18].

The accelerating deployment of renewables has set in motion a global energy transformation that will have profound geopolitical consequences. Just as fossil fuels have shaped the geopolitical map over the last two centuries, the energy transformation will alter the global distribution of power, relations between states, the risk of conflict, and the social, economic, and environmental drivers of geopolitical instability[19]. In this regard, every great transition in energy technology entails a shift in geopolitics as well[20].

SADC Member States will not be immune to this with competing global interests vying for influence in terms of the creation of comparative advantages aligned to specific interests. Regionally, a central theme in energy planning has been in managing the energy transition in a way that is just, and that does not place undue burden upon the developing world, in relation to the decarbonisation requirements.

By its very nature then, the RGMP as a regional plan, has a geopolitical underpinning. The political considerations will be key to understanding the energy market and economy. These drivers can be broadly broken into global and regional dynamics as shown in the figure below.

[18] Hafner, M., Tagliapietra, S., 2020, The Geopolitics of the Global Energy Transition
[19] IRENA, 2019, A New World: The Geopolitics of the Energy Transformation
[20] Hafner, M., Tagliapietra, S., 2020, The Geopolitics of the Global Energy Transition

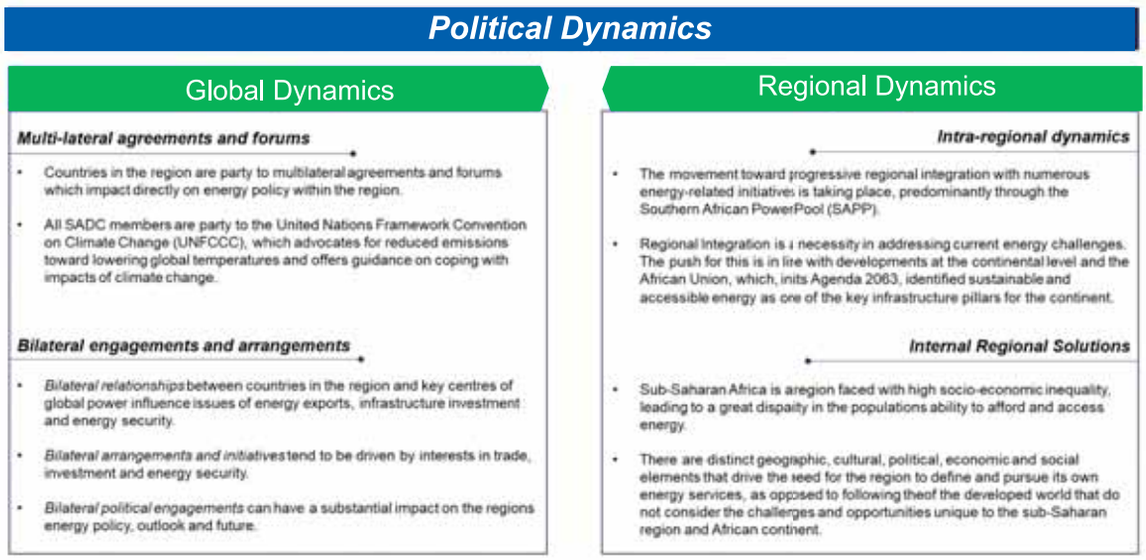


Figure 25: Overarching Geopolitical Themes

7.3.2. Socio-economic Drivers

Energy and economic prosperity are intrinsically linked, as energy is fundamental to economic production and therefore economic growth. Improving energy access, energy security, reducing energy poverty and enhancing affordability is central to a Member State's ability to grow economically and prosper. The socio-economic benefits of achieving this, for a region such as SADC, will and can be significant and is further expanded upon below

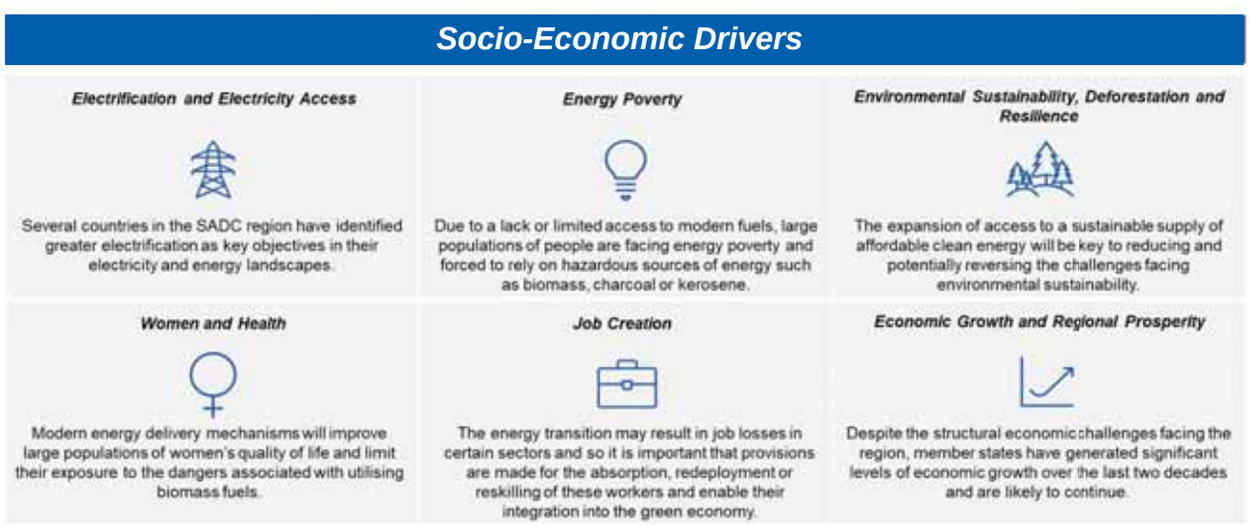


Figure 26: Socio-economic Issues Impacting SADC Member States

For SADC Member States managing the energy transition in a fair and just manner is an imperative. Taking a regional and integrated view to energy planning, so that energy policy serves the interests of the region is foundational for long-term sustainability and regional prosperity.

7.4 Energy Planning and the Energy System Structure

The World Energy Council (WEC) has advanced the notion of the energy trilemma, which addresses the challenge of balancing three competing aims, as illustrated in figure 27.

The recent large natural gas discoveries in SADC present a unique opportunity to address the energy trilemma. Developing a regional energy source, such as natural gas, not only provides energy security but also addresses environmental concerns. It allows the region to diversify from a predominantly coal-based and wood fuel-based energy mix, at a price that accommodates low-income households.

The inherent nature of natural gas also increases the reliability of the supply as it can provide cover for the intermittency of renewable-based power. The benefit of having affordable energy that is relatively clean and that addresses energy reliability and security must be considered as central to longer term prosperity for the region.

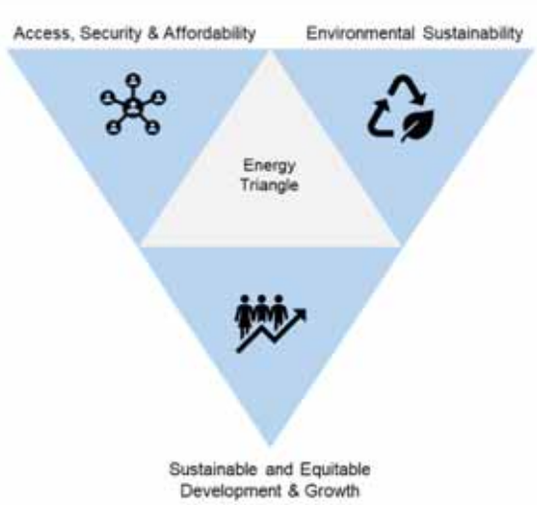


Figure 27: The Energy Trilemma

7.4.1. Integrated Energy Planning

Integrated Energy Planning, on a national and regional level, is a critical tool for SADC Member States to manage the energy trilemma and make timely, informed decisions about managing energy supply and demand [21]. These benefits are outlined in the figure below

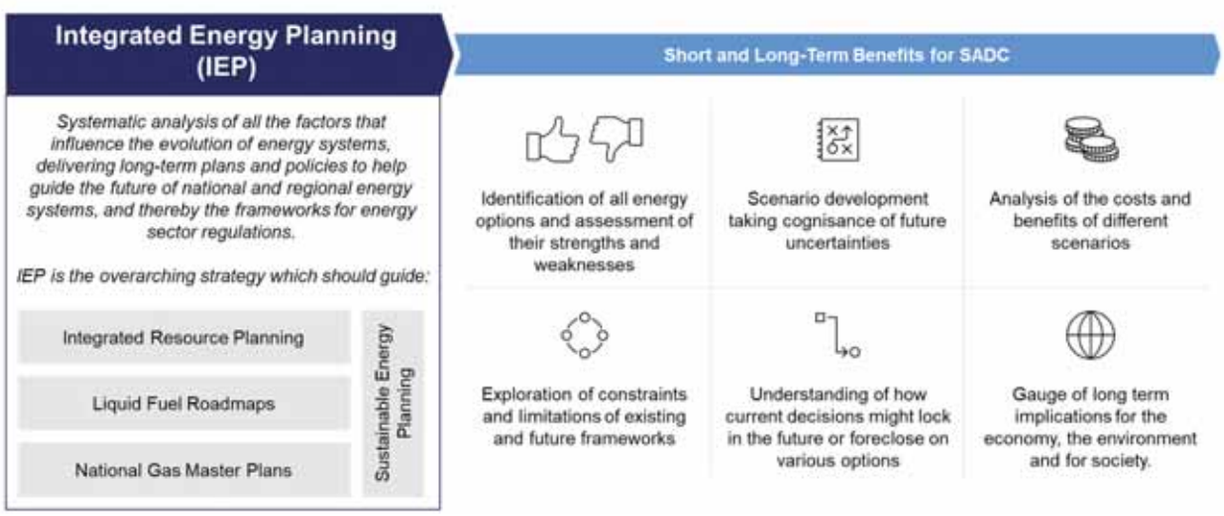


Figure 28: Integrated Energy Planning and its Benefits for SADC

An analysis of energy planning in Member States indicates that few have an IEP, although many have some form of IRP with a focus on electricity, petroleum and/or gas. A strong theme in virtually all policies and plans is national energy security. Most national plans prescribe first developing national resources to secure energy security whilst very few plans and policies refer to regional integration nor consider lower cost regional options over national resources. There is also limited reference to utilising regional markets to develop anchor projects for gas supply off-take. This approach has often given rise to sub-optimal economic and environmental outcomes.

[21] SADC, SACREEE, SAPP, World Bank Group, 2021, "Integrated Resource Planning Development Manual"

The analysis also indicates that gas is not a priority objective in most states due, in large part, to the lack of a regional gas market and infrastructure. Only South Africa, Mozambique, Tanzania, and Angola have active gas industries and they are the only Member States which have integrated natural gas into their energy mix. Some of the plans and policies refer to the introduction of natural gas in the energy mix but most Member States have little to no plans nor national policies for gas development.

There is a drive to develop policies and plans aligned to attaining SDG 7 goals with renewable energy and energy efficiency targets becoming more prominent and clean cooking themes being introduced. What is less prominent however are plans to address the variability of renewable energy and transition nations to a net zero carbon energy mix.

Integrated Energy Planning is not a once off event and should be undertaken regularly in a cyclical manner as energy supply, demand and technologies evolve. This is particularly important as SADC nations progress through the energy transition, to avoid energy shortages and disruptions that lead to elevated electricity prices and increased vulnerability to fossil fuel price fluctuations and emissions.

There are six distinct stages that should be undertaken as illustrated in the Integrated Energy Cycle in the figure below. Ensuring the continued roll out of integrated plans and policies will contribute towards the optimal adoption of natural gas in the regional energy mix and a successful energy transition and achievement of SDGs.

Figure 29: Integrated Energy Planning Cycle

SADC, as a coordinating force, has introduced a variety of energy related or energy specific strategy documents over the years. It does not have any specific protocols on the harmonisation of sectoral policies, but its thematic areas of cooperation, through the directories, comprise components of policy harmonisation. This establishes the base for SADC to introduce energy policy and planning guidelines that would assist the formulation or amendment of national energy policies, by providing guidance on the contents and methodologies required. SADC has the appropriate mandate to introduce IEP guidelines to provide regional energy security that is environmentally sustainable, affordable, and accessible i.e., balancing the competing aims of the energy trilemma.

7.4.2. Policy Convergence

Regional gas market development requires coordination and cooperation between various private and public sector stakeholders to create the enabling conditions to facilitate investment across the value chain. A critical aspect of the enabling environment will be to develop regional and national policies and plans which converge on the themes as displayed in figure 30.

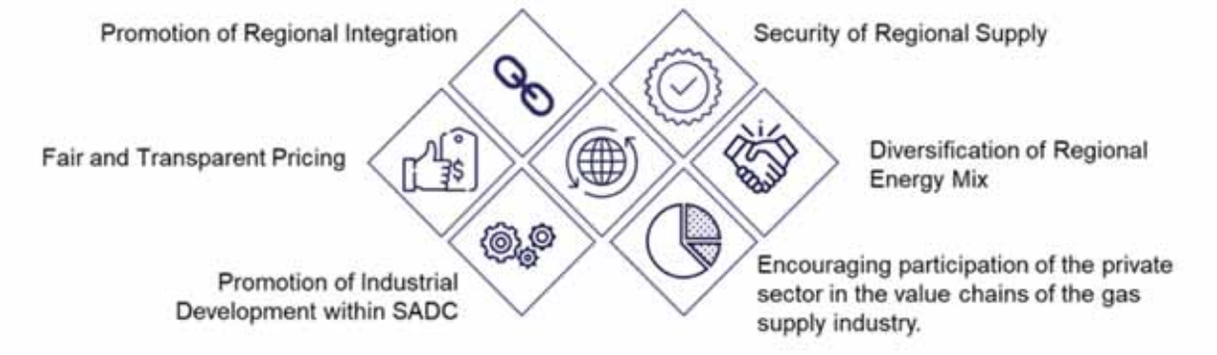


Figure 30: Policy Convergence

The regional policy framework must ensure a careful balance between the needs of Member States to protect national resources and security of energy supply with environmental imperatives and a drive to net zero carbon energy supply, whilst attracting investors into the gas value chain and ensuring competition. An effective regional gas policy should lead to greater efficiencies and economies of scale.

The focus that each country has placed on achieving the SDGs, and their NDCs to the Paris Agreements has led to a concerted regional effort to bridge the energy gap in the SADC region over the last ten years. However, true integrated energy planning is lacking and must be encouraged at a national and regional level if the region is to attain these goals.

South Africa presents a unique opportunity as a significant demand node to enable anchor projects, particularly in the power sector but also in industrial uses, given its existing market. There should therefore be policy convergence on the concept of utilising South Africa as a demand centre for power to unlock the region's gas resources through gas to power projects. This will be of significant benefit to South Africa, through access to more affordable energy resources, and to the gas producing countries (especially Mozambique and Namibia) in being able to unlock significant investment and export revenue. Once these anchor projects have unlocked the gas resources, policy should encourage the development of industrial and commercial and residential markets.

7.5 Legislative and Regulatory

As outlined above, it is critical that SADC Member States first converge on key areas at a policy level before an enabling regulatory framework and mechanisms can be developed, as the regulatory framework should assist SADC and its Member States to achieve their policy objectives. Regulations should then only be introduced where they increase economic efficiency as the compliance costs associated with regulatory uncertainty can reduce investor returns and increase risk, reducing the incentive to invest in gas supply and infrastructure. This is of particular concern if regulatory requirements are seen as less onerous in other regions. East and West Africa have made considerable progress in terms of the efficiency and consistency of their regulatory frameworks and there is the risk that SADC may be left behind in terms of investments if these markets are perceived as lower risk regulated markets [22].

The regulatory framework and mechanisms should facilitate competition and ensure easy access to the market. This could be addressed by an investor friendly regulatory framework which also addresses national needs. There are several characteristics of investor-friendly regulations in the gas market as illustrated in figure 31.

[22] COMESA/RAERESA, 2020, Framework for Regulatory Oversight for the EA-SA-IO Energy Market

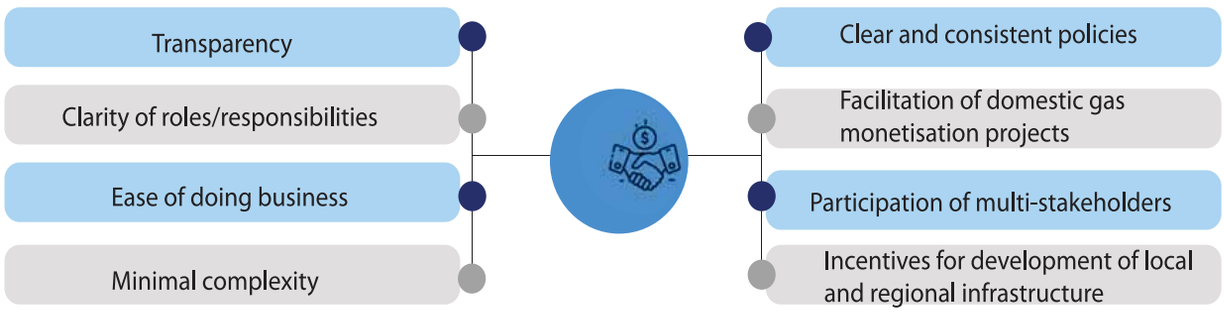


Figure 31: Characteristics of Investor Friendly Gas Regulatory Frameworks

A unique characteristic of the development of gas projects is the critical coordination of all elements of the value chain to ensure that the projects are bankable. It is therefore important that the regulatory framework must enable the development of infrastructure in tandem with upstream asset development and downstream anchor monetisation projects.

7.5.1. Member State Regulatory Frameworks

A thorough analysis was undertaken of the current SADC National Gas Legislative and Regulatory Frameworks. An overview of the analysis is indicated in the following figure:

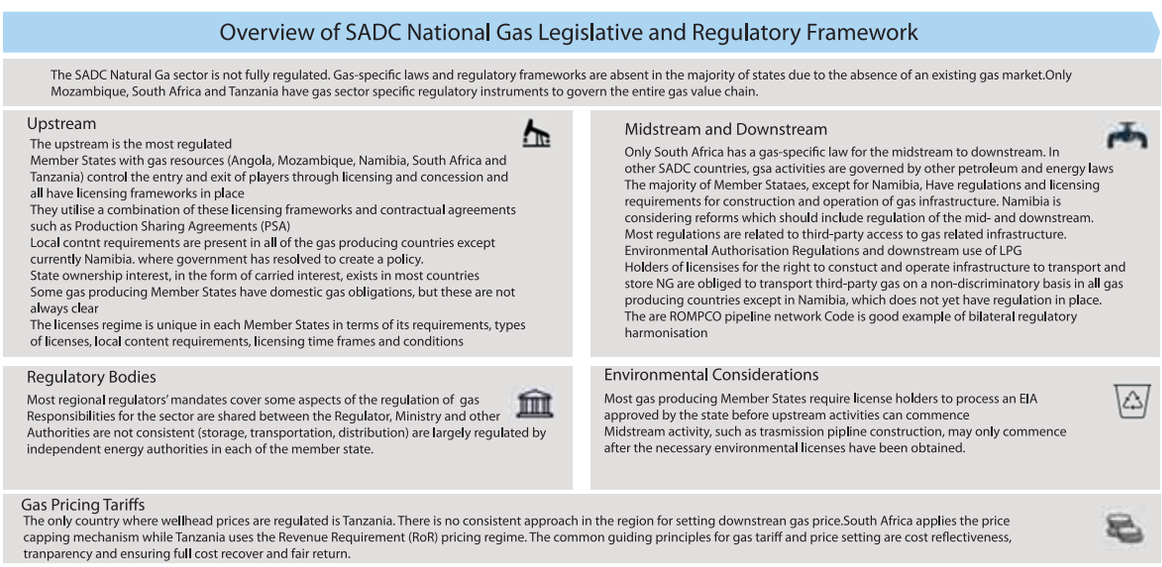


Figure 32: SADC Natural Gas Legislative and Regulatory Frameworks

7.5.2. Guidelines for Regulatory Mechanisms

SADC is in the nascent stage of the development of its gas market. It is therefore important to consider regulatory mechanisms in conjunction with the maturity of the particular market to ensure that any mechanisms employed in SADC are aligned with the market maturity. Therefore, a number of global best practices and case studies were used in developing regulatory mechanisms for the SADC market, including the West African Gas Pipeline (WAGP); European Union, Malaysia, and Pakistan gas markets as well as recent regional regulatory analysis studies by the Regional Energy Regulators Association of Southern Africa (RERA) and the Common Market for Eastern and Southern Africa (COMESA).

The current fragmented regulatory landscape could make the prospects of regional integration and regulatory harmonisation difficult to achieve and so it is recommended that it be approached in a phased manner, starting with bilateral cooperation between countries with existing gas markets and aligned with the clusters and economic corridors. Most gas markets start initially with bilateral agreements and are monopolistic by nature, but regulatory mechanisms should foresee the migration to a multi-player market. This means that

South Africa, Mozambique, and Tanzania will need to lead the way in terms of regulatory harmonisation (both technical and economic) following convergence on a policy level. Thereafter multilateral and then regional harmonisation can take place.

The overriding objective should be to only regulate where it is necessary and to keep the industry competitive without the burden of extra taxes and costs. Regulation of the regional SADC natural gas market should have the following objectives:

- Promotion of regional integration
- Security and reliability of regional supply
- Diversification of regional energy mix
- Promotion of industrial development within SADC
- Encouraging participation of the private sector in the value chains of the gas supply industry
- Promoting competition to create efficiencies and avoid monopolies

In developing guidelines for regulatory mechanisms for the SADC gas market, consideration was given to key dimensions where regulations are necessary. These are illustrated in the figure below;

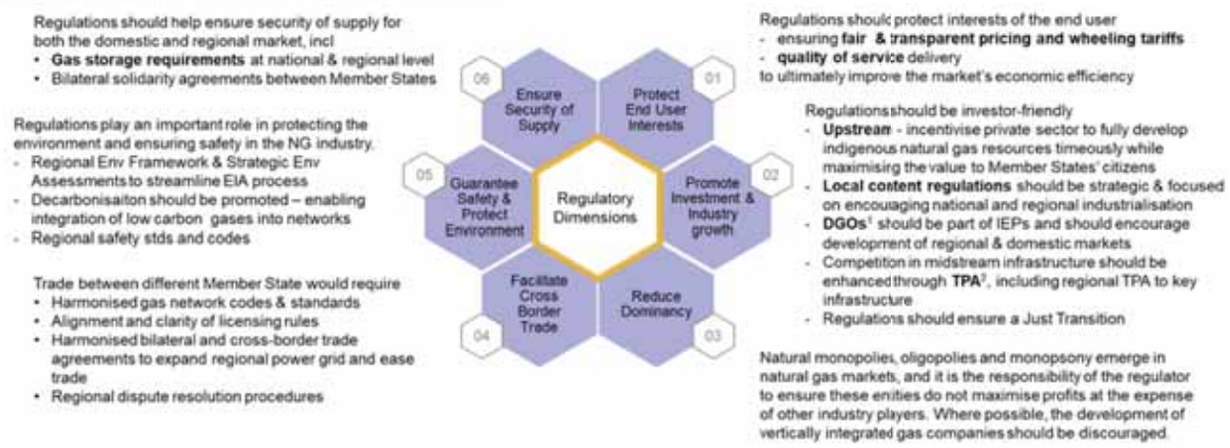


Figure 33: Key Dimensions for Regional Regulatory Guidelines

It is our recommendation that these Regional Energy Guidelines be workshopped among Member States to ensure that it can, practically, ensure harmonisation across energy sectors.

7.6 Capital and Investment Strategies

The economies of most SADC Member States are too small to finance regional gas infrastructure to the extent that will unlock its full potential. Regional integration is likely the only way to overcome this hurdle. Regional integration lowers costs across all aspects of infrastructure. The high cost of infrastructure services in Africa is partly attributable to fragmentary national boundaries preventing achievement of scale economies. Integrating physical infrastructure is both a precursor to, and an enabler for, deeper economic integration, thereby allowing countries to benefit from scale economies.

As indicated, fiscal revenues in SADC member states are unlikely to fully fund gas-based infrastructure projects, requiring a more market friendly approach and private participation. Securing private participation requires creating the ideal environment for investment, underpinned by including the following principles, and leveraging all available mechanisms to improve project economics and bankability, while reducing overall risk, which must consider country and project risks.

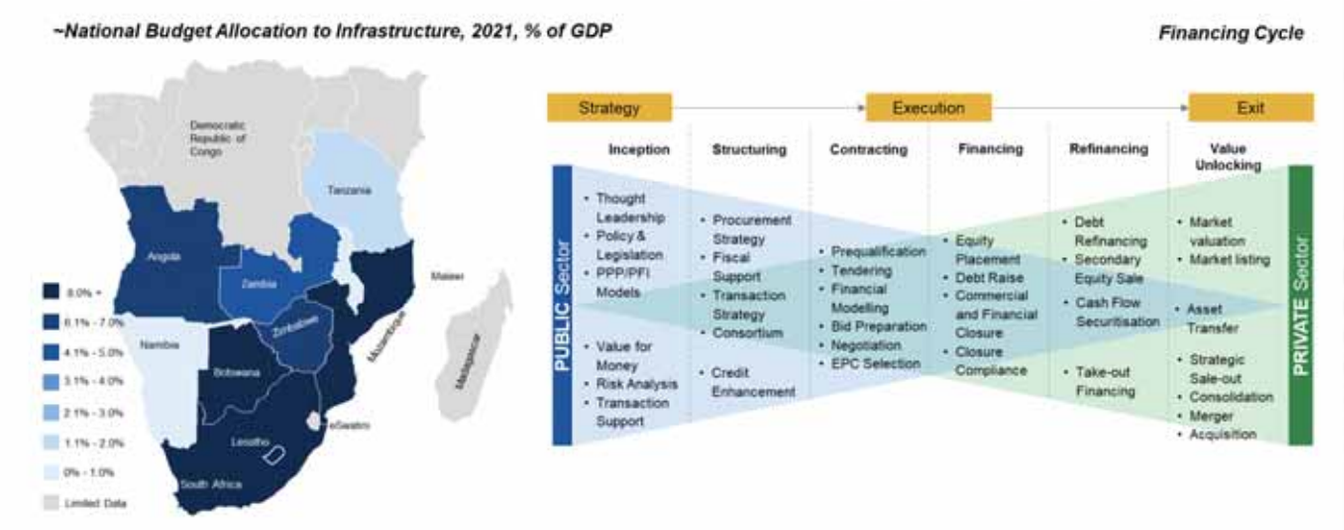


Figure 34: Budgetary Allocation to Financing Cycle

7.6.1. Attracting Investment into SADC

The key in assessing attractiveness in infrastructure projects is the level of perceived risks and the mechanisms to mitigate it. This requires de-risking throughout the project development lifecycle. For Member States to attract investment and fund the development of the regional gas market, the following risk mitigation measures are required.

7.6.1.1 Adoption of the RGMP into National Planning Frameworks

For the RGMP to be implemented, Member States must incorporate regional integration and the RGMP outcomes into National Policy documents. In this regard, National IRPs and Industrial Development Plans must commit to securing long-term gas-based off-take. Without Member States committing to off-take agreements, projects are unlikely to secure bankability necessary for development.

7.6.1.2 Institutional and Member State Support

Member States run the risk of creating unreasonable fiscal terms for developing domestic gas and gas-based infrastructure projects. Support is needed from the highest levels of government and through the national institutional structures, and may include:

- Ensuring clear roles and responsibilities of state enterprises, with clear mandates within legislative and regulatory frameworks,
- Creating enabling regulatory and legislative frameworks for the implementation of such projects
- Costly projects must be affordable within the budgetary framework and projects must therefore be affordable and consistent within fiscal framework, and
- Budget deficits must remain consistent with macro-economic objectives.

7.6.1.3 Project Preparation and Development

The RGMP, together with national master plans, can serve as the basis for infrastructure development. Having a pipeline of projects that are well developed, with suitable detail for private sector involvement, becomes a key component of implementing the RGMP. In this regard it is recommended that Member States undertake the following:

- Commit to a pipeline of priority projects for regional integration of the gas markets,
- Define projects with prefeasibility and feasibility studies supported by the Member States and Development Finance Institutions (DFIs) amongst others,
- Leverage off regional and international DFIs to drive project preparation capabilities together with the SADC Secretariat, and
- Provide support to Member States to manage stakeholder engagements around counterparties in PPP arrangements where required.

7.6.1.4 Financing Mechanisms

For SADC Member States to expedite funding arrangements and promote priority projects through the project preparation and development; such that bankability can be secured, and financing arrangements agreed, an Infrastructure Fund for Gas and related infrastructure may need to be considered. The advantage of such a fund is that Member States can contribute towards the development of regional integration projects, managed through credible regional DFIs, such as the DBSA, to contribute towards the development towards bankability of such priority regional integration gas-based projects. Such a fund could expedite the process and manage delays that can occur between borrowing and implementation, particularly in the instance of bond issuance.

Reliance on multi-lateral development finance, in relation to the changing dynamics around fossil fuels, does introduce specific risks. A means to mitigate this will require SADC Member States to take proactive steps in mobilising resources to facilitate and fast-track development necessary for investment.

7.6.1.5 Counter-party risk

Private sector involvement in regional infrastructure development projects will require partnerships with national and sub-national government entities, including State-Owned Enterprises, presenting counter-party risk when considering the repayment of commercial financing, as when an SOE issues a bond in capital markets.

7.6.1.6 In-country Capacity

Some of the in-country capacity risks include:

- Inability to develop and implement effective infrastructure programmes,
- Poor in-country management contributing to poor project performance, and
- Lack of effective management in capacity in potential off-takers and public service providers can contribute to below standard performance and be a major barrier to increased use of private financing, such as IPPs.

7.6.2. Sources of Funding

Considering the challenges of funding regional gas-based infrastructure projects through fiscal revenues alone, it is recommended that SADC Member States consider potential new funding sources for infrastructure projects. It is however likely that these will differ for the type, scale and strategic nature of such projects. These, together with established mechanisms, can provide the balance of funding necessary to take projects through the development cycle towards bankability, while de-risking and thereby introducing potentially new categories of investment. These are provided for in the figure below.

		Source / Mechanisms	*Stage of Investment*	*Objectives*	*Risk Appetite*
1	*Sovereign/ Member State*	Fiscal Revenues Sovereign Bonds Guarantees (incl. Off-take)	**Early stage (Inception)**	The MS objectives are developmental, de-risking by providing the necessary early stage and developmental capital to facilitate development and growth	***Higher Risk***
2	*Foreign Direct Investment*	Listed multi-nationals Private Equity Sovereign Wealth Funds	**Early stage (Structuring)**	FDI has been primarily in upstream Gas, less in relation to infrastructure, as well as minerals sectors, but IPPs present a viable option	***Medium to Low***
3	*Development Funding*	Regional DFI's Development Capital Multi-lateral DFIs	**Early stage (Inception)**	Development finance has been critical in developing projects with some DFIs looking to promote a development capital approach (providing equity) and an exit strategy	***Higher Risk***
4	*Other Sources*	Pension Funds Infrastructure Funds International Bond Market Export Credit Agencies	**Execution Stage**	Accessing pension funds, creating infrastructure funds and so forth are some of the newer approaches that can taken, however, this will be for projects much close to execution	***Low Risk***

Figure 35: Potential Sources of Funding

Certain infrastructure categories, such as Electrical Transmission lines, may not be amenable to private participation (as these are mostly state-owned monopolies) and therefore should be funded through Member States with support from multi-lateral DFIs and potentially commercial banks. Pipeline infrastructure, as well as LNG regasification, and storage facilities will likely occur in the form of concessionary PPPs, while projects such as IPPs, petrochemicals and so forth will likely be developed privately.

7.6.3. Funding Plan

The funding plan seeks to address the resource mobilisation needs of SADC Member States in implementation of the RGMP. The following categories of infrastructure investment with funding options are presented:

- Regional Interconnectors and Electricity Transmission Lines
- State-owned infrastructure funded through multilateral DFIs and banked through regional
- PPAs. The mechanisms for funding of regional interconnectors are well established and will not be dealt with in the RGMP.
- LNG Regasification Terminals
- Gas Compression and Pipelines

Mid-stream infrastructure such as regional gas pipelines will likely be developed through PPPs and concession agreements. In the instances of regasification and storage facilities, these will likely be developed privately with concession agreements from Port Authorities.

Securing market off-takers will be critical in determining bankability, and therefore, once more Member States will need to commit to off-take take, likely through the Power Sector and PPAs.

- Downstream production (power, industry, petrochemicals)

Downstream infrastructure is likely to have complete private ownership, requiring Member State support through enabling fiscal terms, and signed off-take agreements where necessary. Development funding through the likes of the IDC can contribute towards developing such projects. For downstream projects of a strategic nature, but with potentially marginal economics (e.g., fertilizer production), Member States must provide favourable fiscal terms, to improve economics.

It should be noted that the above is a value chain of activities that has different ownership structures due to the nature of the markets, however without anchor demand that is secured (e.g., electricity through signed PPAs), development of the entire value chain is placed at risk.

7.6.4. SADC Regional Integration Energy & Gas Infrastructure Fund

It is recommended that SADC Secretariat, in partnership with the DBSA, IDC and other DFIs and/or International Financial Institutions (IFIs), should set up a Regional Integration Energy & Gas Infrastructure Fund for the RGMP. Managed by reputable regional entities, such as the DBSA, this fund would be able to help fund the energy infrastructure of SADC member states where individually states might not be able to fund such ventures. Furthermore, where project preparation and development is necessary, this fund can be used to de-risk such projects by taking such projects towards bankability.

This Fund would eventually pay for itself through the provision of funding which could be paid back via divestment of such investments through a public offering or through sell down to various funds and IFIs like the IFC. This could result in returns to the Energy Fund which would allow for an ongoing stream of investments for SADC Member States. Such a fund could be managed by an organisation such as the DBSA. The success of such an Energy Fund would be professional management and a clear but flexible mandate.

7.7 People: Capacity and Participation

The rapid transition currently occurring within the energy sector requires a workforce with the skills that can address the challenges of today, as well as being prepared for those of tomorrow. In certain respects, energy and people are the foundational forces that drive economic development and growth. Thus, having readily available, affordable, secure, and abundant energy is a competitive advantage for a country, while having an abundance of skilled and capable people provides competitiveness for a country[23].

[23] World Economic Forum (WEF), 2016, Economic Progress: What is competitiveness?; https://www.weforum.org/agenda/2016/09/what-is-competitiveness, Accessed: October 2022

When considering SADC Member States in relation to the rest of the world, demographics are in its favour. Member States generally have a young population, with a declining dependency ratio. This is counter to much of the rest of the world and provides the region with a pool of people that can drive economic development. However, structural challenges exist in developing, training, and giving the labour resource base the requisite economic opportunities to leverage its potential. Where the depth of available people may present an advantage, the lack of expertise presents a significant challenge, when one considers the requirements for developing a new technical market, i.e., natural gas.

If Member States are to develop their gas sector, it is an imperative for there to be a workforce supply with the skills required to plan, develop, operate, and regulate the end-to-end and integrated value chains that exist between the gas sector and its downstream industries, including the power sector. Evidence from the sector shows that occupations with specialised technical tasks, such as geoscientists, petroleum engineers, and drillers, need years of formal education, training, and industry experience[24], which will require a long-term view on skills development.

The RGMP occurs within existing Member States' training systems, and therefore the system itself needs to ensure that it has sufficient robustness to cater for the training needs of the sector.

7.7.1. Sharing Knowledge and Experience

The SADC region can benefit from Member States with more mature education systems, and those with established gas industries. Therefore, sharing of knowledge and experience becomes a tangible enabler. It is particularly valuable for countries to share their experiences in dealing with the more difficult challenges of maintaining the relevance of education and training to the world of work, and in moving from policy principles to application[25]. There is also scope for taking a close look at the interlinkages between skills policies, training systems and development and reviewing how knowledge and experience of training strategies and policies can help SADC Member States address their growth and development challenges.

7.7.2. Skills Development Framework

In this regard, the cornerstones of the RGMP policy framework for developing a suitably skilled workforce are:

- availability of good-quality education as a foundation for gas and related industry training needs,
- matching of skills supply to the needs of enterprises and labour markets,
- considering the learning and development life cycle of employees and the requirements of continuous professional development,
- enabling workers and enterprises to adjust to evolving technology and market needs, and
- anticipating and preparing for the skills needs of the future.

The RGMP provides a framework for skills planning, including defining the skills likely to be demanded, ensuring the supply drive is created, and ensuring a clear investment framework is articulated.

The skills requirements for gas importing vs. gas exporting Member States will be different. For gas importing Member States (i.e., those States with no domestic gas resources of their own), the primary initial requirement will be in ensuring downstream energy integration occurs and this will be driven by policy. Thus, for these Member States, the priority is developing and building the skills, and capacity, to ensure appropriate policy alignment occurs in relation to an integrated and evolving energy system. Gas exporting Member States however, will also require skills in the upstream exploration and production spheres as well as midstream technical and regulatory skills.

The following figure reflects the areas in which skills will be required:

[24] Ghana's oil and gas sector, Sector Development Strategy, ILP, 2021
[25] A Skilled Workforce for Strong, Sustainable and Balanced Growth, ILO 2010

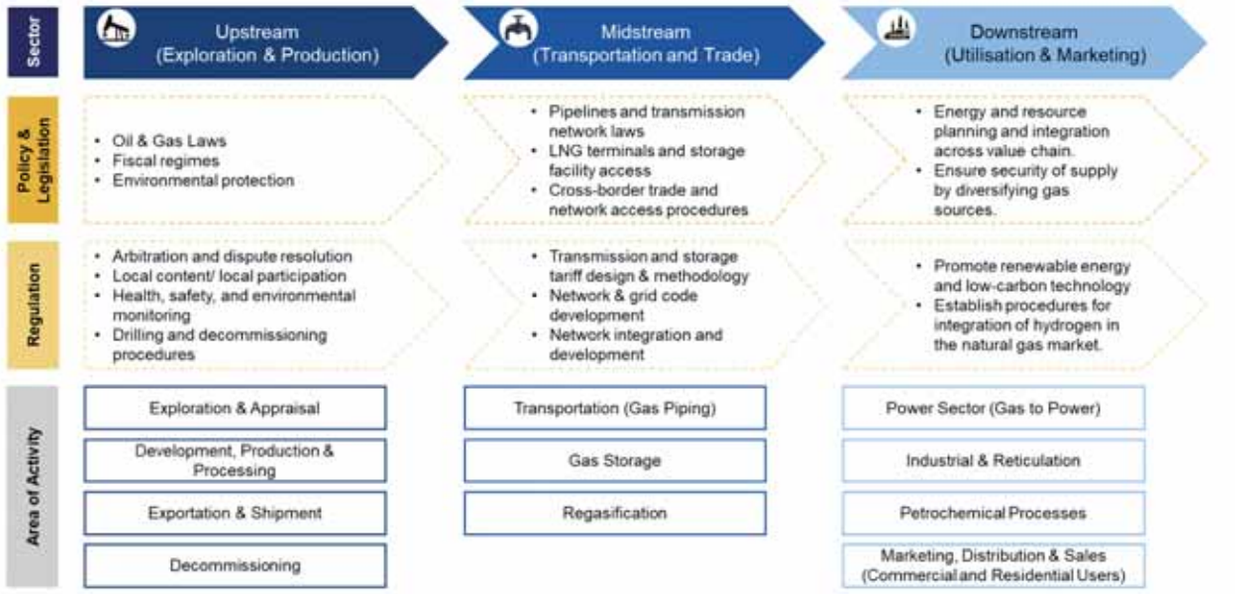


Figure 36: Potential Sources of Funding

The objective of the RGMP Skills Development Framework, is to provide a blueprint for which Member States can align skills development initiatives, ensuring the skills needed for gas market development are considered and met. Furthermore, when we considered the skills development needs of the Member States themselves, it is necessary to ensure the skills in Policy, Legislation and Regulatory development and alignment occurs. The regional gas market can only develop if the correct decisions are taken on a policy level, providing the policy certainty for investment. This requires the appropriate skills to manage and navigate the complexity associated with the geopolitics of energy and the energy transition. Policy direction, together with the requirements of legislative and regulatory frameworks will have a significant impact on the development, operability, and profitability of the market. Building the skills and capacity in line with these functional requirements is essential to ensure appropriate policy alignment occurs in relation to an integrated and evolving regional gas market.

7.7.3. Technical Skills Development

The following recommendations are made for the Technical Skills Development Initiatives:

System and policy alignment

- Regional collaboration in defining and anticipating the skills needs of the sector,
- embedding mechanisms for engaging employers and workers in decisions about training provision, and
- monitoring and evaluation of training outcomes.

Timing of skills development initiatives

- Align skills development initiatives and supply with demand based on planned gas sector developments.
- Regional standards for skills development across gas and related industry programmes, ensuring critical skills programmes are recognised regionally, and
- establishment of Centres of Excellence (CoEs) for specialised vocational, technical, policy, regulatory, and managerial skills, for delivery of regionally recognised skills programmes.

Regional skills transfer and knowledge sharing

- Utilise available SADC and AfCFTA treaties in ensuring specialised and skilled labour are freely transferable between Member States, and

- leverage regional and international expertise to build in-country competency. That is, ensuring skills transfer mechanisms are embedded when leveraging external support.
- Consider the full lifecycle developmental requirements, including tertiary education, on-the-job skills training, and continuous professional development, and
- management of existing talent utilising re-skilling and upskilling to meet the evolving industry demands, supported by coaching and mentoring.

7.8 Institutional Arrangements

National and regional institutions have a key role to play in the development of the regional gas market. This is in terms of policy and regulatory harmonisation, resource mobilisation, aggregation, aligning key stakeholders, capacity building and developing and managing economic corridors. The following table outlines key roles for regional institutions.

Table 4: Key Roles for Regional Institutions

	Southern African Development Community (SADC) SADC has significant enabling power in facilitating and encouraging harmonisation across the Member States. The SADC Secretariat and Inter-State (Regional) Gas Committee have a key role to play in facilitating cooperation between Member States in the regional gas market and enabling the implementation of the RGMP. It is also recommended that they play a leading role in driving policy convergence.
	Regional Energy Regulator's Association of Southern Africa (RERA)RERA's current role as an association of national regulators is an important one as it formalises the avenue for engagement and dialogue between the national regulatory authorities. The Gas, Petroleum and Biofuels Regulation Sub-Committee (GPBRS) is also tasked to facilitate the development of regional petroleum and gas infrastructure and markets that are efficient, reliable, integrated, harmonised, sustainable and investment friendly for the benefit of the region. RERA will be transformed into the SADC Regional Energy Regulatory Authority (SARERA). As such, it will be a very critical organisation in the implementation of the RGMP. It is proposed that SARERA should have the role of implementing rules for participation within the Regional Aggregator and monitor and evaluate compliance with market rules. It is further expected that SARERA will oversee power pool operations within the Southern African Power Pool (SAPP), regulate regional energy trade and facilitate the harmonisation of regulatory policies, legislation, standards, and practices. SARERA should provide a forum to mediate disputes over access to facilities relating to cross-border trade.
	SAPP could play an important role in enabling the RGMP by enhancing the ability of regional GTP projects to access the regional power pool. The Regional Transmission Infrastructure Programme should be developed in order to unlock transmission constraints. This would assist in the harmonisation and standardisation of participation on the SAPP network, by introducing and adopting a uniform, transparent and non-discriminatory regime of open access to the regional transmission grid, harmonising grid codes, developing an updated transmission pricing methodology for fair benefits sharing mechanisms between the countries, and establishing and operationalising an innovative and sustainable financing mechanism for hard and soft infrastructure.

	**SADC Centre for Renewable Energy & Energy Efficiency (SACREEE)** The objective of SACREEE is to contribute towards increased access to modern energy services and improved energy security across the SADC Region through the promotion of market-based uptake of renewable energy (RE) and energy efficient (EE) technologies and energy services. SACREEE can play an important role in aligning the implementation of the RGMP in line with regional renewable energy and energy efficient projects in order to ensure that natural gas plays a role in transitioning the region to a zero-carbon future.
	**Kafue Gorge Regional Training Centre (KGRTC)** The Kafue Gorge Regional Training Centre (KGRTC) is a subsidiary organisation of SADC with the mission to provide a Learner-Centred Environment for the Acquisition of Skills and Competencies in Energy Technologies. KGRTC drives skills development in the Energy Sector throughout the SADC region and can therefore play a significant role in building capacity in the region to develop a regional gas industry.
	**African Development Bank (AfDB) Group** The overarching objective of the African Development Bank (AfDB) Group is to spur sustainable economic development and social progress in its regional member countries (RMCs), thus contributing to poverty reduction. The AfDB can play a key role in the implementation of the RGMP by assisting with the financing of key infrastructure and being an active partner and facilitator for private investment in the sector.
	**NEPAD Business Foundation (NBF)** The New Partnership for Africa's Development (NEPAD) Business Foundation (NBF) is a non-profit organisation that coordinates private sector efforts aimed at Africa's economic growth and development in alignment with the NEPAD thematic areas. NBF can play a key role in the implementation of the RGMP by promoting cooperation and partnership between governments and businesses to assist in the development and implementation of the gas infrastructure investment blueprint.
Corridor Management Groups or Institutions (CMG or CMI)	The efficiency and effectiveness of an economic corridor is largely determined by the role played by the Corridor Management Institution (CMI) that oversee its operations. CMIs would play a key role in the implementation of the economic corridors and facilitation of the gas markets and infrastructure proposed in this report.

There are also critical roles that must be undertaken at a national level to unlock the region's natural gas potential and utilise it to enable the energy transition.

Table 5: Key Roles at the National Level

Ministries	Ministries need to ensure that there is policy convergence, and that national energy policies and plans enable the promotion of regional integration, security of regional supply, diversification of the regional energy mix, promotion of industrial development and encouragement of the private sector in the value chains of the gas supply industry. This should be pursued in a phased manner, initially on a bilateral basis utilising agreements such as Inter-Governmental Memorandum of Understanding (IGMoU) or bilateral treaties focusing on strategic nodes, Ministries should be involved in the early stages of development of the proposed economic corridors and drive the development of such MoUs.

National Regulators	National regulators are critical enablers of the RGMP. They should drive the harmonisation of regulatory frameworks, first at a bilateral level along the defined corridors between existing gas trading countries and ultimately on a multilateral and finally regional level. This should be done in collaboration with RERA. There is, however, regional inconsistency with the mandates of the various regulators, particularly with respect to mid-stream infrastructure which makes communication and decision making difficult. It is therefore recommended that alignment is reached on regulatory institutions and mechanisms within each of the identified corridors.
National Gas Industry Associations	National gas industry associations can play a central role in ensuring safety, capacity building and awareness in the sector. They can do this by acting as a partnership between public and private sector to promote the sector and ensure the security and quality of natural gas. As such, they can play a vital role in creating awareness and understanding of the RGMP in the broader regional industry.

8. HARD INFRASTRUCTURE

The development of gas related infrastructure was considered on a corridor basis, centred around important sources of supply and demand in the region. This was aligned with the recommendations provided in Phase I.

The different corridors are shown in the map below:

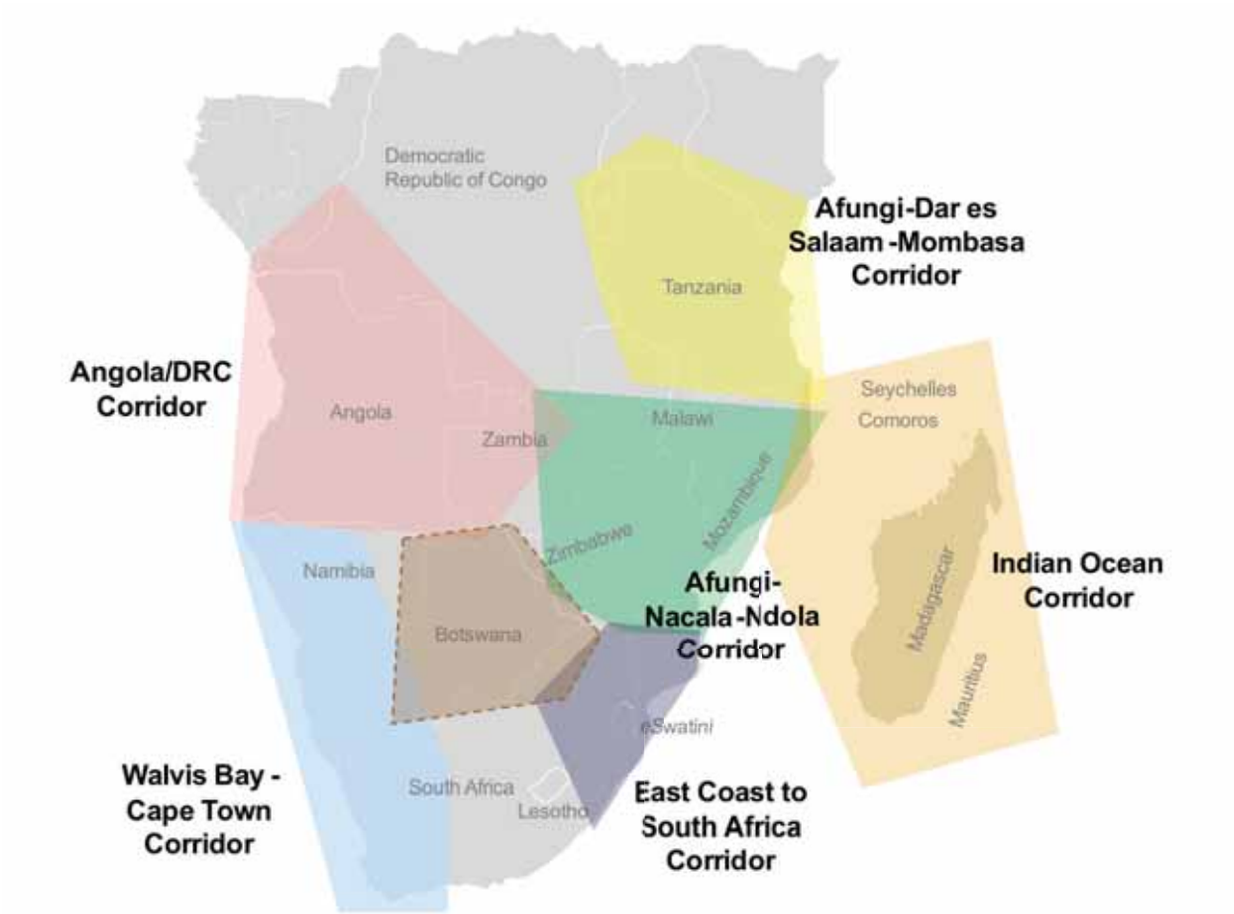


Figure 37: Map Demonstrating the Economic Corridors

8.1 Economic Corridors and Clusters

8.1.1. East Coast to South Africa Corridor

8.1.1.1 Infrastructure Blueprint and Enablers

The infrastructure blueprint for this corridor is predicated on the development of an LNG import terminal at the Matola Harbour in Mozambique as an initial anchor project. This project is critical to ensure continued supply security to the industrial heartlands of South Africa as supply from the fields in southern Mozambique begin to decline. There is also potential for the development of an LNG import terminal at Richards Bay Harbour to supply GTP as well as the South African KwaZulu Natal markets, but this would be a national and not a regional project.

Once this infrastructure is in place, additional scope exists to increase supply of gas for both power generation and latent demand for industrial heating applications, displacing coal and supporting growth.

Table 6: Corridor Summary - East Coast to South Africa

Proposed Infrastructure:
- FSRUs at Matola & Richards Bay
- Pipeline from Port of Matola to ROMPCO pipeline
- Power infrastructure from Beluluane to the Motraco line

Step 1 – Existing demand creates anchor	Enablement & Requirements	Step 2 – Industrial growth
Current industrial & power demand of ~209 PJ can anchor FSRU as Pande Temane gas supply declines New demand likely to come from power sector by 2026 • New GTP IPP ~ 25 PJ • Diesel conversion 4-6 PJ • Eskom re-purposing ~5 PJ • Embedded generation ~10 -20 PJ	Hard Infrastructure Develop LNG import terminal infrastructure in Maputo and Richards Bay Strengthening grid infrastructure from Maputo & Richards Bay Soft Infrastructure Change policy to enable regional projects to participate in South Africa's IPP Programmes Ensure that Integrated Energy Planning is instituted and there is a focus on regional energy security and reliability	Growth in demand for industrial heating ~15 – 27 PJ by 2030 Potential to displace coal in industrial applications ~10 – 20 PJ by 2035 Potential to grow residential use of CNG to displace LPG & power ~5 PJ Power & industrial applications in Eswatini ~10 PJ

Challenges

South Africa needs to reframe its IRP to include regional gas supply and open up its procurement programme to such supply.

Further investigation for gas pipeline options is required for gas supply.

Timing of projects in line with decline of Pande-Temane

Table 7: Infrastructure Investment - East Coast to South Africa Corridor

Country	Type of Project	Project Title / Definition	Year	Dependency	CAPEX (US$m)
Mozambique	Power Project	400/11 kV generation station with 3 x 1000 MVA transformers	2030	Yes	237
Mozambique	Power Project	New GTP - Maputo 3x 400 kV line (6km)	2030	Yes	8
Mozambique	Power Project	Maputo - Arnot 400 kV line (284 km) with Series Capacitor	2030	Yes	111
Mozambique	GTP	Beluluane power station	2025	Yes	2,334
Mozambique	FSRU	Maputo FSRU	2025	Yes	466
Mozambique	Matola Pipeline	Maputo to Ressano Garcia	2025	Yes	60
South Africa	FSRU	Richards Bay	2025	Yes	252
South Africa	Pipeline	Richards Bay to Secunda	2025	Yes	1,682

Dependency Key	Yes
	No
	Partial

Successful delivery of these projects would result in a slight decrease in total carbon footprint in the region of ~20 kt when compared to a scenario where no LNG project goes ahead. This slight net decline is due the following factors:

- the likely switch by industrial gas users to more carbon intensive energy sources should imported LNG not be available; and
- the chance afforded by the greater availability of natural gas for industrial and other energy con sumers to switch from their current use of more carbon intensive energy sources such as coal, LPG and diesel.

These reductions in emissions almost completely offset the emissions that result from the regassification of the LNG and power generation.

8.1.1.2 Demand

The interior South African provinces of Gauteng, Mpumalanga, and Free State, together with the southern provinces of Mozambique (Inhambane, Gaza, and Maputo) consume ~489 MMscf/d[26] (197 PJ/a) with ~94 MMscf/d (38 PJ/a) being sold within Mozambique. Uniquely, the bulk of South Africa's gas demand is for use in the industrial sector.

Synthetic fuels and chemicals production at Sasolburg and Secunda (utilising the Fischer-Tropsch process) accounts for between 100 and 120 PJ of natural gas demand and dominates the off-take of gas within the inland of South Africa. This off-take is critical in providing an anchor for any future gas development and importation.

An additional 23 PJ[27] of Methane Rich Gas (MRG), produced as a by-product of the Coal-to-Liquids (CTL) process in Secunda, is sold within KwaZulu-Natal.

Future demand growth is likely to come mostly from power with a total of 4450 MW of new GTP being planned over the next decade. These new power facilities will be in southern Mozambique, Eswatini and South Africa. In addition, the potential exists to convert ~3000 MW of diesel fired peaking capacity and repurpose decommissioned coal fired power stations using natural gas.

While this represents a very substantial volume of power, significant challenges lie in both the very low planned utilisation of much of this capacity (~6000 MW likely to operate at 5-12%[28] capacity and consume ~25-54 PJ/a) as well as significant uncertainty as to their feasibility. Only the expected GTP investments in southern Mozambique are expected to run at base-load utilisation with demand of ~27 PJ/a.

Finally, should South Africa adopt the least-cost generation path in its next iteration of the IRP[29], a further ~1000-1500 MW of mid-merit GTP by 2030 and ~5000 MW by 2040 could be required. This would require an additional 31 PJ of gas by 2030 and 123 PJ by 2040. However, to realise this potential, South Africa would need to take account of potential regional sources of GTP in its planning.

8.1.1.3 Supply

This demand is currently supplied from producing fields at Pande-Temane in Inhambane Province in southern Mozambique, transported via the ROMPCO pipeline, as shown in the figure below. However, supply from these fields is due to start declining from 2028[30] which would require importation, via pipeline or LNG to maintain supply. In addition, Sasol have given notice of withdrawal of Methane Rich Gas from the KwaZulu Natal market by 2026.

[26] Sasol, 20F 2021
[27] Sasol, 20F 2021
[28] DMRE, 2019. Integrated Resource Plan (IRP2019)
[29] DMRE, 2019. Integrated Resource Plan (IRP2019)
[30] Sasol, 2022

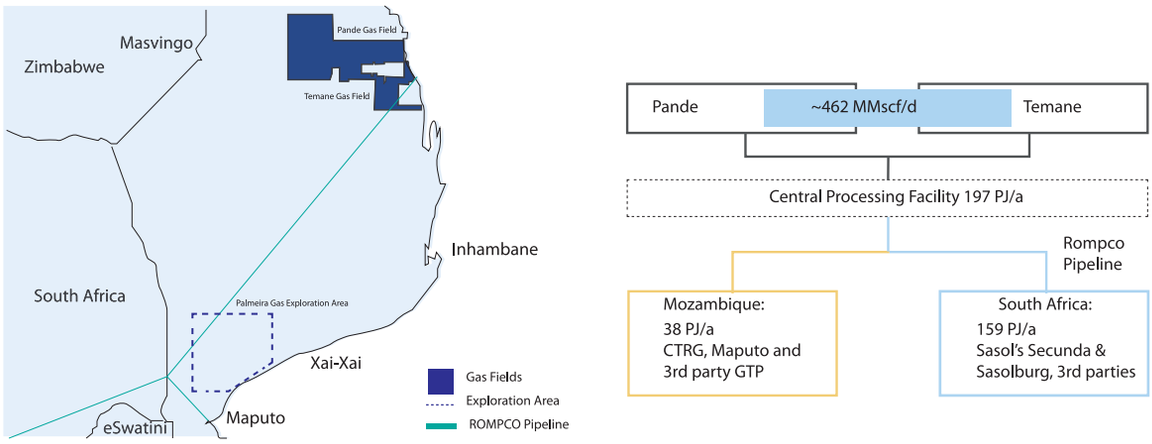


Figure 38: Current supply from southern Mozambique

The analysis below provides a comparison of the economics of potential supply of gas via pipeline from northern Mozambique/ southern Namibia or via a generic LNG terminal.

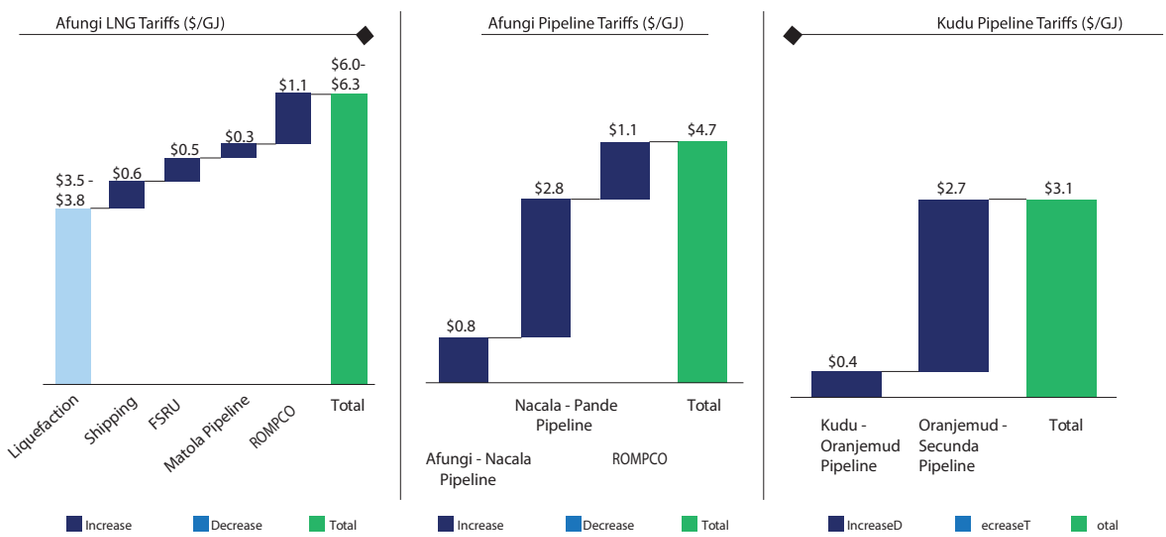


Figure 39: Comparison of Tariffs to Transport NG to inland South Africa

While the above economic analysis would seem to indicate that a gas pipeline would be more economic than LNG importation, the inherent flexibility of LNG, risk of infrastructure lock-in and time required to develop a pipeline all favour LNG as an import option. Consequently, it will be important that LNG importation be pursued as a short-term priority with potential pipeline supply from southern Namibia or northern Mozambique being pursued as a longer-term option.

To provide the required throughput for LNG importation, a base-load industrial demand will be needed as the envisaged peaking power demand will be too small and erratic. The only source of this large industrial demand lies within the inland of South Africa. Both the ports of Ngqura and Richards Bay would require substantial investment in new pipeline infrastructure. Hence, Maputo will need to play a critical role as an LNG hub for the region. Through the Motraco line, Maputo offers good evacuation of up to 2000 MW power and can therefore also provide a site for peaking power. Consequently, the Port of Maputo needs to be considered as an LNG supply option for South Africa.

There is also potential for an LNG import facility at Richards Bay for power and to support Sasol's current MRG customers. The development of this terminal could lead to the development of a larger gas market in South Africa's KwaZulu Natal province but this is likely to be a national project and not a regional one.

8.1.1.4 Key Decisions and Infrastructure Plan

Critically, South Africa needs to reframe its planning for both power and energy to consider a broader range of energy resources within the region. This planning would need to include both the prospect of LNG and peaking GTP supply from Maputo as well as mid-merit GTP from Mozambique and Namibia.

This approach will hold an advantage for South Africa in unlocking abundant and highly competitive GTP resources in the region. In turn this can allow the country to move to the least cost generation path in the IRP and enable substantially greater volumes of renewable power. The rest of the region can also benefit by anchoring large GTP development that can be leveraged to drive greater energy access and gas-based development.

8.1.1.5 Additional projects

Within this corridor, the following projects of smaller size are being pursued that need to be considered as part of the Master Plan:

- Virginia Gas field. The reserve comprises reserves of ~0.2 TCF of methane at 1P and ~0.4 TCF of methane at 2P. The methane is associated with ~0.07 TCF of helium at 1P and ~0.14 TCF[31] at 2P. The field is being developed to produce helium and market the methane as LNG.
- Amersfort gas field. This comprises both a Coal Bed Methane and conventional gas field with contingent resources of 4.9 TCF. This is being developed by Kinetiko Energy with plans to drive a five core well exploration programme from Q4 2022 through calendar year 2023.
- Durban Basin. A drilling programme by Sasol and ENI was due to start, however this has been subject to substantial environmental challenge and delay.
- Aside of these developments in South Africa several areas in southern Mozambique and Zimbabwe including PT-5C, Block 16/19, the Zambezi basin, Angoche basin and Caborra Bassa basin are being explored. As yet, no discoveries have been made in any of these exploration areas.

8.1.1.6 Recommendations

To realise the full potential that this corridor holds to unlock the gas economy in the region the following key decisions and investments will be required:

1. South Africa to update its IRP, including regional supply of GTP.
2. Regional GTP supply options should be allowed to bid in the South African Gas IPP Programme.
3. To avoid undue risk aversion by LNG importers and IPP developers and thus ensure the optimal LNG-to-Power solution, the gas IPP RFP should clearly specify the level of availability required, & notice periods. This should be based upon a clear understanding of risks that will be accepted by the system operator and that which needs to be mitigated by the IPP.
4. Investment in pipeline infrastructure connecting Matola with the ROMPCO pipeline will be needed.
5. Investment in the power infrastructure from Beluluane to the Motraco line and possible strengthening of the Motraco Power Station to ensure n-1 redundancy is maintained.

See infrastructure development requirements in the Annexure.

8.1.2. Afungi-Nacala-Ndola Corridor

8.1.1.7 Infrastructure Blueprint and Enablers

The Afungi-Nacala-Ndola Corridor is underpinned by an investment in a large-scale GTP facility at Nacala, supplying the South African power market. This sizeable power facility and associated gas demand is required to underpin the development of a gas pipeline from Afungi to Nacala which in turn can facilitate the development of a gas hub in Nacala.

This hub can then play a critical role to enable the development of gas supply to various manufacturing facilities in northern Mozambique, Malawi, and Zambia. Depending on the price of gas and tax incentives, gas supply to Nacala could form the basis for large scale fertiliser production.

[31] Renergen, 2022

Table 8: Corridor Summary: Afungi-Nacala-Ndola

Proposed Infrastructure:
- Pipeline from Afungi to Nacala
- Commission GTP plants in Afungi & Nacala

Leveraging Existing Infrastructure:
- Road infrastructure: Mozambique, Malawi, and Zambia

Step 1: Large GTP creates anchor	Enablement & Requirements	Step 2: Unlock gas usage in industry
Develop Nacala GTP of ~900 MW underpinned by South African demand Target displacement of diesel & Heavy Fuel Oil (HFO) in 190 MW of power generation in Malawi and Zambia	Hard Infrastructure Ensure Area 1 & Area 4 onshore LNG facilities are implemented Develop Afungi-Nacala pipeline Electricity grid infrastructure strengthening from Nacala into the SAPP network Develop Nacala gas hub incorporating 1 GW GTP, small scale LNG & CNG Ensure infrastructure is dual use for hydrogen & natural gas Soft Infrastructure Enable regional projects to participate in South Africa's IPP Programmes. Bilateral agreements between Mozambique & Zambia	Short/Medium Term Coal/ HFO/ LPG displaced from existing industrial plants ~15 – 60 PJ Supply to new potential steel plant in Tete province ~5 – 10 PJ Unlock world scale ammonia / fertiliser investment* ~28-29 PJ Long Term Create opportunity for Mozambique to develop a position as a world leading supplier of blue hydrogen *Requires highly advantaged gas price & tax incentives

Challenges/Risks

Lack of regional supply options in national energy planning

Lack of easily accessible, consistent, and transparent wheeling tariffs across different utility electricity grids

Timeous development of Area 1 and Area 4 LNG projects to provide required domestic market allocation

Table 9: Infrastructure Investment – Afungi-Nacala-Ndola Corridor

Country	Type of Project	Project Title / Definition	Year	Dependency	CAPEX (US$m)
Mozambique	Power Project	220/110 kV Nacala Substation	2026	Yes	49
Mozambique	Power Project	1x220 kV Nacala-Namialo line (100)	2026	Yes	35
Mozambique	Power Project	1x220 kV line bay at Namialo	2026	Yes	1
Mozambique	Power Project	220/110 kV Nacala Substation	2026	Yes	54
Mozambique	Power Project	1x220 kV Nacala-Namialo line (100)	2026	Yes	69
Mozambique	Power Project	2x220 kV line bay at Namialo	2026	Yes	2
Mozambique	Power Project	1x220 kV 75 Mvar Shunt Capacitor at Nacala	2026	Yes	2
Mozambique	GTP	GTP (+ 650 MW)	2026	Yes	759
Mozambique	GTP	GL Africa Energy Plant	2023 & 2026	No	292
Mozambique	Pipeline	Afungi to Nacala	2026	Yes	1 015
Mozambique	Pipeline	Nacala to Pande-Temane	2026	Yes	3 299
Mozambique	Industrial Plant	Baobab Resources - Steel and Vanadium Plant		No	
Mozambique	Gas to Commodities	Niassa Cement Plant, Chimbonila, Niassa	2022	No	20

Dependency Key	Yes
	No
	Partial

Successful implementation of this plan will result in a net reduction in GHG emissions of ~700 kt vs a business-as-usual baseline. This reduction in total emissions can be ascribed to the following:

1. Replacement of more polluting feedstocks such as diesel and HFO in power generation facilities in Zambia, Malawi, and Mozambique,
2. Displacement of coal, LPG, and diesel as an industrial heating fuel, and,
3. Avoidance of the need to liquefy and ship the gas used domestically as LNG.

These net reductions in GHG emissions compared to the baseline, more than offsets the additional emissions that will arise from the compression and transportation of gas as well as the development of new GTP facilities at Nacala.

8.1.1.8 Supply

This gas corridor is enabled by the substantial gas reserves (174 TCF in situ and 126 TCF recoverable) in Area 1 and Area 4 in the Rovuma Basin[32].

These reserves will be developed on the back of deep-sea export of LNG, with a total of ~31 MMt of LNG capacity due to be developed in the first wave. While virtually all the production from these fields has been contracted, a total of 400 MMscf/d is planned to be supplied to the domestic market in two phases (100 MMscf/d +300 MMscf/d). Out of this volume, 100 MMscf/d will be made available at the start-up of the liquefaction units of the Mozambique LNG project. The remaining 300 MMscf/d of gas will be made available at a later date. Similar to Area 1, the Area 4 concessionaires have committed to supply 500 MMscf/d of gas to Mozambique's domestic market to be made available in two phases (150 MMscf/d + 350 MMscf/d). The 150 MMscf/d of gas will be made available at the start-up of the liquefaction units of the Rovuma LNG project. The remaining 350 MMscf/d of gas will be made available at a later date.

It will however be critical that credible off-take projects are developed, providing both the required volume and economics to provide a credible alternative monetisation option to exported LNG

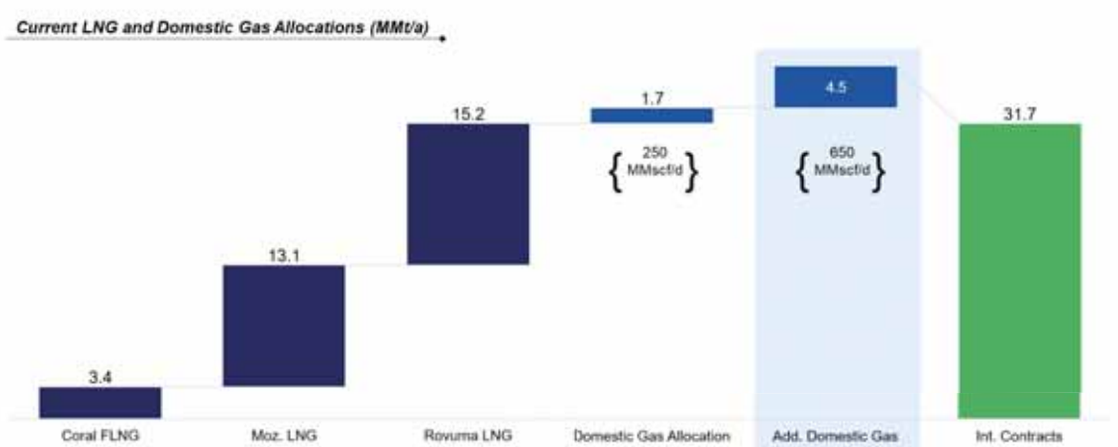


Figure 40: Current LNG Terminals and Domestic Gas Allocation

Beyond these initial LNG projects, sufficient reserves exist for Mozambique to develop a further 60-90 MMt/a of LNG. The IEA forecasts that Asian demand for LNG from Africa could reach up to 60-70 million tonnes by 2050 in a low energy transition scenario. Given the ideal strategic location of the Rovuma Basin to serve this market, Mozambique could support another 5 to 8 LNG trains (24-39 MMt/a) by 2050. Assuming similar allocations of domestic gas, the possibility exists that future LNG developments could be up to 1300 MMscf/d of domestic gas allocation by 2050..

[26] INP, 2022

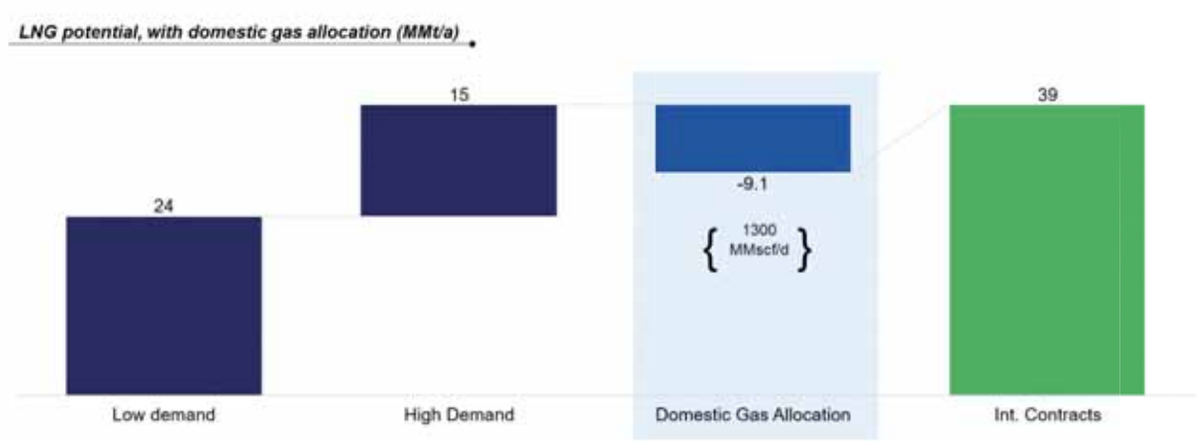


Figure 41: Potential Additional LNG Terminals and Domestic Gas Allocation

In addition, depending on the scale and pace of the energy transition, there is a possibility of stranded gas in the Rovuma Basin. The figure below outlines the potential gas reserves that will still potentially be in place in 2050 assuming the roll-out of LNG described above. However, if the world aggressively transitions to net zero emissions the IEA has said that no further gas, other than those developments already sanctioned, should proceed. In this case Mozambique may have stranded gas reserves of 120-130 TCF in situ.

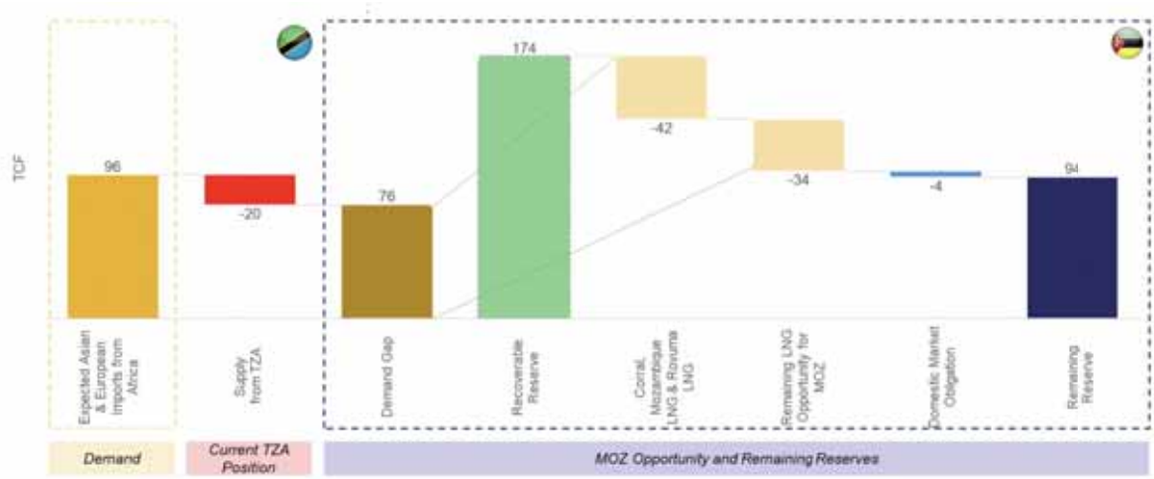


Figure 42: Potential Stranded Gas

This all indicates that Mozambique stands in a very advantageous gas supply position and it is critical that it expedites its LNG export projects.

8.1.1.9 Demand

The key objective of the demand analysis is to determine the potential demand that can be secured to utilise the domestic gas allocation from the Mozambique and Rovuma LNG Projects. This could create the infrastructure that can in turn be leveraged to utilise further supply as it becomes available. This has been done by identifying key demand nodes that can, within the timeframe of 2026-2030 potentially support the development of infrastructure and a gas economy.

The Port of Nacala provides the first important demand node. The importance of this node lies in its connection, via road particularly, to population, mining, and industrial centres in southern Malawi, Tete Province, and Zambia.

Critically, we believe that Nacala can establish itself as a key node for GTP generation totalling ~1000 MW by 2030. This generation could account for ~31 PJ/a of gas demand. Together with potential industrial demand in Nacala as well as demand in southern Malawi and the Zambian Copperbelt, potential demand of ~80 PJ could be unlocked. This could support the development of a gas pipeline from Afungi to Nacala,

with further supply being realised through the supply of compressed natural gas via truck and rail. Over time as this market grows, a pipeline could be envisaged.

To enable the development of such a large GTP facility, and hence the full gas hub at Nacala, it will be critical that regional power markets open up to power supply from northern Mozambique. The South African IRP has a critical role in this regard.

Currently the lack of easily accessible, consistent, and transparent wheeling tariffs across different utility electricity grids is a potential constraint. This deficiency adds unnecessary time and complexity to the project development process, thus hindering investment in power infrastructure. It will be important that such standardised and transparent wheeling tariffs be established across the region alongside a harmonised grid code.

The South African IRP currently provides for gas only for peaking purposes due to the lack of gas availability. However, should energy planning in South Africa be opened up to regional supply options, greater and more economic gas resources can be unlocked. The figure below outlines the cost advantages GTP supplied from Nacala would have, over imported LNG in South Africa.

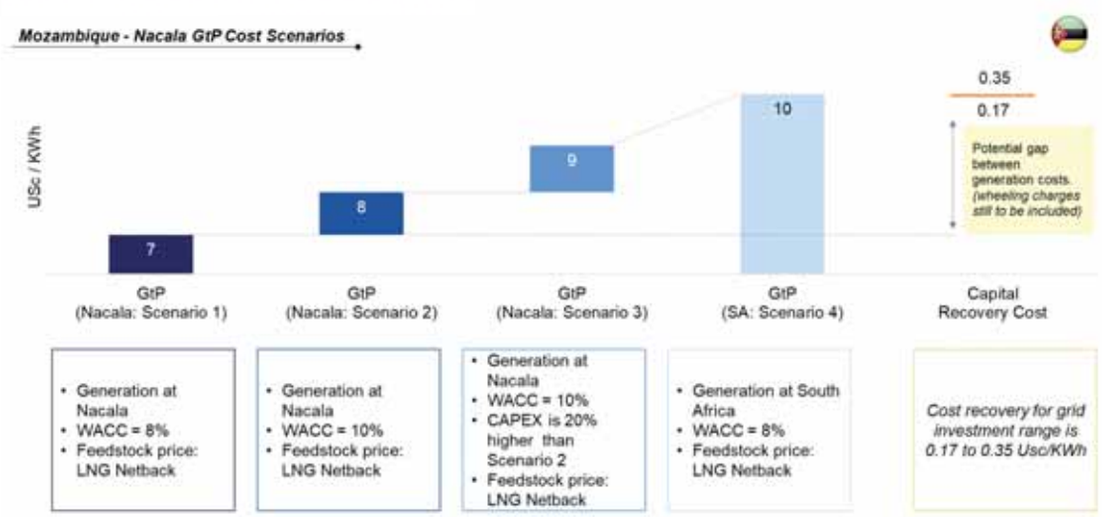


Figure 43: Mozambique - Nacala GTP Scenarios

To unlock this GTP however, investment of ~US$128 million will be required in strengthening the power distribution grid from Nacala to Namialo.

The possibility does exist, given the large volumes of gas available in the Rovuma Basin, to develop either GTL, fertiliser, or methanol facilities. However, all these technologies would require landed gas prices below US$3/GJ and significant tax incentives. Therefore, should the Mozambique Government view these as strategic priorities, it will have to commit significant resources to enabling them.

Should the proposed projects be successfully executed, Mozambique should be able to utilise a large portion, if not all, of their initial domestic gas allocation.

Further options exist for Mozambique to leverage export to southern Mozambique and South Africa as well as Tanzania to utilise the remaining gas volumes. Furthermore, the infrastructure can be leveraged to exploit further domestic gas allocations to supply the full requirement of South African mid-merit GTP requirement by 2040.

In the longer term, Mozambique should monitor and investigate the possibility of producing zero emission

hydrogen through Carbon Capture and Storage (CCS) as a means of monetising the very substantial gas resources that are likely to remain in place until 2050.

8.1.1.10 Key Decisions and Infrastructure Plan

Critical to the execution of the gas roadmap in this corridor is the development of 1 GW of GTP at Nacala. This will enable the development of Nacala as a key gas hub that can support development of domestic gas and export of gas to Malawi and Zambia.

Critical to the development of this GTP is the ability of Mozambique power generation to access regional markets, particularly South Africa. It will therefore be important that South Africa reframe its IRP taking account of regional gas supply and open up its procurement programme to such supply.

8.1.1.11 Recommendations

The most important step is to ensure that the significant cost advantage of generating power from gas in northern Mozambique is exploited to supply power on a mid-merit basis to the region, particularly South Africa.

To do this the following key decisions and investments are needed:

1. The Area 1 and Area 4 onshore LNG projects must be expedited such that natural gas is available onshore timeously. This will require political and security interventions.
2. Countries within the region need to update their electricity plans to take account of the possibility of regional supply of GTP at prices below the cost of imported LNG.
3. Standardised and transparent wheeling tariffs should be established across all electricity utilities in the region to facilitate investment in power projects.
4. Countries need to finalise policy decisions that would open the way for greater import of regional power supply.
5. Planning and completion of necessary environmental assessments and funding for critical electricity grid infrastructure that strengthen the electricity grid from Nacala into the SAPP network needs to be finalised.
6. Planning and funding for a gas pipeline from Afungi to Nacala needs to be finalised.

See infrastructure development requirements in the Annexure.

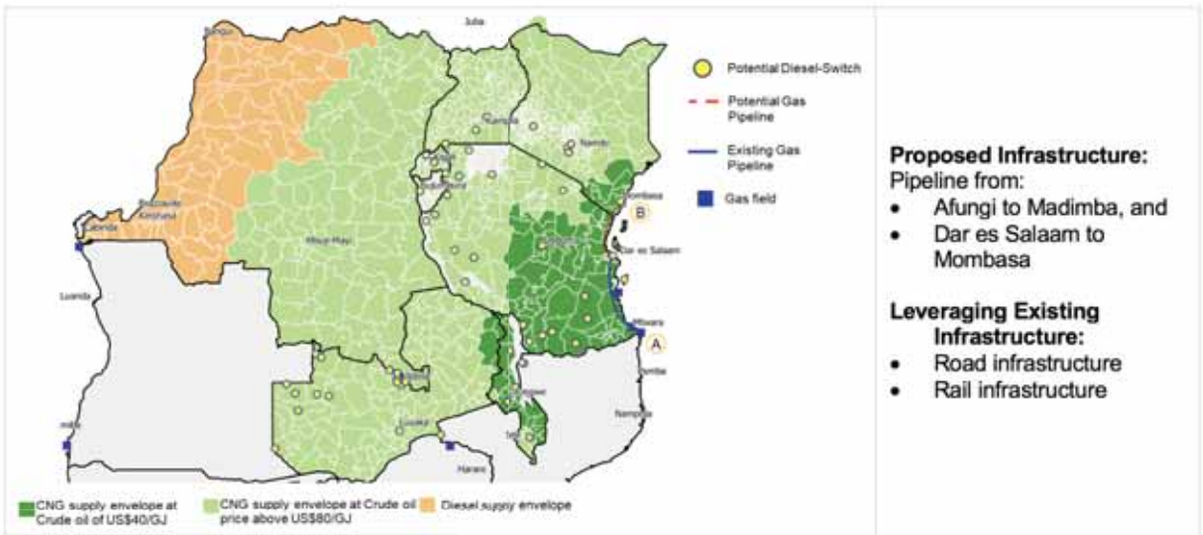
8.1.3. Afungi-Dar es Salaam-Mombasa Corridor

8.1.1.12 Infrastructure Blueprint and Enablers

The Afungi-Dar es Salaam-Mombasa Corridor is underpinned by two key investments taking place. The first is to expedite the development of the offshore LNG in Blocks 1,2 and 4 and ensure that a suitable domestic gas supply framework is established and agreed to. The second, it is to build a pipeline that will link the gas fields in Mozambique to the Mtwara pipeline.

Once these investments have taken place the secure supply of gas will enable continued development of further GTP as well as extended supply of gas through much of east Africa, Malawi and Zambia via small scale LNG and CNG which will provide the basis for the development of gas markets in these countries until pipelines can be economically developed.

Table 10: Corridor Summary: Afungi-Dar es Salaam-Mombasa, Malawi, Zambia and Uganda



Step 1: Ensure supply to current demand is secured	Enablement & Requirements	Step 2: Grow power supply & industrial use	Challenges/Risks
Current demand in Tanzania is between 52 and 60 GJ/a, largely driven by power Onshore supply is at threat of declining by 2030 Ensure LNG projects are expedited and secure favourable domestic supply Secure gas supply from Mozambique Baseload supply to Kenya through GTP	Hard Infrastructure Invest in gas pipeline from Afungi to Madimba Strengthening of grid infrastructure to enable continued growth of GTP Investigate Dar es Salaam-Mombasa pipeline Ensure infrastructure is dual use for gas/ hydrogen Soft Infrastructure Secure favourable domestic supply obligations from Tanzania LNG Bilateral Agreement between Tanzania and Mozambique for gas supply	Short/ Medium Term Further power requirements ~76 PJ by 2030 Industrial demand growth of ~14 PJ Potential demand in Kenya Diesel displacement ~16 PJ New power ~14 PJ Industrial demand ~30 PJ Long Term Utilise long term supply of blue hydrogen from large reserves in the Rovuma	Timeous delivery of Tanzania LNG and failure to secure domestic supply from offshore resources Lack of formal agreement between Tanzania and Mozambique on gas supply Lack of willingness by consumers to commit to gas demand due to supply uncertainty

Table 11: Infrastructure Investment – Afungi-Dar-es-Salaam-Mombasa Corridor

Country	Type of Project	Project Title / Definition	Year	Dependency	CAPEX (US$m)
Tanzania	Power Project	400 kV busbar with 3 feeder bays at Masasi	2030	Yes	6
Tanzania	Power Project	400 kV busbar with 3 feeder bays at Masasi	2030	Yes	6
Tanzania	Power Project	400/220 kV Transmission Station with 1x500 MVA transformers	2030	Yes	2
Tanzania	Power Project	1x400 kV Lindi-Masaisi line (141 km)	2030	Yes	0
Tanzania	Power Project	1x400 kV Masasi-Tunduru line (194 km)	2030	Yes	0
Tanzania	Power Project	1x400 kV Tunduru-Songea line (230 km)	2030	Yes	0
Tanzania	Pipeline	Afungi to Madimba	2027	No	93
Kenya	Pipeline	Dar es Salaam to Mombasa	2027	Yes	619

Dependency Key	
	Yes
	No
	Partial

8.1.1.13 Demand

Tanzania has an existing gas supply industry with off-take varying between ~300 and ~400 MMscf/d[33] and substantial growth forecast.

The Tanzanian Power System Master Plan requires 5713 MW of net new GTP capacity by 2044[34], adding a further ~431 MMscf/d (~173 GJ/a) to gas demand by 2040. These demand forecasts are however based on aggressive growth assumptions.

Tanzania is also facing potential constrained gas supply from their current onshore reserves. We have consequently focused the analysis on understanding what is required to continue meeting current Tanzanian demand and potential growth in GTP and industrial demand to 2030. The figure below shows Tanzania's domestic gas allocation profile.

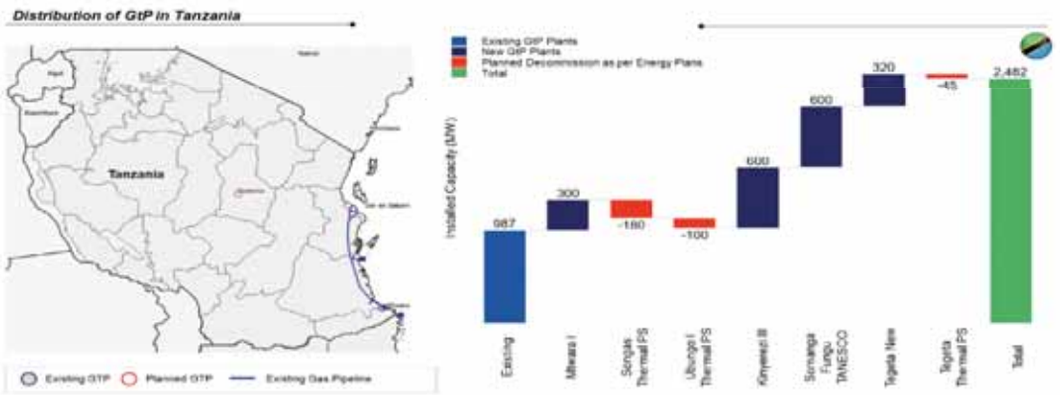


Figure 44: Tanzania Domestic Gas Allocation Profile

[33] Tanzania Ministry of Energy and Minerals
[34] Tanzania Power Development Master plan, 2021

In addition, there is potential to grow the demand for gas from industry and also opportunities to export gas to Kenya, DRC, Uganda and Malawi which could support further demand of between 40 and 90 PJ/a. Tanzania has recently signed a Memorandum of Understanding (MOU) with Uganda for the supply of gas, linked to the East African Oil pipeline and are in the process of finalising MOUs with both Malawi and Zambia for the supply of gas.

8.1.1.14 Supply

8.1.1.14.1 Gas Reserves

The Tanzanian Natural Gas Utilisation Master Plan (TGUMP) shows total gas resources in place of 57.54 TCF with 10.41 TCF onshore and a further 47.13 TCF offshore[35]. However, based on an analysis of company disclosures, we estimate total reserves to be in the region of ~40-44 TCF. The detail is shown in the figure below:

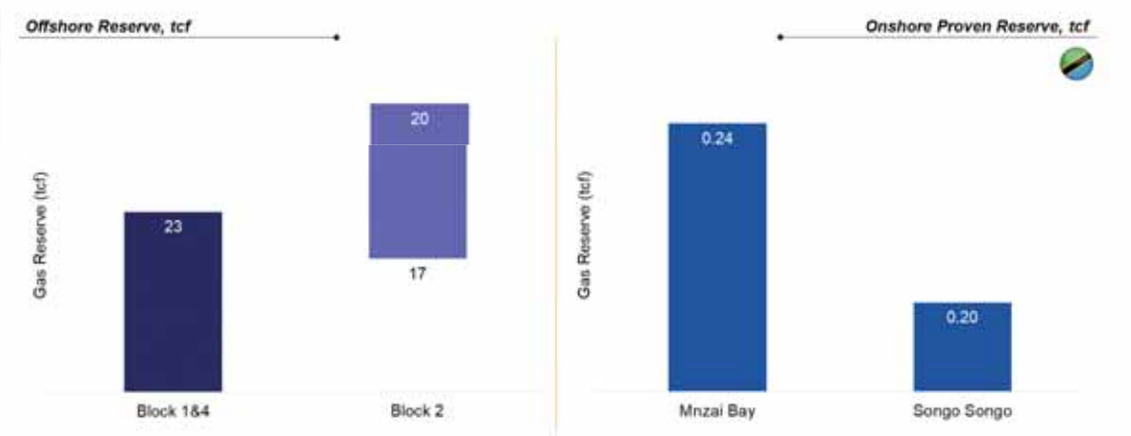


Figure 45: Tanzania Gas Reserves, TCF

The offshore resources are all situated in deep water at depths of 2.5 km and ~100 km offshore. Assuming 60-70% recoverability, this would imply recoverable gas resources of ~30 TCF offshore.
Aside from Songo Songo and Mnazi Bay, the most important resources are to be found in the Ruvu Basin with a discovery of 2.17 TCF of possible gas resources made in 2016[36]. These resources are still being assessed with 3D seismic data recently acquired[37].

8.1.1.14.2 Current Supply and Potential Future Supply

Collectively, the onshore gas fields provide the country with 180-200 MMscf/d[38] [39] of gas. A key risk identified in the Tanzanian Gas Utilisation Master Plan (TGUMP) and also in analysis done for this report is that these fields risk being depleted by between 2028 and 2033.

In the absence of further onshore exploration success or upside in supply, Tanzania will require domestic supply from the offshore reserves. It will be critical therefore for the development of these fields to be expedited. However, given the depth and distance of these reserves from shore, only export LNG can provide a commercially viable means to develop these fields.

Based on an analysis of the recoverable reserves in the offshore blocks, we assessed that Tanzania could support the production of 15-20 mmtpa of LNG for a period of 30 years, with recent announcements regarding TLNG pointing to a 15 mmtpa development[40]. This would require an allocation of ~25 TCF to LNG production while the TGUMP forecasted demand of ~11,1 TCF for LNG. Current indications are that the allocation for domestic gas from the TLNG projects would be 200 MMscf/d[41].

[35] United Republic of Tanzania, 2016. Natural Gas Utilisation Master Plan (2016-2045)
[36] Dodsal Group, 2016
[37] United Republic of Tanzania Ministry of Energy and Minerals
[38] Wentworth Resources, 2021
[39] Orca, 2021
[40] Standard Bank Tanzania LNG Macro Economic report
[41] Standard Bank Tanzania LNG Macro Economic report

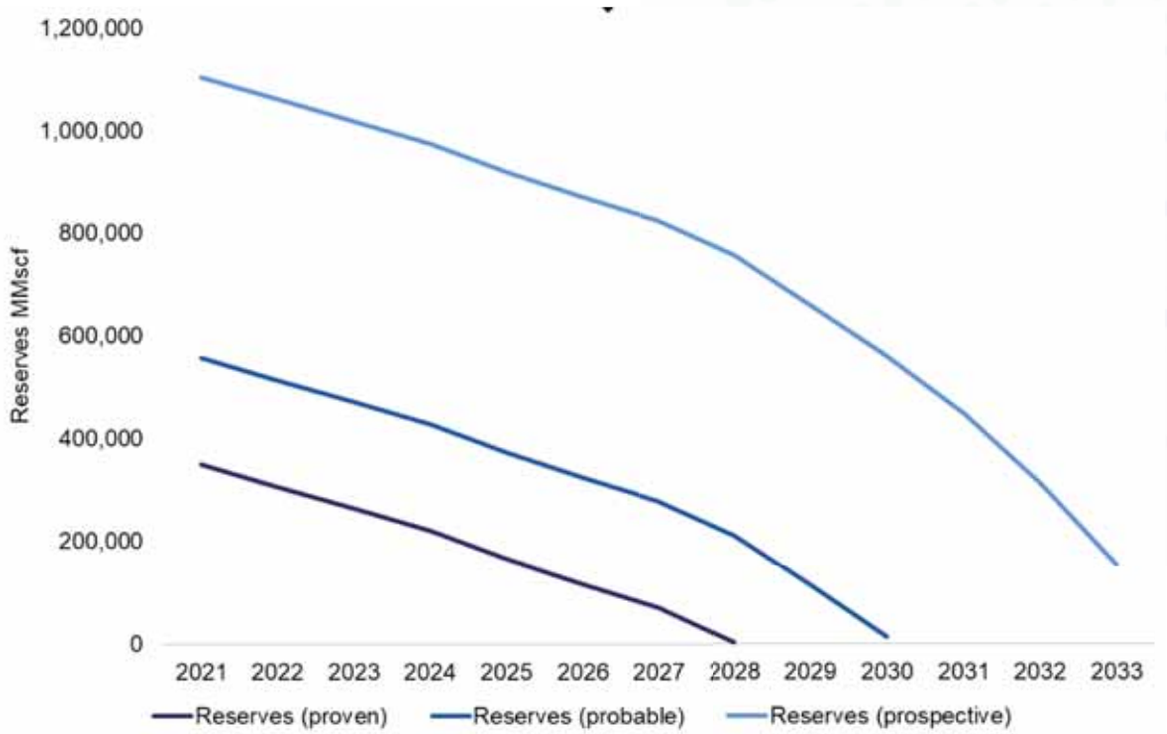


Figure 46: Available onshore gas resources to meet domestic Tanzanian gas demand

As shown in the analysis below, the likely availability of gas from offshore production will be substantially lower than the requirement foreseen in the Power System and Gas Utilisation Master Plans as well as ensuring sufficient supply to meet the pipeline export demand foreseen.

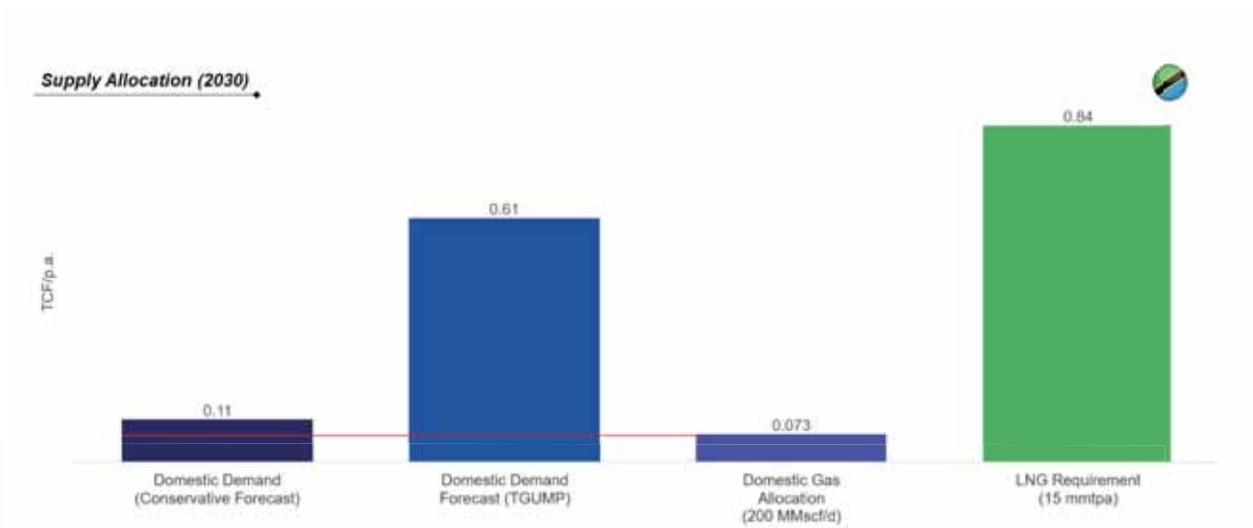


Figure 47: Tanzania – Domestic Gas Requirement & Allocation, Demand Forecast and LNG Requirement, 2030, TCF/a

Consequently, it will be prudent for Tanzania to consider the option of importing gas from northern Mozambique. This can offset supply risks and allow Tanzania to develop export markets to Kenya, Uganda, Rwanda, Burundi, Malawi and elsewhere in east and southern Africa. This investment can be justified even on a conservative estimate of demand in Tanzania based purely on a conservative outlook for power generation.

Importantly, this can facilitate the development of a fully integrated gas supply and demand system encompassing a number of gas supply sources, in excess of 150 TCF of recoverable reserve, with multiple off takers.

8.1.1.15 Key Decisions and Infrastructure Plan

The most critical decision and intervention within this corridor is for Tanzania to secure its supply of gas resources so that it can maintain its ambitious growth in electricity supply. In order to do this, we believe that four critical steps need to be taken, as illustrated in the recommendations below.

1. Additional projects

Within this corridor the following projects, of smaller scale, are being pursued and should continue as part of this master plan:

• Auctioning and potential development of the Makelele, Lwandjofu and Idwi blocks in Lake Kivu in the DRC. Bids for these blocks have recently closed. The estimated resource is believed to be ~2,3 TCF[42] with the expected monetisation being through power generation. The planned connection of the East Africa Power Pool (EAPP) and SAPP can act as an important enabler of this project.

8.1.1.16 Recommendations

To facilitate the full development of the gas potential within the Afungi-Dar es Salaam- Mombasa Corridor the following key actions and decisions need to be made:

1. Continued exploration for onshore natural gas resources should be expedited to reduce the risk of supply shortfalls and ensure low-cost gas supply.
2. Ensure that the development of the offshore gas fields and Tanzanian LNG reaches a final investment decision (FID) by 2023 and reaches production by 2027.
3. Commence a joint feasibility study, between the governments of Tanzania and Mozambique to develop a gas pipeline from Afungi to Madimba so that a firm commitment regarding gas off-take can be made by 2024, should additional supply from Mozambique be needed.
4. Once certainty is achieved regarding domestic gas supply from offshore fields and gas supply from Mozambique via the Afungi-Madimba pipeline, evaluation of pipeline supply to Kenya can commence.
5. Invest ~US$14 million to strengthen the power grid to accommodate additional gas generation.

See infrastructure development requirements in the Annexure.

8.1.4. Angola/ DRC Corridor

8.1.1.17 Infrastructure Blueprint and Enablers

The key infrastructure development that will need to occur will be the development of the Kwanza Basin as well as an associated GTP development to anchor gas being brought onshore. Once this has been achieved, a number of other possibilities for the industrial utilisation of gas opens up. For instance, Angola has significant deposits of iron ore and, depending on a sufficiently competitive gas price and incentives, the potential for fertiliser production may also exist. Angola needs to leverage energy demand from large demand centres such as South Africa and the Zambian copper-belt to base-load the infrastructure required for domestic gas market development.

The Lake Kivu gas blocks comprising the Makelele block, the Idjwi block and the Lwandjofu block are also linked to the following development corridors:

- Mwambeni Corridor links with Uganda and Tanzania. Coordination of this corridor is based in Butembo:
- Mombasa Corridor links with Kenya, Uganda and South Sudan. The coordination of this corridor is based in Kisangani;
- North Corridor links with Rwanda, Burundi and Kenya. The coordination of this corridor is based in Goma;
- Eastern axis of Central Corridor 1 (Kalemie-Moba-Kalemie-Uvira) links with Tanzania, Uganda, Burundi and Rwanda. The coordination of this corridor is based in Kalemie;
- Central Corridor 2 links with Tanzania, Uganda, Burundi and Rwanda. The coordination of this corridor is based in Bukavu;
- Central Corridor 3 (axis Kalemie-Kabalo-Kindu and Kabalo-Kamina) link with Tanzania Uganda Burundi and Rwanda. The coordination of this corridor is based in Kabalo.

[42] Ministere des Hydrocarbures du Congo,2022 bid round document.

The gas blocks of the coastal basin in Kongo Central comprising Yema II block, Nganzi block and Matamba-Makanzi block of the Muanda coast are linked to the following development corridor:

- Lower Congo Corridor which links with the Republic of Congo Brazzaville and Republic of Angola.

The coordination of this corridor is based in Bom.

There is also a Walvis Bay Corridor linking with Namibia and Zambia; a Lobito Corridor linking with Angola and Zambia and Malanje Corridor linking with Angola and Zambia.

Table 12: Corridor Summary – Angola/DRC

Proposed Infrastructure:

- Commission GTP in Soyo of additional 720 MW
- Commission GTP in Lobito of 1200 MW
- Power infrastructure investment

Step 1: Anchor domestic gas supply through GTP for South Africa	Enablement & Requirements	Step 2: Grow power supply & industrial use	Challenges/Risks
Proceed with 720 MW GTP at Soyo to anchor remaining domestic supply Anchor pipeline – Soyo to Luanda via GTP (assuming 720 MW at Soyo does not proceed) Develop 1200 MW GTP at Lobito to anchor supply from Kwanza Basin	Hard Infrastructure Finalise 720 MW GTP at Soyo Develop pipeline to Luanda supported by conversion of diesel power generation Leverage latent gas demand in copper-belt to unlock gas infrastructure Develop 1200 MW GTP at Lobito Strengthen grid and integrate with SAPP network via Angola Namibia (ANNA) integrator project Soft Infrastructure Change policy to enable regional projects to participate in South Africa's IPP Programmes. Ensure that Integrated Energy Planning is instituted and there is a focus on regional energy security and reliability	Opportunities for ammonia and fertiliser production* Industrial demand in the steel and cement sectors * Economic viability depends on the cost to produce and land the gas	Dependency on the development of the Kwanza Basin to provide gas supply South Africa reframe its IRP to include regional gas supply and open up its procurement programme to such supply

Table 13: Infrastructure Investment – Angola Corridor

Country	Type of Project	Project Title / Definition	Year	Dependency	CAPEX (US$m)
Angola	Power Project	3x 500 MVA 400/15 kV Lobito Substation	2030	Yes	102
Angola	Power Project	2x400 kV Lobito-PS BioPio lines (5 km)	2030	Yes	3
Angola	Power Project	2x400 kV Lobito-Lubango line (260 km)	2030	Yes	140
Angola	Power Project	2x400 kV Lubango-Cahama line (190 km)	2030	Yes	102
Angola	Power Project	6x400 kV line bay	2030	Yes	16
Angola	GTP	Soyo II	2022	No	840

Dependency Key	
	Yes
	No
	Partial

8.1.1.18 Supply

8.1.1.18.1 Congo Basin

The only domestic supply of gas currently in Angola is of associated gas produced from oil fields in the Congo Basin. This gas is gathered and piped to the Angola LNG facility at the town of Soyo on the mouth of the Congo River. A commitment to supply 1.3 bcm of gas to the local Angolan market currently provides the basis for domestic gas supply.

8.1.1.18.2 Kwanza Basin

The Kwanza Basin extends south of Luanda down to Lobito. In recent years, some significant discoveries were made in this basin. However, after the bankruptcy of Cobalt International Energy and the withdrawal of British Petroleum (BP), exploration came to a halt.

In 2019 activity in the Kwanza Basin resumed with the awarding of Block 21 to TotalEnergies who have subsequently commenced with appraisal of the block. Expectations are that these blocks could reach production by the late 2020s, early 2030s. It is estimated that production costs could range in the region between US$3 and US$6 per MMbtu.

8.1.1.19 Demand

Angola's electricity plan envisions substantial growth in electricity generation to meet the needs of a growing economy and a desire to improve levels of energy access. This is largely focused on increasing hydro-power generation, gas, and renewables. The plan provides for a total of 1500 MW of GTP at Soyo, of which 750 MW has already been commissioned and a further 720 MW of GTP is still planned at some point.

A further 1200 MW GTP is forecast to be commissioned in either Lobito or Namibe. This facility will need to depend on the successful development of the Kwanza Basin to provide gas supply. Successful development of this power supply will position Angola well to provide power to the South African market on a mid-merit basis. However, it will require investment of ~US$360 million in grid strengthening to bring this power to the market.

This is illustrated in the chart below:

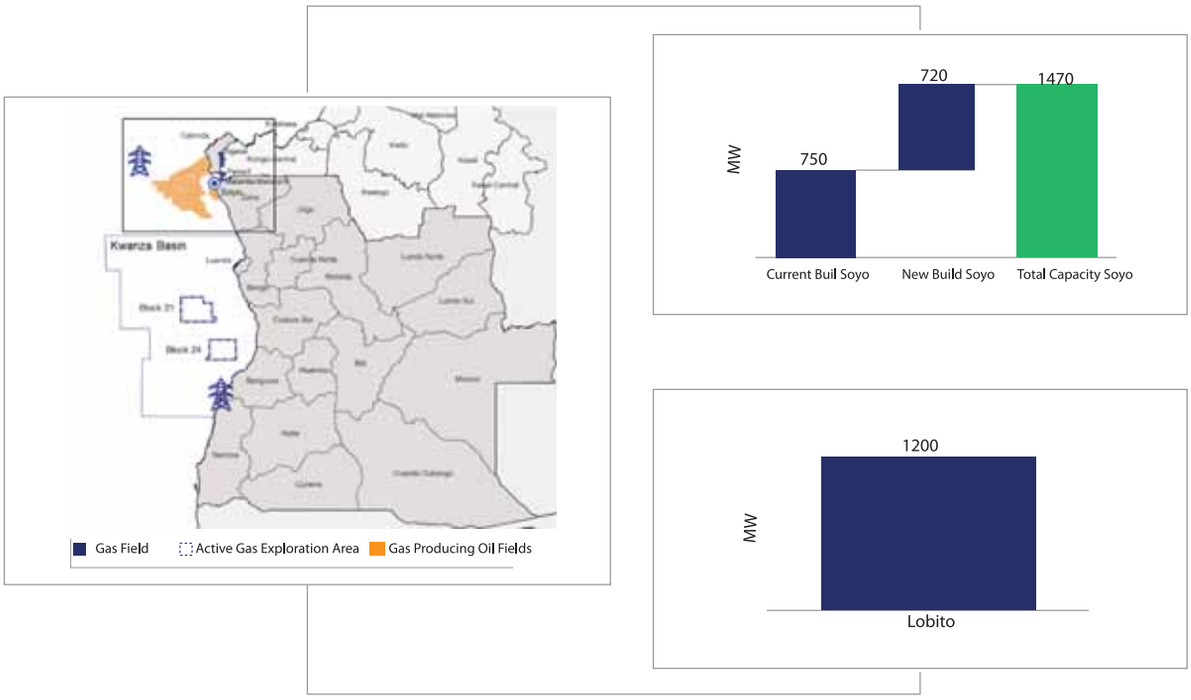


Figure 48: Angola – GTP Plans, MW

Should the gas in the Kwanza Basin be brought to market, an opportunity exists to convert 148 MW of currently installed diesel generation capacity to gas in Luanda with a further ~2300 MW of diesel-based generation scattered across the country. In addition, the potential exists for the subsequent development of industrial demand once the initial power projects have anchored development of domestic gas.

8.1.1.20 Key Decisions and Infrastructure Plan

The critical focus within this corridor is for the continued appraisal and hopefully eventual development of gas resources in the Kwanza Basin. This would facilitate the development of GTP within southern Angola and potentially other gas utilisation opportunities.

2. Additional projects

Within this corridor, the following potential gas developments would also need to be considered.

- Three onshore blocks (Nganzi, Yema 2 and Matamba Makanzi 2) in the coastal Congo basin in the Democratic Republic of Congo blocks have recently been put forward in a bid round.

These blocks are believed to contain potential resources of ~4 billion BOE oil and gas.

8.1.1.21 Recommendations

There are three key steps that need to be taken to unlock the gas economy in this corridor:

1. The construction of the 720 MW Soyo II Combined Cycle Gas Turbine (CCGT) should proceed, together with the strengthening of the grid infrastructure through the construction of a 400 kV line to evacuate the power to the south of Angola.

2. Exploration within the Kwanza Basin should continue to prove up the resource base that can potentially support the supply of gas to a 1500 MW GTP facility.

3. South Africa should review its IRP to take account of the possibility of economically priced gas resources in the region and make provision for projects within the wider region to bid in a gas IPP RFP.

See infrastructure development requirements in the Annexure.

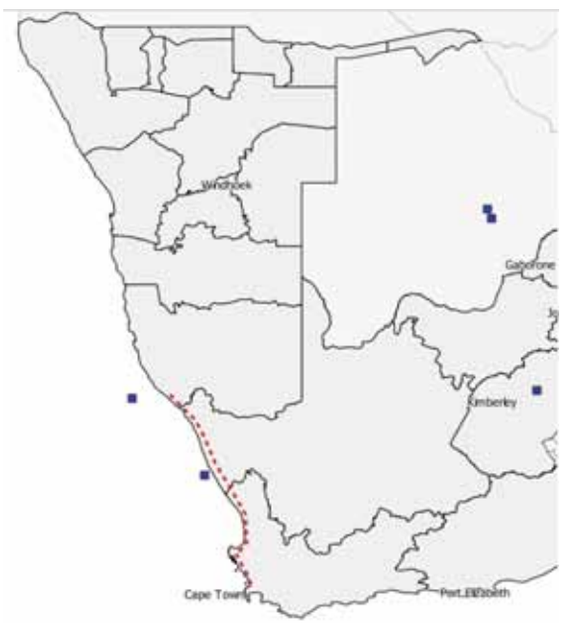
8.1.5. Walvis Bay-Cape Town Corridor

8.1.1.22 Infrastructure Blueprint and Enablers

The first critical investment required to enable gas supply in this corridor is the development of a GTP facility of between 450 MW and 1250 MW at Elizabeth Bay. This will enable the development of the large gas and associated gas fields in southern Namibia. The second investment will be the development of the Coega LNG import terminal (FSRU) at the Port of Ngqura which has been identified as a priority of South Africa's DMRE. This will include a GTP with a capacity of 1000 MW. The other investment is the development of the newly discovered gas fields in the Outeniqua Basin utilising the mothballed GTL facility at Mossel Bay as an anchor.

Once these anchor projects have been realised, a number of ancillary opportunities can be unlocked through the development of a pipeline to bring gas to Cape Town to satisfy the demand for gas in a market currently largely being served by diesel and LPG.

Table 14: Angola – GTP Plans, MW



Proposed Infrastructure:
- Commission GTP in Elizabeth Bay
- Power infrastructure investment
- Pipeline from Oranjemund to Saldanha Bay to Cape Town

Step 1: Leverage GTP & GTL as anchors	Enablement & Requirements	Step 2: Supply markets in Gauteng & Cape Town	Challenges/Risks
Orange Basin GTP at Elizabeth Bay of between 420 MW and 1250 MW 250 MW supply to Namibia 170-1000 MW supply to South Africa Outeniqua Basin Re-commission GTL at Mossel Bay Convert Gourikwa diesel peaker Coega FSRU and GTP of 1000 MW	Hard Infrastructure Strengthening of the electricity grid infrastructure in the Northern Cape and southern Namibia Gas pipelines: • Oranjemund – Cape Town • Oranjemund – Gauteng Soft Infrastructure Change policy to enable regional projects to participate in South Africa's IPP Programmes Bilateral agreement/ alignment between Namibia/South Africa on gas/power supply	Short/ Medium Term Convert Ankerlig, Gourikwa & Dedisa diesel peakers to gas (2400 MW) Industrial, domestic, and commercial demand of ~60 PJ centered largely around Cape Town, Saldanha bay and Gqeberha Maintain supply to industrial users in Gauteng (209 PJ) Further demand growth in eastern parts of South Africa – 25-57 PJ Long Term Leverage gas pipeline network for green hydrogen supply to Cape Town & Gauteng	South Africa to reframe its IRP to include regional gas supply and utilising greater renewables and gas for baseload. PetroSA GTL re commissioning Availability of FSRUs before 2026

Table 15: Infrastructure Investment – Walvis Bay-Cape Town Corridor

Country	Type of Project	Project Title / Definition	Year	Dependency	CAPEX (US$m)
Namibia	Power Project	400/11 kV generation station with 3x500 MVA transformers	2023	Yes	71
Namibia	Power Project	Kudu PS - Obib 1 x 400 kV line (115 km)	2023	Yes	41
Namibia	Power Project	Kudu PS - Oranjemund 2 x 400 kV line (15 km)	2023	Yes	13.6
Namibia	GTP	Kudu Gas Power Plant	2025	Yes	490
Namibia	GTP	Elizabeth Bay mid-merit Plant	2025	Yes	1 458.8
South Africa	Power Project	Oranjemund 400/220 kV Substation Yard	2023	Yes	39.5
South Africa	Power Project	Gromis - Oranjemund 2 x 400 kV line (130 km)	2023	Yes	42
South Africa	Pipeline	Oranjemund to Saldanha Bay	2025	Yes	1 328
South Africa	Pipeline	Saldanha Bay to Ankerlig	2025	Yes	137
South Africa	Pipeline	Ankerlig to Cape Town	2025	Yes	60
South Africa	FSRU	Coega LNG	2026		466
South Africa	GTP	Coega GTP	2026		1500

Dependency Key	
	Yes
	No
	Partial

Should these plans be successfully realised it will result in a ~1,9-million-ton increase in GHG emissions vs. a business as usual (BAU) baseline. This increase in net emission results largely from the additional 1,450 MW GTP at Elizabeth Bay. The increase in emissions is partially offset by the reduction in net emissions due to a reduction in consumption of LPG and HFO in favour of natural gas in various heating applications.

It should be noted that this calculation does not consider the positive grid synergies between gas and renewables that will open up grid space for renewables in the Northern Cape. This will have a positive impact on South Africa's overall emissions profile by hastening the roll-out of renewables.

8.1.1.23 Supply

8.1.1.23.1 Orange Basin

In the Orange Basin, the most important source of potential supply is the Kudu Gas Field with proven gas reserves of 1.3 TCF. Additionally probable and possible reserves could bring the total available resource base to 9 TCF. There have also been recent discoveries within the Basin (Graff-1 and Venus) that promise to yield significant volumes of associated gas. Further down the west coast of South Africa, the Ibubhesi Gas Field has proven resources of 0.5 TCF.

8.1.1.23.2 Outeniqua Basin

In the Outeniqua Basin, recent discoveries by TotalEnergies within Block 11B/12B provide another promising source of supply to the Corridor.

The finds made in both basins within this corridor point to the potential for further discoveries, particularly south of the Namibian border in the South African portion of the Orange Basin.

8.1.1.24 Demand

We have considered the Corridor as consisting of two distinct but interlinked gas supply/demand systems. Within the Orange Basin, the demand analysis was conducted to ascertain viable gas demand options that could baseload the development of the proven Kudu resource base. This could then be expanded as the other gas resources within the basis are proven up.

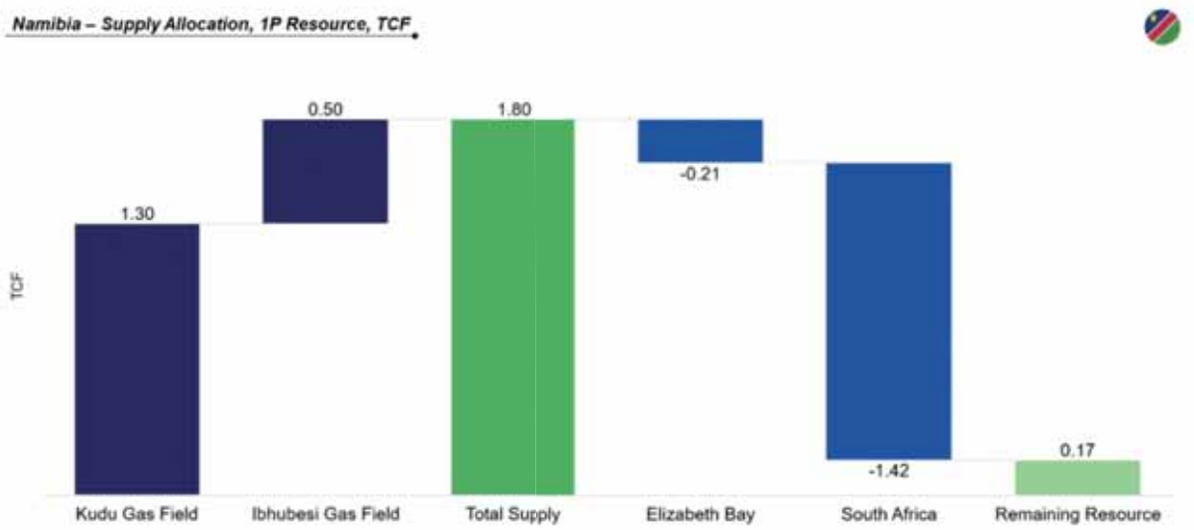


Figure 49: Namibia – Supply Allocation, PJ

The primary focus would be to secure a 420 MW GTP facility in southern Namibia coupled with a gas pipeline to the Western Cape to provide gas to industry and the conversion of the Ankerlig diesel peaker at Saldanha Bay. These off-takes have been sized to absorb 66 PJ/a (171 MMscf/d) of demand over a 20-year period. This would entail supplying ~55 PJ/a of gas to the Western Cape via a pipeline and 11 PJ/a to supply power.

Critical to underpin the GTP is the ability of this power to access the South African market as the power market in Namibia can only support 250 MW of demand.

Should the further resources in the Orange Basin be proven, the prospect for potential GTP of ~1250 MW is available. In this case 1000 MW of mid-merit gas would need to be provided to South Africa. The opportunity for pipeline supply of gas to the large energy markets of Gauteng could also be investigated.
As part of a grid analysis done for all proposed GTP facilities, it was found that synchronous generation (in this case using gas) near the Northern Cape grid, with its high penetration of renewables, can assist in improving fault levels and providing inertia which would otherwise be lacking. Consequently, additional renewables capacity can be unlocked.

Within the Outeniqua Basin, the most important source of potential demand is the PetroSA LNG facility at Mossel Bay. A 45 000 bbl/d condensate and GTL refinery would require gas feed of ~75 PJ/a. This demand would be sufficient to unlock supply from the new discoveries. This in turn would create the possibility of conversion of the Gourikwa diesel peaker and supply via trucked CNG to Gqeberha and potentially to Cape Town via pipeline.

A key issue that will need to be resolved will be to ensure the landed gas price can meet the economic requirements of the GTL facility as this baseload demand will be critical to unlock the Basin.

Should gas be produced at an affordable price then our expectation is that PetroSA would require 1.4 TCF and the Gourikwa peaking plant a further 0.15 TCF over a period of 20 years. This would then leave a further 1.65 TCF for supply to both the Western and Eastern Cape.

8.1.1.25 Key Decisions and Infrastructure Plan

A number of critical decisions need to be taken to unlock the gas potential within this corridor. Firstly, the South African IRP would need to be reframed to include potential GTP supply from elsewhere in the region. This would enable the development of a GTP facility in southern Namibia which can in turn support the strengthening of the power grid in the Northern Cape with positive spinoffs for renewables deployment.

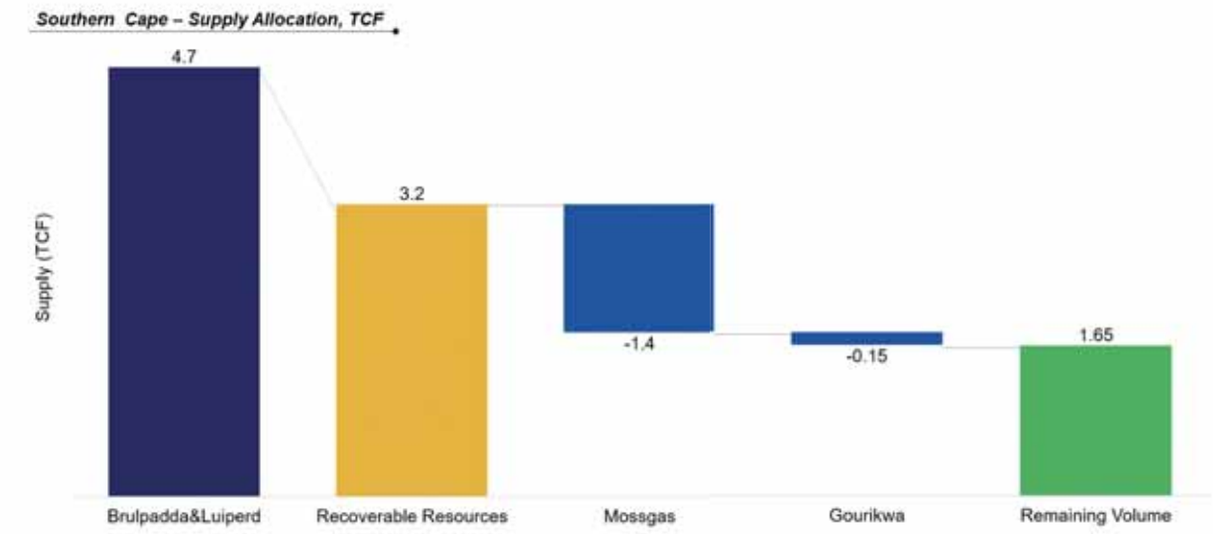


Figure 50: Southern Cape – Supply Allocation, TCF

Secondly, exploration and appraisal activities within both the Orange and Outeniqua Basins need to be expedited. Finally, negotiation of gas supply from the new gas finds in the Outeniqua Basin to supply PetroSA need to be finalised to enable landed gas supply from the Outeniqua Basin to the southern Cape.

8.1.1.26 Recommendations

To unlock the full potential of gas within this corridor, the following key decisions and actions need to be taken:

1. South Africa needs to update the IRP 2019 to take account of the possibility of regional gas supply and of utilising greater renewables and gas for baseload.
2. Continued exploration, particularly in the southern part of the Orange Basin, should be accelerated in light of the promising discoveries made on the Namibian side of the Basin.
3. South Africa should update its gas IPP procurement rules to allow for regional supply projects to compete to supply.
4. A Gas Sales Agreement (GSA) to be concluded between PetroSA and the owners and operators of the Brulpadda and Luiperd gas fields for the PetroSA GTL plant.

See infrastructure development requirements in the Annexure

8.1.6. Indian Ocean Corridor

The island states off the east coast of Africa do not possess any indigenous gas resources and will therefore depend on LNG imports to meet their requirements.

Table 16: Corridor Summary: Indian Ocean

Step 1: Establish Anchor Demand	Step 2: Supply markets in Gauteng & Cape Town	Challenges/Risks
Largest potential market is Mauritius, with expected 130-140 MW gas-to-power capacity planned. Gas demand of ~ 15PJ **Enablement & Requirements** Soft Infrastructure National IEPs should consider all energy options, including gas	Comoros may be supplied from LNG vessels transporting LNG from Rovuma to global markets	• No domestic gas production in any of the countries within the region and no significant exploration activity • Lack of a current gas market in the region • Relatively small potential for future growth • Small volumes can only be supported through the re-export of LNG from proposed LNG import terminals at Maputo or Richards Bay. • Small forecast volumes and availability of LPG infrastructure pose a competitive challenge to LNG

Mauritius, as the largest potential importer of LNG, announced its intention to shut 265 MW of its 665 MW of hydrocarbon thermal power capacity, to be replaced by various renewable sources including biomass as well as potentially gas. The Central Energy Board has issued an RFI for LNG supply to supply a 130-140 MW gas-to-power. This would require ~150 kt p.a. of LNG supply.

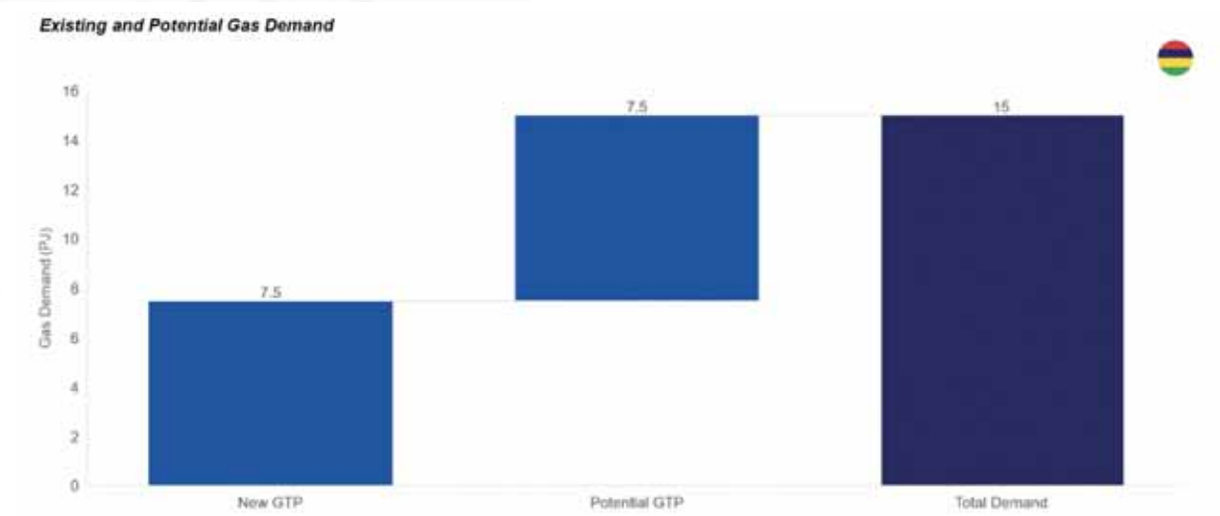


Figure 51: Existing and Potential Gas Demand in Mauritius

In addition, Mauritius would need to consider the need to develop further gas-to-power capacity to supplement biomass generation. This would require a potential total demand in the region of ~300kt p.a. Importantly Mauritius already has infrastructure for the importation of LPG which, although traditionally at a premium to LNG, may be more suited to Mauritius' needs due to the lower cost of storage.

Beyond power, opportunities for the use of natural gas in either bunker fuel, transport or industry is seen as being very limited.

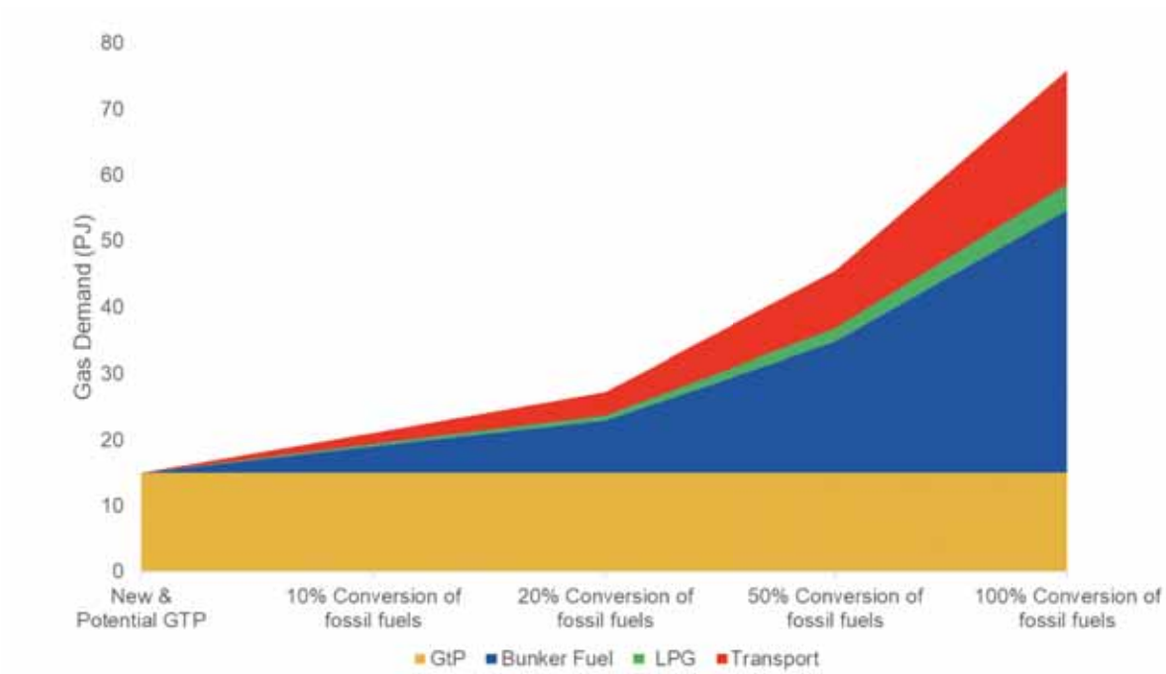


Figure 52: Mauritius – Varying LNG Volume Conversion Rates

Mauritius should continue investigating the possibility of LNG supply for power, while also investigating the use of LPG.

Total potential demand in the other states was forecast at between 18 thousand and 50 thousand tonnes of LNG per annum.

These volumes would make Mauritius a smaller LNG importation hub than other ports in the region such as Maputo or Richards Bay. Consequently, it is doubtful that it could achieve the economies of scale required to position itself as a regional re-export hub for LNG.

Mauritius should continue to investigate the economics of LNG import for power generation compared to LPG. In addition, it should monitor developments regarding bunker fuel as well as regional developments to ascertain the opportunity for larger investment in LNG import capacity

8.1.7. Inland areas of the SADC

Botswana, Zambia and Zimbabwe are landlocked nations which currently possess limited domestic gas resources and are far from the large gas finds off the cost of Mozambique, Tanzania, South Africa, Namibia and Angola. However, they stand to benefit substantially from the plan through the potential availability of natural gas to displace more expensive hydrocarbons such as diesel, the possibility of securing lower cost and reliable supply of power and finally by developing a gas market that can potentially be supplied through future discoveries within these countries.

8.1.1.27 Supply

The Lesedi Coal Bed Methane comprises a 2P resource of 0.04TCF. In addition a further supply options may be the potential gas fields within the Caborra Bassa Basin with a prospect of up the 4-7 TCF of gas in situ.

8.1.1.28 Demand

A total of between 20-30 PJ of latent aggregate demand has been identified across the three countries. This arises largely from the replacement of diesel, HFO or LPG and in certain instances also coal in both industrial heat as well as power generation.

8.1.1.29 Infrastructure

The challenge for the inland countries within SADC is that the demand of ~30 PJ is spread across all three countries with some concentration in the Copper Belt, central Zimbabwe and southern Malawi. To supply these markets via gas pipeline is unlikely to be feasible initially. Natural gas, particularly at ambient temperature, has a low energy density by volume when compared to many of the competing hydrocarbon energy carriers such as diesel and heavy fuel oil. While 27 litres (0.27 m3) of diesel will provide 1 GJ of energy, 25.5 m3 of gas is required to provide the same GJ of energy.

The graph below illustrates the challenge faced to finance a pipeline for smaller volumes of natural gas demand as volumes decline.

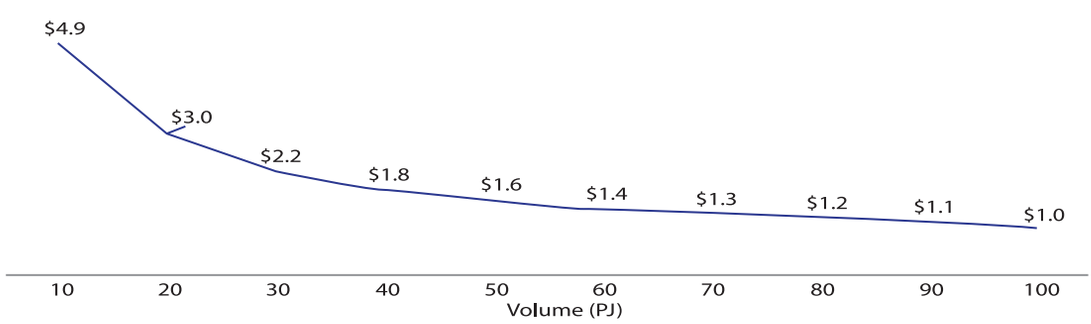


Figure 53: Pipeline Financing Required as a Function of Volume (in PJ)

Countries within the interior of Southern Africa will nevertheless benefit from the greater availability of natural gas through transport mechanisms such as CNG which can be brought via truck or rail. This can result in access to energy in these countries at prices that can range from 0.5 US$ to 10 US$/GJ depending on the prevailing oil price and the distance from the different gas fields.

8.2 Investment Requirement Summary

The figure below summarises the estimated investment requirement to develop each corridor with estimated investments contributions from the respective SADC Member States of each corridor.

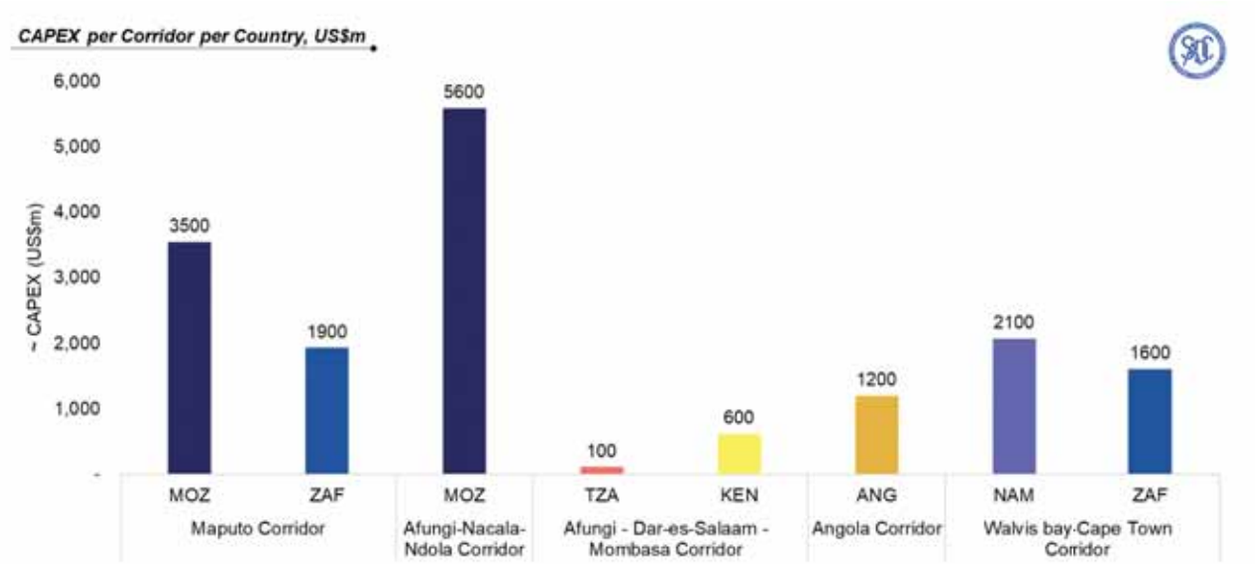


Figure 54: Corridor Summary: Indian Ocean

In total, it is estimated that approximately US$17 billion of investment will be required to develop a regional gas economy within the SADC region.

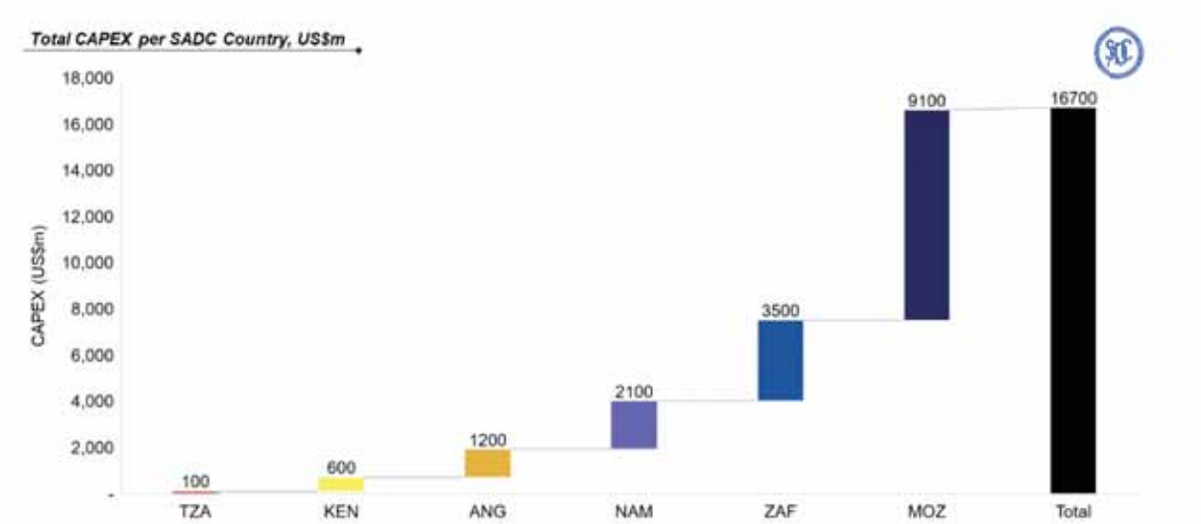


Figure 55: Total Estimated CAPEX per Country, US$m

9. CONCLUSIONS

There is great potential within the SADC region to develop a regional gas market. However, for the RGMP to fulfil its mandate it must ensure that the following takes place:

1. National and Regional policy convergence on the use of natural gas and the role of regional integration in enabling market development and energy security.

2. Expeditious development of the large regional gas fields and LNG export terminals.

3. Anchor demand from potential large-scale national gas markets (e.g., South Africa) and bankable signed off-take agreements with anchor tenants (either electron or molecule).

4. Utilisation of domestic and regional gas to meet regional mid-merit power demand.

5. Utilisation of imported LNG to meet current industrial demand and substitute diesel in peaking plants, including long-term LNG contracts for base anchor demand and the development of LNG importation infrastructure.

6. Development of pipeline infrastructure to create integrated gas supply/demand systems where gas resources are close to demand.

7. Facilitation of regional industrialisation through the development of petrochemical facilities close to gas resources.

8. Increase momentum of energy transition through facilitation of renewable energy and hydrogen economy. This could be through strengthening grid infrastructure in areas with high renewable energy potential; the development of blue hydrogen projects can act as an enabler of green hydrogen and positioning gas pipelines as precursors to green hydrogen pipelines.

9. Developing and maturing a regional market with multiple supply and demand options, increasing market liquidity and movement towards gas-on-gas competition.

ANNEXURE A

Infrastructure Development Blueprint

Project Prioritisation

The projects within this roadmap have been put through a filter to firstly prioritise projects that enable regional integration. Thereafter, considerations of ease of execution, period to commissioning, cost and impact were considered.

East Coast to South Africa Corridor

The figure below indicates the infrastructure development requirements to anchor demand for natural gas along the corridor, as well as infrastructure to import and transport natural gas inland via a reversal and expansion of the Matola Gas Pipeline. It will also require investment in power distribution.

Index	Development - Supply via Maputo	Type of Infrastructure	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1	South Africa updates IRP and includes greater options for regional gas demand													
2	FID for 50 PJ Matola LNG													
2	EPC for 200 PJ Matola LNG													
2	Commissioning of 50 PJ Matola LNG	LNG Import												
3	Upgrade of Ressano-Garcier pipelines for 50 PJ additional capacity, with reversal of flow direction.	Pipeline												
4	Upgrade of Ressano-Garcier pipelines for 45 PJ additional capacity and linking to Eswatini	Pipeline												
5	500 MW for Beluluane power plant	Demand												
5	1500 MW for Beluluane power plant	Demand												
6	Development of Gas power station in Eswatini	Demand												
7	Production in Pande-Temane Gas fields begins to decline													
8	Exploration and production concession contract for PT5-C	Supply												
8	Exploration and production concession contract for Z5-D	Supply												
8	Exploration and production concession contract for Z5-C	Supply												
8	Exploration and production concession contract for A5-A	Supply												
8	Exploration and production concession contract for A5-B	Supply												
8	Exploration and production concession contract for Cahora Bassa Basin	Supply												
9	Potential conversion of coal power plant in ZAF: Komati	Demand												
9	Potential conversion of coal power plant in ZAF: Camden	Demand												
9	Potential conversion of coal power plant in ZAF: Hendrina	Demand												
9	Potential conversion of coal power plant in ZAF: Grootvlei	Demand												
9	Potential conversion of coal power plant in ZAF: Arnot	Demand												
9	Potential conversion of coal power plant in ZAF: Kriel	Demand												
9	Potential conversion of coal power plant in ZAF: Duvha	Demand												
9	Potential conversion of coal power plant in ZAF: Matla	Demand												

Key:
Plan as per energy plans/stakeholder engagements
Potential Demand
Exploration and Production

Figure 56: Maputo-South Africa Corridor Investment Blueprint

The figure below indicates infrastructure requirements to anchor demand along the southern east coast of the region, as well as infrastructure to import and transport natural gas inland via a reversal of gas flow and expansion of the Lily Pipeline.

Index	Development - Supply via Richards Bay	Type of Infrastructure	2022	2023	2024	2025	2026	2027	2028
1	Richards Bay LNG import facility goes online (70 PJ)	LNG Import							
1	Richards Bay LNG import facility goes online (49.4 PJ)	LNG Import							
2	Development of Richards Bay Gas Power station (1000	Demand							
2	Development of Richards Bay Gas Power station (2000	Demand							
3	Reversal of Lilly Pipeline	Pipeline							
4	Conversion of Avon Power station	Demand							
5	Production in Temane / Pande Gas fields begins to decline	N/A							

Key:
Plan as per energy plans/stakeholder engagements

Figure 57: Richards Bay-South Africa Corridor Investment Blueprint

Afungi-Nacala-Ndola Corridor

The figure below indicates the infrastructure requirements to anchor demand along the northern east coast of the region as well as in Malawi, Zambia, and Zimbabwe. Natural gas will be transported via pipeline from Afungi to Nacala to facilitate local demand and road transportation into Malawi, Zambia and Zimbabwe.

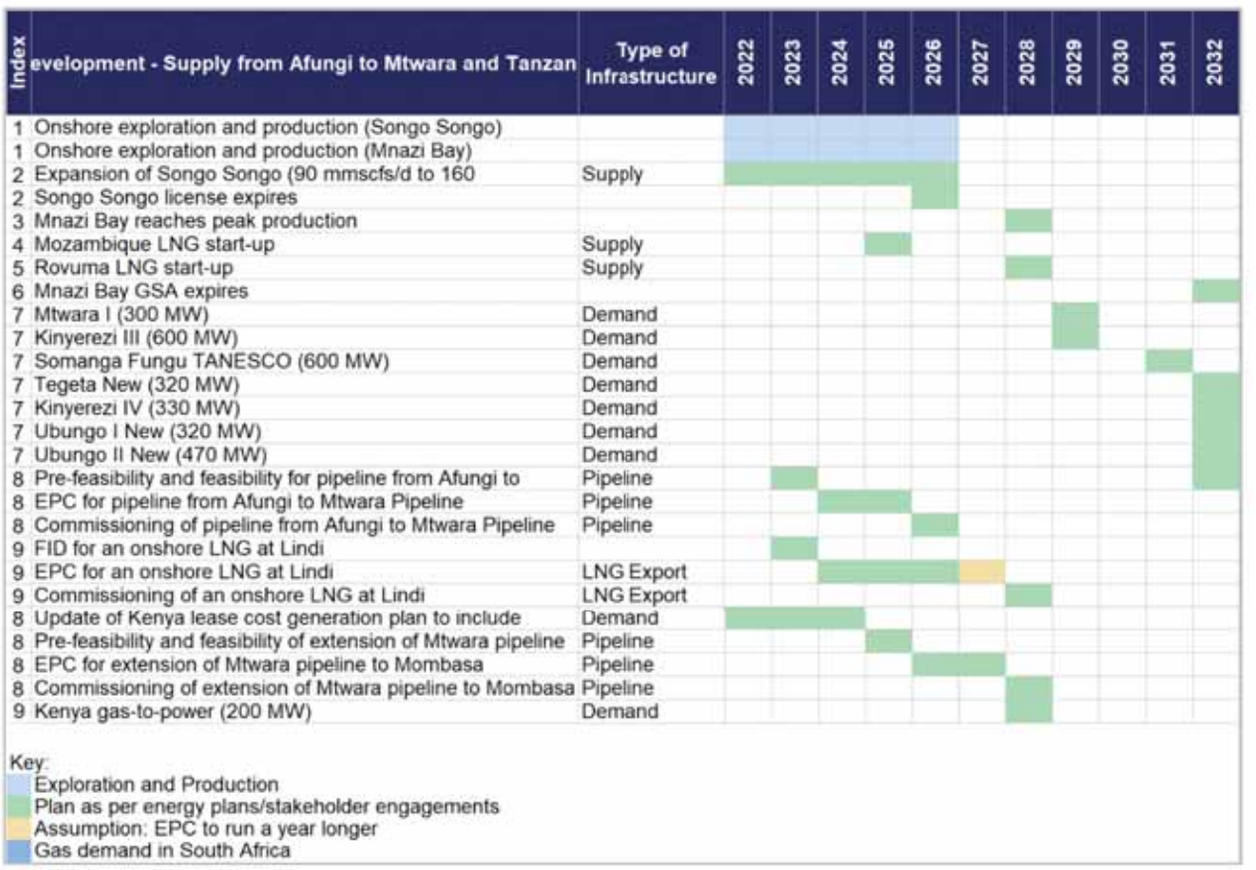
Index	Development - Supply via Nacala	Type of Infrastructure	2022	2023	2024	2025	2026	2027	2028
1	Coral Floating LNG (Offshore) goes online	N/A (export)							
2	Mozambique LNG (onshore) goes online	Supply							
3	Rovuma LNG (onshore) FID								
3	Rovuma LNG (onshore) goes online	Supply							
4	First domgas is available (400 MMscf/d)								
5	First domgas is available (500 MMscf/d)								
6	MWI | ZMB | ZWE gas available								
6	MWI | ZMB | ZWE potential switching of diesel power plants								
7	Pre-feasibility and feasibility for pipeline between Afungi and Nacala	Pipeline							
7	FID for pipeline between Afungi and Nacala	Pipeline							
7	EPC for pipeline between Afungi and Nacala	Pipeline							
7	Commissioning of pipeline between Afungi and Nacala	Pipeline							
8	Commissioning of Power stations in Afungi	Power							
9	Conversion of HFO/Diesel Power plants in Nacala (102.5 MW)	Demand							
9	Commissioning of GLAE MOZ LNG Power Plant (250 MW)	Demand							
10	First Gas IPP in ZAF								
10	Second Gas IPP in ZAF								
11	SADC countries to update Electricity Plans								
11	Countries make firm committemt for GtP offtake								
11	Transmission grid development	Power							
11	Commissioning of Power stations in Nacala (additional 650 MW)	Demand							
12	Pre-feasibility and feasibility for Ammonia Plant in Nacala								
12	EPC for Ammonia Plant in Nacala	Demand							
12	Commissioning of Ammonia Plant in Nacala	Demand							
13	Potential conversion of Luanshya Nchanga in ZMB (14.6 MW)	Demand							
13	Potential conversion of Lusaka Diesel Power Plant in ZMB (15 MW)	Demand							
13	Potential conversion of Mufulira Nchanga Diesel Power Plant in ZMB (10 MW)	Demand							
13	Potential conversion of Nkana Diesel Power Plant in ZMB (20 MW)	Demand							
13	Potential conversion of Bancroft Diesel Power Plant in ZMB (20 MW)	Demand							
13	Potential conversion of Kankoyo Diesel Power Plant in ZMB (10 MW)	Demand							
13	Potential conversion of Maclaren Diesel Power Plant in ZMB (10 MW)	Demand							
13	Potential conversion of Luangwa Diesel Power Plant in ZMB (2.6 MW)	Demand							
13	Potential conversion of Ndola HFO Power Plant in ZMB (105 MW)	Demand							

Key:
- Infrastructure for export
- Plan as per energy plans/stakeholder engagements
- AIA proposed time
- Gas demand in South Africa

Figure 58: Afungi-Nacala-Ndola Corridor Investment Blueprint

Afungi-Dar es Salaam-Mombasa Corridor

The figure below indicates the infrastructure development requirements to anchor demand for natural gas along the Corridor, as well as infrastructure to import and transport natural gas into Tanzania and north towards Kenya.



Index	evelopment - Supply from Afungi to Mtwara and Tanzan	Type of Infrastructure	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1	Onshore exploration and production (Songo Songo)												
1	Onshore exploration and production (Mnazi Bay)												
2	Expansion of Songo Songo (90 mmscfs/d to 160	Supply											
2	Songo Songo license expires												
3	Mnazi Bay reaches peak production												
4	Mozambique LNG start-up	Supply											
5	Rovuma LNG start-up	Supply											
6	Mnazi Bay GSA expires												
7	Mtwara I (300 MW)	Demand											
7	Kinyerezi III (600 MW)	Demand											
7	Somanga Fungu TANESCO (600 MW)	Demand											
7	Tegeta New (320 MW)	Demand											
7	Kinyerezi IV (330 MW)	Demand											
7	Ubungo I New (320 MW)	Demand											
7	Ubungo II New (470 MW)	Demand											
8	Pre-feasibility and feasibility for pipeline from Afungi to	Pipeline											
8	EPC for pipeline from Afungi to Mtwara Pipeline	Pipeline											
8	Commissioning of pipeline from Afungi to Mtwara Pipeline	Pipeline											
9	FID for an onshore LNG at Lindi												
9	EPC for an onshore LNG at Lindi	LNG Export											
9	Commissioning of an onshore LNG at Lindi	LNG Export											
8	Update of Kenya lease cost generation plan to include	Demand											
8	Pre-feasibility and feasibility of extension of Mtwara pipeline	Pipeline											
8	EPC for extension of Mtwara pipeline to Mombasa	Pipeline											
8	Commissioning of extension of Mtwara pipeline to Mombasa	Pipeline											
9	Kenya gas-to-power (200 MW)	Demand											

Key:
- Exploration and Production
- Plan as per energy plans/stakeholder engagements
- Assumption: EPC to run a year longer
- Gas demand in South Africa

Figure 59: Afungi-Dar es Salaam Corridor Investment Blueprint

Angola/DRC Corridor

The figure below indicates the infrastructure development requirements to anchor demand for natural gas along the corridor, as well as infrastructure to supply LNG into the corridor.

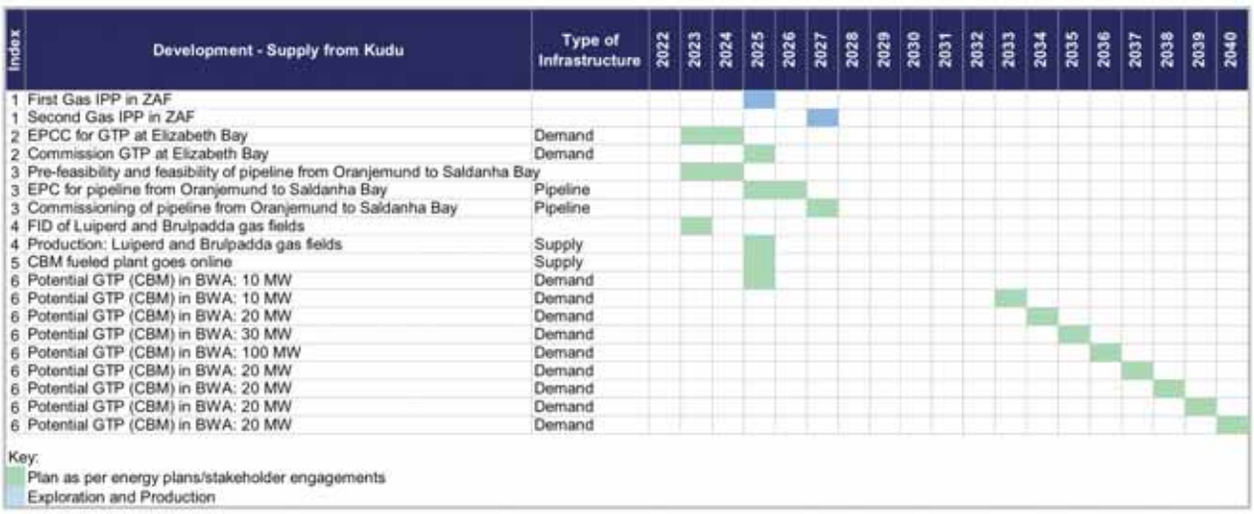
Index	Development - Supply from Soyo	Type of Infrastructure	2022	2023	2024	2025	2026	2027	2028
1	Soyo LNG reaches full capacity	Supply							
2	Comission GTP in ANG: Soyo2-2 (720 MW)	Demand							
3	Developing Gas Fields in Kwnaza Basin	Supply							
4	Grid Infrastructure Investment								
4	Comission GTP at Lobito (1200 MW)								

Key:
- Plan as per energy plans/stakeholder engagements

Figure 60: Angola/ DRC Corridor Investment Blueprint

Walvis Bay-Cape Town Corridor

The figure below indicates the infrastructure development requirements to anchor demand for natural gas along the corridor, as well as infrastructure to transport natural gas from southern west coast into the corridor



Index	Development - Supply from Kudu	Type of Infrastructure	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
1	First Gas IPP in ZAF																				
1	Second Gas IPP in ZAF																				
2	EPCC for GTP at Elizabeth Bay	Demand																			
2	Commission GTP at Elizabeth Bay	Demand																			
3	Pre-feasibility and feasibility of pipeline from Oranjemund to Saldanha Bay																				
3	EPC for pipeline from Oranjemund to Saldanha Bay	Pipeline																			
3	Commissioning of pipeline from Oranjemund to Saldanha Bay	Pipeline																			
4	FID of Luiperd and Brulpadda gas fields																				
4	Production: Luiperd and Brulpadda gas fields	Supply																			
5	CBM fueled plant goes online	Supply																			
6	Potential GTP (CBM) in BWA: 10 MW	Demand																			
6	Potential GTP (CBM) in BWA: 10 MW	Demand																			
6	Potential GTP (CBM) in BWA: 20 MW	Demand																			
6	Potential GTP (CBM) in BWA: 30 MW	Demand																			
6	Potential GTP (CBM) in BWA: 100 MW	Demand																			
6	Potential GTP (CBM) in BWA: 20 MW	Demand																			
6	Potential GTP (CBM) in BWA: 20 MW	Demand																			
6	Potential GTP (CBM) in BWA: 20 MW	Demand																			
6	Potential GTP (CBM) in BWA: 20 MW	Demand																			

Key:
Plan as per energy plans/stakeholder engagements
Exploration and Production

Figure 61: Afungi-Nacala-Ndola Corridor Investment Blueprint

Plot 54385, Central Business District
Private Bag 0095, Gaborone, Botswana
Tel: +267 395 1863 Fax: +267 397 2848
Email:registry@sadc.int
Website:www.sadc.int

DBSA
DEVELOPMENT BANK OF SOUTHERN AFRICA

IDC
Industrial Development Corporation