South African Gas Master Plan: Basecase Report (v 01)

DEPARTMENT OF MINERAL RESOURCES AND ENERGY

GAS MASTER PLAN 2022

BASE CASE REPORT

STAKEHOLDER CONSULTATION

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Revision Control

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Table of Contents

Table of Tables

List of Figures

Appendices

Abbreviations

BOT	Build-Operate-Transfer
BOOT	Build-Own-Operate-Transfer
CBM	Coal Bed Methane
CNG	Compressed Natural Gas
CTL	Coal-to-Liquid
DNG	Delta Natural Gas
E&P	Exploration and Production
EC	Eastern Cape
ENH	Empresa Nacional de Hidrocarbonetos
EPC	Engineering, Procurement and Construction
EWURA	Energy and Water Utilities Regulatory Authority
FS	Free State
FET	Further Education and Training
FID	Final Investment Decision
FSRU	Floating, Storage and Regasification Unit
GDP	Gross Domestic Product

GP	Gauteng Province
GTL	Gas-to-Liquid
GTW	Gas-to-Wire
IEP	Integrated Energy Plan
IGUA-SA	Industrial Gas Users Association – South
IMO	International Maritime Organization
INP	Institute of National Petroleum
IOC	International Oil Companies
IRP	Integrated Resource Plan
KZN	KwaZulu-Natal
LNG	Liquefied Natural Gas
LEAP	Long-range Energy Alternatives Planning
LP	Limpopo
LPG	Liquefied Petroleum Gas
MP	Mpumalanga
MPRDA	Mineral and Petroleum Resources Development Act
NDP	National Development Plan
NERSA	National Energy Regulator of South Africa

NG	Natural Gas
NGC	Natural Gas Compression
PASA	Petroleum Agency SA
PEPDA	Petroleum Exploration Development and Production Agreement
PPA	Petroleum Production Agreement
PSA	Production Sharing Agreement
PURA	Petroleum Upstream Regulatory Authority
RFO	Residual Fuel Oil
RMIPPPP	Risk Mitigation Independent Power Producer Procurement Programme
ROMPCO	Republic of Mozambique Pipeline Company (joint venture company between Central Energy Fund (SA Government), Companhia Mozambicana de Gasoduto S.A (Mozambique Government) and Sasol Gas Holdings.
SA	South Africa
SAB	South African Breweries
SABOA	South African Bus Operators Association
SADC	Southern Africa Development Community
SEA	Strategic Environmental Assessment
SEPI	Sasol Exploration and Production International

SPA	Sales and Purchase Agreement
SSA	Sub-Saharan Africa
TRT	Tshwane Rapid Transit
US	United States
VAT	Value-Added Tax
WC	Western Cape

Conversion Factors

Natural Gas & LNG	To convert					
	Billion cubic meters NG	Billion cubic feet NG	Million tonnes oil equivalent	Million tonnes LNG	Trillion British thermal units	Million barrels oil equivalent
From	**Multiply by**					
1 billion cubic meters NG	1.000	35.315	0.860	0.735	34.121	5.883
1 billion cubic feet NG	0.028	1.000	0.024	0.021	0.966	0.167
1 million tonnes oil equivalent	1.163	41.071	1.000	0.855	39.682	6.842
1 million tonnes LNG	1.360	48.028	1.169	1.000	46.405	8.001
1 trillion British thermal units	0.029	1.035	0.025	0.022	1.000	0.172
1 million barrels oil equivalent	0.170	6.003	0.146	0.125	5.800	1.000

1. Introduction

1.1. Background

The National Development Plan (NDP) envisions that by 2030 South Africa will have an energy sector that promotes economic growth and development through adequate investment in energy infrastructure.

At just 2.6% of the country's total energy mix, South Africa's natural gas market is small, but with all its inherent benefits, it has the potential to completely change the economy by stimulating economic growth and development, stability, and job creation.

The meaningful addition of natural gas to the country's energy mix will rejuvenate an overburdened, out-dated energy infrastructure and reduce cyclical energy shortfalls. Perhaps even more importantly, it will stimulate the economy by allowing business and industry to lower their energy and operational spend while also creating significant numbers of new jobs and skills development opportunities.

Considering that nearly 90% of South Africa's existing natural gas demand is supplied by a single entity, namely Sasol Gas, the associated economic and employment risks of limited supply options, development and sourcing of alternative natural gas resources are high. It is imperative to ensure economic and employment stability within the natural gas sector by introducing more suppliers.

Southern Africa's gas potential has been revealed by major discoveries that, when developed, widen options for greater regional energy trade. South Africa's unconventional gas potential remains to be quantified but raises the prospect of possible domestic production in the longer term. Globally the natural gas industry has moved into a supply surplus, favouring a larger role for gas as a clean fossil fuel in many countries' energy policies.

A challenge in developing the gas sector is to bring gas demand and supply on stream at the same time and spread geographically to stimulate broader localized demand through South Africa. Without such localized gas demand, it is difficult to develop distributed gas supply and without such distributed gas supply it is difficult to develop localized gas demand. One way of breaking this impasse is to create significant "anchor" gas demand through the development of a gas-to-power programme. In pursuit of adding generating capacity, lowering carbon emissions, enhancing energy security and supporting industrial development, South Africa has taken the first steps in a gas-to-power programme to be executed under the Integrated Resource Plan 2019, aiming to increase the national energy mix natural gas contribution from 2.6% to 15.7% by 2030.

1.2. Document Purpose

The purpose of this document is to establish baseline information for the natural gas sector in South Africa and to outline the Gas Master Plan roadmap. Such baseline information includes an overview of the gas value

chain and regulatory framework, hence it is named basecase report. The report will also set the scene for the Gas Master Plan development process.

The Gas Master Plan document, once developed, will serve as a policy instrument, providing a roadmap for taking strategic, political and institutional decisions which will guide industry investment planning and coordinated implementation.

1.3. Report Limitation

At the time of finalizing this report the Department was yet to procure a suitable modelling tool to model the current gas sector in the country as well as to develop immediate sector expansion scenarios. This work is current underway and will be published in due course, together with natural gas demand projections.

2. Natural Gas as Energy Source

Natural gas is an abundant and integral part of the world's energy supply, accounting for nearly 24% of 2018's global primary energy consumed (BP Statistical Review of World Energy, 2020). When burned, natural gas is one of the cleanest and most powerful forms of energy available. Considering that only 2.6% of South Africa's primary energy needs are currently sourced from natural gas and Government's international climate change and carbon reduction commitment, exploitation of natural gas will play an integral part of South Africa's future energy mix diversification.

Natural gas is a fossil fuel naturally occurring as a gaseous mixture of light hydrocarbons in sedimentary rocks. Though it primarily consists of methane, there are other hydrocarbons that contribute to the makeup of natural gas and after natural gas is refined, those individual hydrocarbons can be used as various sources of energy.

Natural gas can be contained in a variety of different types of deposits that must be accessed if the natural gas is to be used. Natural gas has been extracted from conventional natural gas deposits for a long time, while the unconventional resources are resources that are being extracted using newly developed techniques.

Conventional resources are "pockets" of gas contained within relatively porous rock and are the most easily mined. Conventional gas has been extracted for many years and is the cheapest to extract, yielding the largest returns. While newer technologies like hydraulic fracturing have allowed for more expansive access to these deposits, they can be mined without its use.

Unconventional resources are made up of natural gas resources which are not readily available as conventional natural gas and have only been explored and extracted as energy resources in the last couple of decades. These unconventional resources consist of the following proven types of resources:

- *Coal bed methane* is natural gas consisting mostly of methane, which is trapped inside coal seams. This is extracted while the coal is being mined, as diminishing the pressure in the coal seam allows the gas to flow out of the seam and into a wellbore, where it is extracted.

- *Shale gas* is natural gas found inside a fine-grained sedimentary rock called shale. Shale is porous, but it is non-permeable, which means the gas cannot flow through it. Shale gas requires the use of hydraulic fracturing for extraction.

- *Biogenic gas* is formed at shallow depths and low temperatures by anaerobic bacterial decomposition of sedimentary organic matter. Biogenic gas consists almost entirely of methane and is unrelated to the processes that form oil.

- *Landfill gas* is a natural by-product of the decomposition of organic material in landfills. When municipal solid waste is first deposited in a landfill, it undergoes an aerobic decomposition stage and within one year, methane-producing bacteria begin to decompose the waste and generate methane. Instead of escaping into the air, landfill gas can be captured, converted and used as a renewable energy source, generating revenue and creating jobs in the community.

- *Biogas* is a type of biofuel that is naturally produced from the decomposition of organic waste, such as municipal wastewater and solid waste, industrial wastewater and agricultural waste. Anaerobic digestion is a natural form of waste-to-energy that uses the process of fermentation to break down organic matter. Biogas is known as an environmentally friendly energy source, alleviating the global waste epidemic and reliance on fossil fuel for energy.

Landfill gas and biogas are not classified as natural gas reserves but can be used as an energy source for gas, electricity, heat and transportation due to the high content of methane.

3. South African Gas Sector

The gas industry encompasses a range of different activities and processes which jointly contribute to the transformation of underlying resources into useable end-products valued by industrial and private customers.

The physical workflow architecture for the natural gas business is built around a capital-intensive asset base. The assets of each of the three principal business segments are held by exploration and production (E&P) companies (upstream), gas transmission providers (midstream) and local distribution companies (downstream). Figure 3-1 depicts a typical natural gas business value chain.

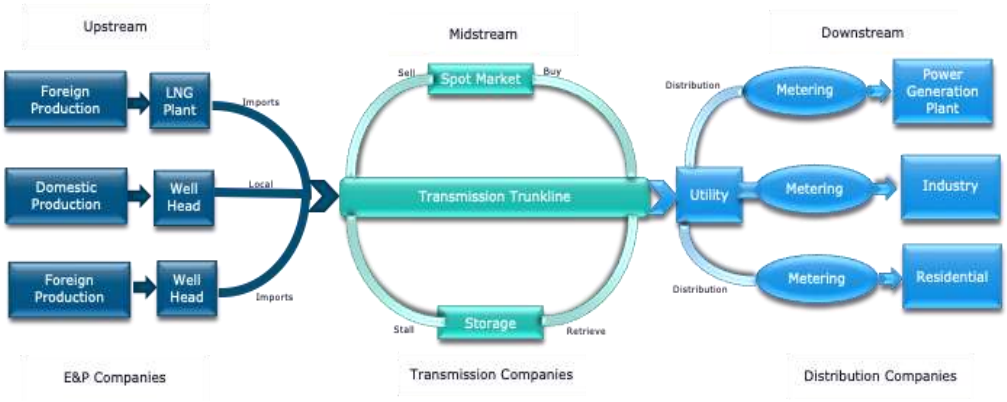

Figure 3-1: Gas Value Chain: Natural Gas Business

The value/business chain is divided into upstream, midstream and downstream components. The upstream sector of the value chain contains the exploration and production section of gas fields. The processes and activities involved in the upstream sector are exploration, field development and production operations. The midstream sector of the value chain is focused on transportation, processing and storage of natural gas, while the downstream sector involves distribution of natural gas to the end market. The current South African natural gas value chain structure, and associated dominant players, is depicted in Figure 3-2.

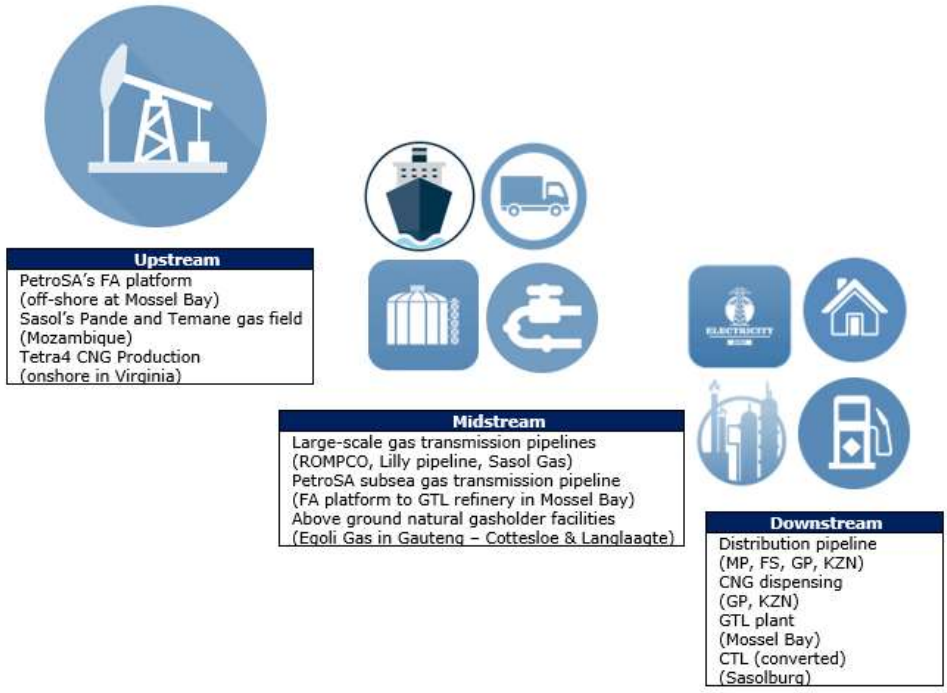

Figure 3-2: South African Natural Gas Value Chain

3.1. Upstream Gas Sector

PetroSA, Sasol Exploration and Production International (SEPI) and Tetra4 are the E&P companies currently involved in the upstream gas business sector.

The national natural gas demand is predominantly met through importation of natural gas from Sasol's Pande and Temane gas fields located in Mozambique. PetroSA has an indigenously produced offshore gas supply to the Gas-to-Liquid (GTL) plant located in Mossel Bay and Tetra4 is supplying natural gas extracted and compressed in Virginia to their customer, Megabus.

PetroSA's current indigenous offshore gas reserve is estimated to be depleted by 2029, while Sasol's Pande and Temane gas supply to South Africa is expected to decline by September 2023 if additional investments to extend the production plateau are not approved (Sasol Limited, 2018) (De Lange, 2019) (Smit, 2019).

3.2. Midstream Gas Sector

PetroSA has a transmission line leading from the FA platform to the GTL refinery in Mossel Bay. However, PetroSA does not operate as a gas transmission company since its offshore gas transmission pipeline is dedicated for own use.

Sasol Gas, ROMPCO and Transnet are the only transmission companies functioning within the midstream gas business sector in South Africa.

There are transmission pipelines distributing natural gas from Mozambique via the ROMPCO supply line, running from Secunda to Gauteng and finally down to Durban via Transnet's Lilly pipeline.

The ROMPCO pipeline allows for third party access along its transmission route, connecting South Africa to Mozambique. This transmission infrastructure presents a corridor opportunity for anyone who has secured natural gas in Mozambique and is willing to pay transport charges.

At present, above ground natural gasholder facilities are the only type of natural gas storage in South Africa. Egoli Gas' main storage-station is located at Cottesloe, with three larger gasholders capable of storing around 0.00000001 tcf of natural gas. Secondary smaller storage facilities, with seven high-pressure gas vessels, are situated at Langlaagte.

3.3. Downstream Gas Sector

South Africa currently has one purpose-built GTL refinery situated in Mossel Bay, with a design capacity of 45,000 bbl/day. The GTL refinery operation is currently limited to one reformer and one synthol train mode because of the declining gas reserves.

The Sasol Secunda and Sasolburg Coal-to-Liquid (CTL) facilities were adapted to accept natural gas as feedstock. The Sasolburg facility was eventually converted to only operate on natural gas.

Distribution and trading companies participating in the national downstream gas sector include Sasol Gas, Spring Lights Gas, Novo Energy and NGV Gas, Virtual Gas Network, Tetra4, Egoli Gas, Columbus Steel, Phambili Gas, Zemvelo Gas and Iliza Gas.

Sasol Gas has a competitive advantage within the downstream gas business sector, being the only supplier of gas and thus exhibiting a price advantage over other traders. Appendix B contains the list of National Energy Regulator of South Africa (NERSA) - approved natural gas licensees (NERSA, 2021).

3.4. Gas Sector Prices and Tariffs

The Gas Act (Act 48 of 2001) makes a clear distinction between gas prices (charge for a gas molecule) and gas tariffs (charge for network or gas service). Gas charges in South Africa comprise of both prices and tariffs. Figure 3-3 illustrates the composition of the total charges for piped-gas in South Africa.

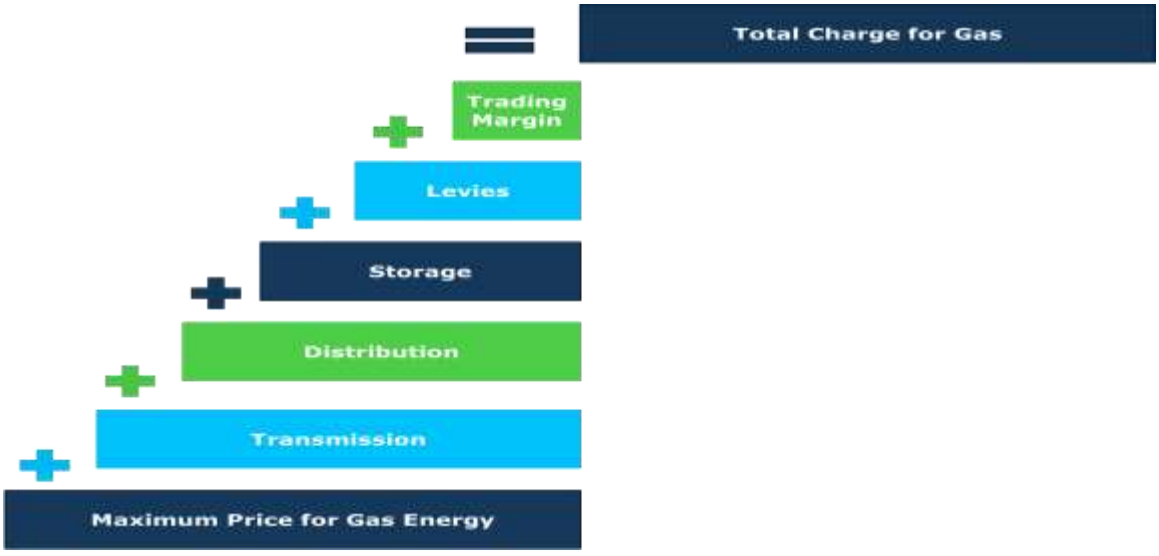

Figure 3-3: South African Piped-Gas Total Charge Composition

NERSA is guided by piped-gas regulations when monitoring and approving piped-gas trading margins. The regulations provide that gas prices must enable the licensee to recover all efficient and prudently incurred investment and operational costs and make a profit commensurate with

its risk. The methodology to approve maximum prices for piped-gas in South Africa makes provision for the gas trader to recover the transmission and distribution tariffs.

3.4.1. Gas Prices

Section 21 of the Gas Act (48/2001) provides that NERSA should regulate prices in the event of inadequate competition as contemplated in Chapters 2 and 3 of the Competition Act (Act 89 of 1998). Therefore, a competition assessment ought to be conducted before regulation of prices in terms of the Gas Act (48/2001).

NERSA has developed a new methodology for approving maximum prices for gas in South Africa. The methodology provides for two approaches, as detailed below.

3.4.1.1 Competitive Benchmarking

The competitive benchmarks used, include the Henry Hub, the Title Transfer Facility (TTF) Platts and the National Balancing Point (NBP). Gas prices in these trading hubs are largely determined by the interplay between supply and demand and are therefore suitable benchmark hubs against which a gas price, that seeks to mimic competition, can be linked.

This is the maximum price of the existing gas and it is the maximum value of gas at the point of its first entry into the transmission or distribution system.

3.4.1.2 Pass Through of Costs

The pass through of costs will be used by third party traders and importers of Liquified Natural Gas (LNG). The approach requires a passing through of costs, which include:

- Gas acquisition cost;
- Calculated trading cost;
- Appropriate margin (benchmarked to Japan Korea Marker (JKM) for LNG);
- Shipping and/or regasification costs;
- Transmission tariffs; and
- Distribution tariffs.

3.4.2. Gas Tariffs

A tariff is a charge for the infrastructure services provided for the transmission of gas via pipeline or storage of gas in various forms, including LNG storage tanks and compressed natural gas storage facilities. The regulation of tariffs is not subject to an inadequate competition finding.

NERSA's guidelines for monitoring and approving transmission and storage tariffs allow for:

- Rate of return regulation;
- Incentive regulation (price and revenue caps);
- Hybrid approaches (rate of return and incentive regulations);
- Profit share or sliding scales; and
- Discounted cash flow model of allowable revenue.

The rate of return and discounted cash flow methodologies are used to encourage entry and investment, allowing investors to recover costs and make a fair return on investments.

4. Gas Supply and Production

4.1. Domestic Gas Reserves and Resources

Ten countries hold more than two-thirds of the world's total proven natural gas reserves according to the latest publications by US EIA, OPEC and BP. Although South Africa does not currently feature on any of the published proven natural gas reserve lists, the country has the potential to rank amongst the top 30 countries, provided the initial gas estimates, specifically unconventional natural gas reserves, hold true (BP Statistical Review of World Energy, 2020) (EIA, 2019) (OPEC, 2019).

South Africa has several natural gas opportunities for local natural gas production, either from conventional (onshore/offshore) or unconventional (shale gas/coal bed methane) sources. Refer to Figure 4-1 for a simplified graphical representation of the domestic gas fields and their quantified reserve volumes. A map indicating the locations of these reserves and ongoing exploration activities along with the list of current exploration rights holders are available in Appendix A (Petroleum Agency SA, 2021). Appendix A provide further details of South Africa's gas resources.

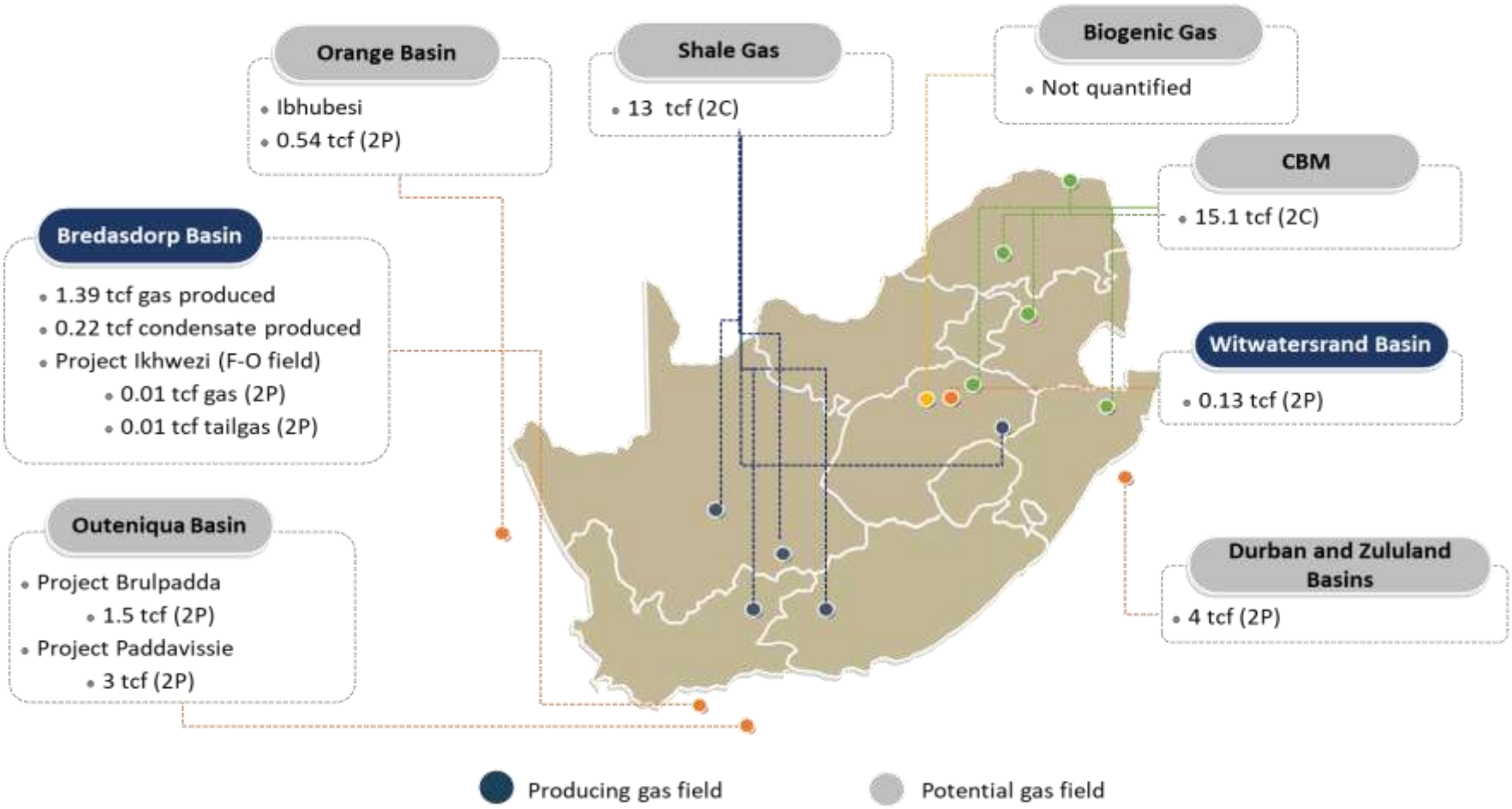

Figure 4-1: Domestic Gas Reserves

Document Title	Document Classification	Status	
Base Case Document	NEDLAC Consultation Document	First Draft	

4.1.1. Orange Basin

The Orange Basin forms part of the Southwest African Coastal Basin, which lies offshore Namibia and western South Africa.

Ibhubesi is the most significant play in the South African portion of the Orange Basin to date. Independently certified gas reserves have been certified at 0.54 tcf (2P), with the best estimate perspectivity certified to be close to 8 tcf of gas. Ibhubesi Gas Projects were in negotiations with Eskom for the provision of gas to the existing Ankerlig Power Station, the DMRE Independent Power Producer procurement program, as well as other major industrial users (SAOGA, 2017).

It is suggested that the Kudu-type play extends southwards into the South African portion of the Orange Basin, with the play currently being explored by companies with concessions over the northern and central parts of the Orange Basin.

4.1.2. Bredasdorp Basin

Petro SA has secured nearly 1.39 tcf gas and 0.22 tcf condensate feedstock for the GTL refinery from the F-A and Satellites, E-M, South Coast Gas and F-O gas fields (Ross, 2019).

Project Ikhwezi forms part of PetroSA's plan to secure additional reserves to sustain the Mossel Bay GTL refinery. Project Ikhwezi was expected to yield 0.24 tcf of gas though five wells (PetroSA, 2016). The production volume recorded from December 2013 until 31 March 2019, was 0.05 tcf, through three wells from the F-O gas field. The remaining F-O gas field reserve is estimated at 0.01 tcf (2P) and 0.01 tcf (2P) contingent resources (tailgas). The reserve is expected to sustain GTL operations until end-2029, but there remain further undeveloped contingent resources available in the F-O field (De Lange, 2019).

4.1.3. Outeniqua Basin

Total and its partners announced early February 2019 that a significant gas condensate discovery had been made in Block 11B/12B, 175 km off the southern coast. The Brulpadda project's reserve is estimated at approximately 6 tcf of gas and condensate. On 28 October 2020, Total and its partners announced a significant gas condensate discovery on the Luiperd Prospect, with Project Paddavissie's gas potential estimated in the range of 3 tcf (2P). Geophysical estimates have suggested 3 tcf (2P) of the potential gas reserves (Brulpadda and Luiperd) can be recovered (Broyard, 2021).

The most probable use for the gas would be to serve as feedstock to PetroSA's GTL plant, due to proximity to existing infrastructure from the FA platform to Mossel Bay. The Brulpadda or Paddavissie field could substitute the GTL plant's current waning gas reserve, preventing the plant from shutting down and the associated loss of jobs and infrastructure in South Africa.

The current timeline involves studying of the possible development schemes, with the objective, subject to approval by partners and government, to produce gas by the end of 2025 (Broyard, 2021).

4.1.4. Witwatersrand Basin

The biogenic gas resource probable recoverable volume has been estimated at 0.13 tcf (2P), with associated helium reserves valued at 0.003 tcf. Tetra4, a subsidiary of Renergen, has reserved the rights to develop the onshore gas field situated near the town of Virginia, in the Free State province.

Given the unusual nature of this unconventional play, commercial exploitation of biogenic gas has become a reality with business opportunities for compressed natural gas (CNG) and liquefied natural gas (LNG) production, power generation supply and helium for industrial applications.

LNG produced from both Phase 1 and Phase 2 is earmarked for the domestic market. Phase 1 gas supply has already been contracted to Total for its downstream retail arm as trucking fuel to replace diesel, and is expected to come online in 2021, delivering approximately 2,500 GJ LNG daily (Renergen, 2021).

4.1.5. Durban and Zululand Basins

The offshore Durban and Zululand Basins became of interest to the oil and gas industry following large discoveries along the eastern margin of Africa, most notably in Tanzania and Mozambique. The Petroleum Agency's gas-in-place prospective evaluation is estimated at 4 tcf (Petroleum Agency SA, 2012).

Eni South Africa BV (Eni), and Sasol Africa Limited (Sasol) hold an Exploration Right off the East Coast of South Africa and are in the process of obtaining final approval for conducting an exploration drilling programme in Block ER236 (12/3/236) to assess the commercial viability of the hydrocarbon reservoir for future development. The drilling program proposed by Eni is to drill at least one exploration well within the northern or southern areas of interest in the short term. If the first exploration well shows a hydrocarbon discovery, up to two exploration drilling wells at different locations and up to three appraisal wells will follow (ERM, 2018).

In 2019, 47 interested and affected parties filed appeals against the deep-sea exploration drilling endeavour, which has delayed final approval of the exploration drilling programme. On 17 December 2020, the Minister of Environment, Forestry and Fisheries dismissed 47 appeals challenging the authorisation to proceed with drilling, which could see a deep-water wildcat spud off KwaZulu-Natal as early as 2022, provided regulatory approval of the renewal exploration application is received.

4.1.6. Unconventional

4.1.6.1 Shale Gas

The southern Main Karoo Basin is the most prospective area for shale gas in South Africa. Exploration right applications have been received from Shell International, Falcon Oil and Gas, in partnership with Chevron and Bundu Gas. The shale as resource in the Karoo Basin is unknown, due to the scarcity of relevant geoscientific data, but the preliminary estimate of the technically recoverable resource is speculated to be 30 tcf (2C) (Gas Strategies Group, 2017) (PASA, 2019).

A major investment in infrastructure of this remote and arid region of South Africa will be required to ensure economic viability. These reserves have not reached commercial extraction, and their economic viability is still to be confirmed.

4.1.6.2 Coal Bed Methane

There is great interest in the coal bed methane (CBM) potential of South Africa's Ecca Group coal deposits in the north-eastern Main Karoo Basin. The most significant exploration work conducted in the northern Karoo Basin has occurred in Lephalale, Mopane and Ermelo coalfields.

Lephalale Basin is the country's most promising target for CBM exploration at present. Anglo Thermal Coal has reported a technically recoverable reserve of 1 tcf, with the Petroleum Agency's gas-in-place evaluation estimated at 4 tcf (2C) (PASA, 2019).

Springbok Flats Basin is largely untested, and the Petroleum Agency's gas-in-place estimation is in the order of 2 tcf (2C) (PASA, 2019).

Mopane Sub-Basin, in the *Soutpansberg Basin*, is considered favourable for the occurrence of CBM, similar to the successfully developed Lephalale Basin. The Petroleum Agency's gas-in-place estimation is in the order of 1.2 tcf (2C). The exploration license is held by Sunbird (74%) and Umbono (26%), with newly drilled data suggesting a resource potential of 1.9 tcf (PASA, 2019).

Tshipise-Pafuri Sub-Basin, in the *Soutpansberg Basin*, is also considered favourable for the occurrence of CBM. The Petroleum Agency's gas-in-place estimation is in the order of 1.6 tcf (2C) (PASA, 2019).

Tuli Basin is considered favourable for the occurrence of CBM, and the Petroleum Agency's gas-in-place estimation is in the order of 1.4 tcf (2C) (PASA, 2019).

Ermelo Coalfields comprises of Amersfoort Gas Project, which is the most promising target for CBM production, since the area is nearby existing coal-based energy and power generation

infrastructure and within proximity to major industrial, mining and manufacturing areas. Afro Energy has drilled 21 exploration core holes and prospective resources are estimated to be approximately 2.4 tcf (2C) of gas-in-place (PASA, 2019).

Highveld Coalfields is considered favourable for the occurrence of CBM and based on the Petroleum Agency's evaluation, could potentially host gas-in-place resources in order of 2.5 tcf (2C) (PASA, 2019).

4.1.6.3 Biogenic Gas

Gas encountered within the coal-bearing Karoo strata in the region is believed to have migrated from the underlying Witwatersrand Basin, which is biogenic in origin and is thus constantly replenished. Given the unusual nature of this unconventional biogenic play, the volume of technically recoverable gas resource has not yet been quantified.

4.2. Regional Gas Reserves and Resources

Four of the largest potential natural gas producing countries in Africa, namely Zimbabwe, Mozambique, Namibia and Botswana, are neighbouring South Africa. Due to the proximity, sourcing from these countries would be ideal. South Africa also has the opportunity for regional supply from Angola and Tanzania. Figure 4-2 presents a graphical illustration of the geographical locations of the potential South African Development Community (SADC) natural gas supply countries.

Figure 4-2: SADC Regional Gas Supply Options

4.2.1. Angola

The Angola LNG project, situated in Soyo in the Zaire district, became operational in early 2013. The project is the result of a partnership between Sonangol, Chevron, BP, ENI and Total, to collect, process and launch 0.25 tcf of LNG in the global market annually. The facility utilizes associated gas resources, primarily from shallow-water fields, for LNG production. The facility is currently restricted to produce below 0.25 tcf per annum and more wells are required to ensure stable, long-term production rates (MacauHub, 2018).

Angola LNG has signed an offtake multi-year agreement with Vitol and Glencore for the supply of LNG. Agreements have also been reached with Germany's RWE to deliver LNG products (ESI Africa, 2017). According to Oil Review Africa, Angola has been selling all its LNG through competitive tenders in the global spot market.

4.2.2. Botswana

Botswana discovered CBM reserves in the Lesedi region. The Lesedi CBM project has an independently certified contingent gas resource of 3.2 tcf. The concessionaire Tlou Energy places the commercial proven reserves at 0.15 tcf and commercial possible reserves at 0.26 tcf. Tlou Energy is seeking project finance to build infrastructure to connect the Lesedi Power Project to the existing electricity grid in Botswana. The infrastructure includes transmission lines, electrical substations as well as the installation of gas and solar generation assets. FID is expected once a third-party technical review of the project, as part of the due diligence process, has been completed. The proposed off-taker of the power generated by Tlou is the Botswana Power Corporation, with a signed a PPA for the first 2MW of electricity and a pending submission to secure a PPA for up to 10MW (Tlou Energy Limited, 2021).

4.2.3. Mozambique

Mozambique has the largest gas discoveries among the focus countries. It already produces gas from its Pande and Temane fields, has discovered large volumes of offshore gas (predominantly concentrated in the Rovuma basin), and has an unquantified onshore potential (e.g. CBM prospects in Tete). Combining all the recoverable reserves (onshore, offshore and CBM), Mozambique could supply as much as 3.9 tcf annually by 2030.

Given Atlantic Basin competition, South Africa may not be the first market of choice for Mozambique's LNG. Even if a substantial part of these volumes would be initially reserved for export through LNG, vast potential remains for regional supply. South Africa is Mozambique's

neighbour and has an established and deep trading relationship, and significant existing investment by South Africa into Mozambique (Standard Bank, 2019).

South Africa has purchased natural gas from Mozambique, through Sasol Gas, since 2004. The project served as a milestone in Southern African energy and infrastructure development, initiating a much-needed broadening of the energy supply mix in the region and impacting positively on both the Mozambican and South African economies. The development provided an anchor offtake to facilitate development of gas fields in Mozambique, which in turn stimulated the development of South African and Mozambican gas markets.

The Petroleum Production Agreement (PPA) resulted in expansion of South Africa's industrial sector, with the existing industrial companies combined economic contribution amounting to more than R 150 billion per annum, providing employment for over 46,000 South Africans (IGUA-SA, 2019). The Pande and Temane gas field reserves are declining and the imminent gas supply shortage could be catastrophic for South Africa's economy and labour force.

The Production Sharing Agreement (PSA) licence is set to bring about the next wave of development, supporting the Mozambican Government's drivers for in-country monetisation, energy security, further industrialisation and skills development. Sasol approved the FID on the PSA, with gas earmarked for a 450 MW gas-fired power plant Central Térmica de Temane and a Liquefied petroleum Gas (LPG) facility in the same time frame. The balance of the gas produced is anticipated to be exported to South Africa to sustain Sasol's operations (Sasol, 2021).

The Golfinho project in Mozambique has been provided a loan facility of approximately 1 billion USD by Standard Bank, underwritten by the Export Credit Insurance Corporation of South Africa and a similar loan facility is expected for the Rovuma LNG project. These Mozambican projects thus offer significant opportunities for South African industrial players to ramp up their capacity and supply a wide variety of value-added products into these projects (Department of Trade and Industry, 2018).

Wood-Mackenzie estimates the total recoverable Rovuma reserves at approximately 120 tcf. Relatively small offshore reserves were also found at the Njika and Buzi fields, totalling nearly 1.3 tcf of recoverable reserves.

An early development plan is underway for a 2,600 km gas pipeline from the Rovuma Basin in northern Mozambique to Gauteng, South Africa. A cooperation agreement has been signed between ENH, Profin Consulting, SacOil and China Petroleum Pipeline Bureau. The consortium's next task is to conduct a feasibility study to determine the possible economic benefits for the project and these results will determine the future steps for the project (Kiganda, 2018).

The Total-operated Mozambique LNG project, consisting of two LNG trains with a total annual capacity of 13.1 MT, will be Mozambique's first onshore LNG development. Area 1 contains more

than 60 tcf of gas resources, of which 18 tcf will be developed with the first two train project which took FID in June 2019. The project was originally expected to come into production by 2024 but following the evolution of the security situation in the north of the Cabo Delgao Province, Total claimed Force Majeure end of April 2021, which is likely to affect the timeline of the project (Broyard, 2021).

The partners in the Mozambique Rovuma Venture submitted the development plan to the government for the first phase of the Rovuma LNG project, which will produce, liquefy, and market natural gas from the Mamba fields located in the Area 4 block offshore Mozambique. The plan details the proposed design and construction of two LNG trains which will each produce 0.37 tcf per annum (Offshore Energy Today, 2018). FID was expected by 2019 and production is anticipated by 2024.

The Coral South project is the first LNG project in Mozambique, led by ENI, to exploit the huge reserves of Area Four in the Rovuma Basin through the first worldwide ultra-deep floating LNG plant. Area 4 comprises a total recoverable gas reserve of 58.2 tcf, with 17.6 tcf currently estimated to be commercially recoverable. The production capacity is 0.17 tcf, for 25 years, starting 2022.

In addition to these recent offshore discoveries, Mozambique is already producing gas from its onshore Pande and Temane fields, with the remaining recoverable reserves estimated at 2.3 tcf. Production is also expected to come online from the adjacent Inhassoro PSA, which has recoverable reserves of 0.4 tcf (100% owned by Sasol). All three fields feed the ROMPCO pipeline to Secunda.

Mozambique is expected to have unconventional gas potential from its CBM resources in the Tete region. These reserves are still unquantified and would likely be more economically challenging to develop compared to the country's conventional gas reserves.

4.2.4. Namibia

The Kudu gas field, situated offshore southern Namibia, have proven and probable recoverable reserves estimated at more than 3.3 tcf (Reuters, 2018). Transporting gas by pipeline from the Kudu gas field in Namibia to the East Coast region has proven to be commercially challenging, with various studies on the technical and commercial viability proving marginal results. More importantly, the government of Namibia have indicated a preference to use natural gas for indigenous requirements rather than for exportation to South Africa. Although Kudu was discovered in 1974 it has not been developed and if Kudu comes online by 2030, Namibia's annual gas supply potential is estimated at approximately 0.04 tcf.

4.2.5. Tanzania

Tanzania's natural gas reserve is estimated at 57.5 tcf. Currently, the natural gas extracted is for domestic use rather than exportation.

Tanzania expects a consortium of internal oil companies to start building a long-delayed LNG project in 2022. Equinor, alongside Royal Dutch Shell, Exxon Mobil and Ophir Energy and Pavilion Energy, plan to build the onshore LNG plant in the Lindi region. The project will have a capacity of 0.49 tcf LNG annually. Construction is expected to commence in 2022 and will be concluded in 2028 (Reuters, 2019).

4.2.6. Zimbabwe

Invictus Energy raised prospects of natural gas in Mzarabani and Msasa, which could result in Zimbabwe joining countries in the SADC region as leading natural gas producers. The Mzarabani Prospect's natural gas reserve was independently estimated at 9.25 tcf by Getech Group Plc, with the net mean recoverable conventional potential estimated at 6.5 tcf. In addition, the Msasa Prospect is estimated to contain 1.05 tcf on a total gross mean unrisked basis (Invictus Energy Limited, 2019) (Oil Review Africa, 2019).

On 26 March 2021, Invictus signed a Petroleum Exploration Development and Production Agreement (PEPDA) with the Republic of Zimbabwe. The execution of the PEPDA puts in place the necessary framework to rapidly develop the Cabora Bassa Project on exploration success and provides a 25-year production licence. Invictus is currently in the second exploration period and completed capital raise to accelerate the exploration campaign throughout 2021 (Invictus Energy Ltd, 2021).

South Africa is one of the potential off-takers earmarked for the natural gas reserve, in addition to Zambia.

CBM reserves were discovered in the Lupane-Lubimbi area a few decades ago, but commercial exploitation has not taken off. The reserve is estimated at over 0.02 tcf. Exploration and pilot production have since been conducted and results indicate that the resource can be exploited commercially (allAfrica, 2019).

The gas fields remain undeveloped and the prospective resource relates to undiscovered accumulations which have both a risk of discovery and a risk of development.

4.3. Global Gas Reserves and Resources

According to the BP Statistical Review of World Energy, the total global proven natural gas reserves at the end of 2019 was 7,019 tcf, with the distribution of global reserves shown in Figure 4-3 (BP, 2020).

Figure 4-5 displays the global potential LNG supply projects, with expected FIDs between 2019 and 2023 (Bloomberg NEF, 2019).

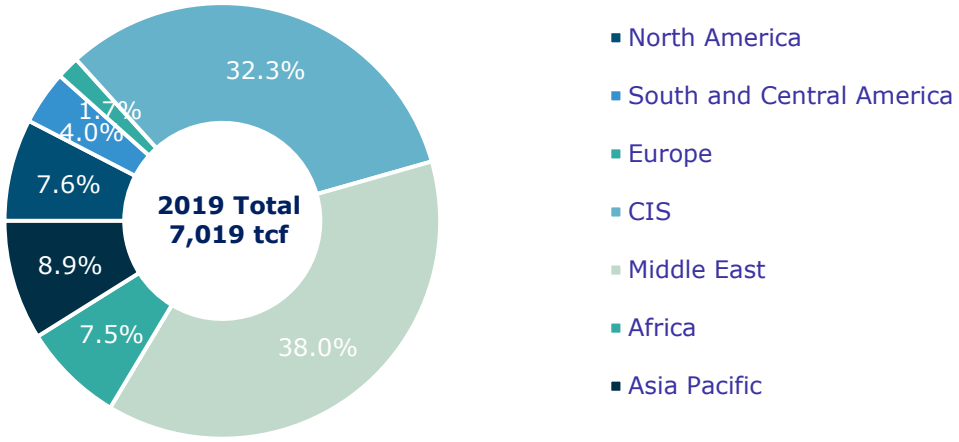

Figure 4-3: Global Natural Gas Proven Reserve Percentage Distribution

The highest ranking global natural gas exporters for 2019 are depicted in Figure 4-4 (BP, 2020). The 2018/19 wave of investment in liquefaction projects delver additional export capacity in North America, Africa and Russia.

Forecast slower gas demand (average annual growth rate of 1.5% compared to the initial 1.8%) post-2020 will limit the risk of a tight LNG market over the medium term (IEA, 2020).

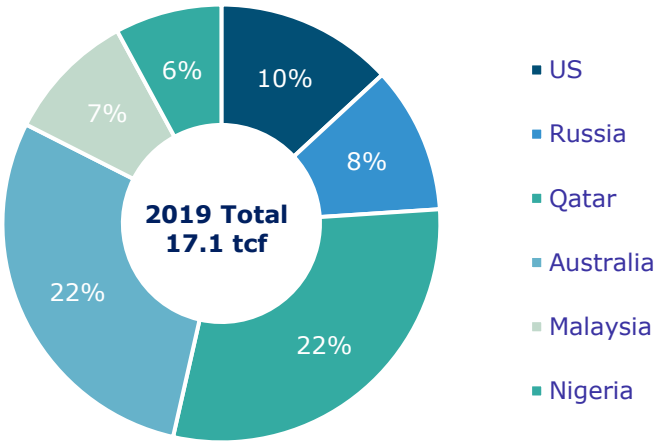

Figure 4-4: Global Liquified Natural Gas Exporters Percentage Distribution

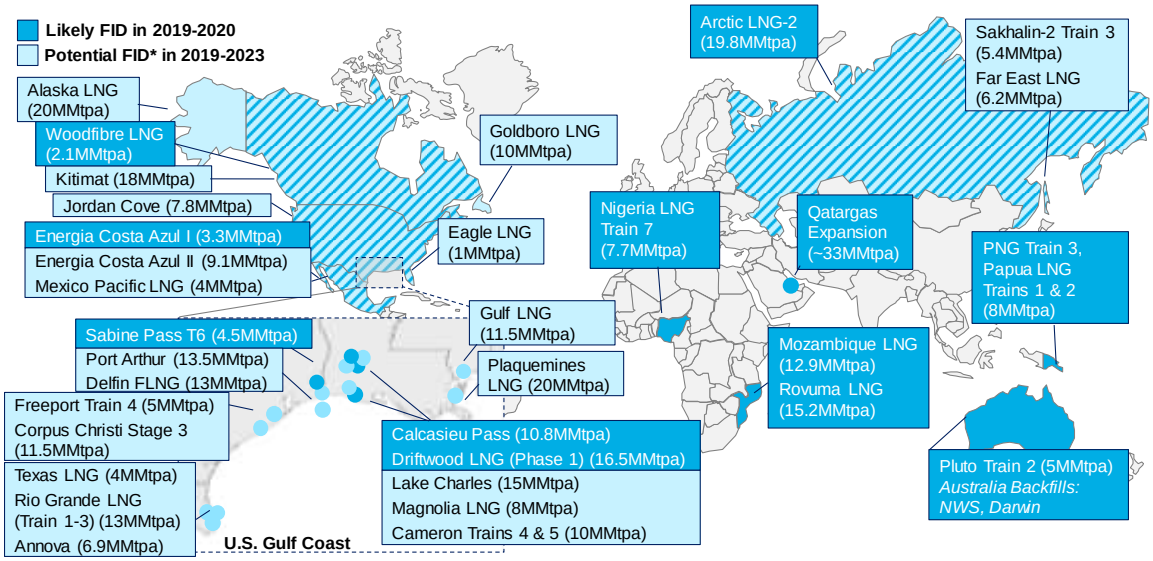

Figure 4-5: Potential LNG Supply Project FIDs in 2019-2023

The major natural gas trade movements, either through inter-regional pipelines or LNG industries, are indicated in Figure 4-6 (BP Statistical Review of World Energy, 2020).

North America and Europe are the dominant piped gas markets, while major suppliers, such as Australia and Nigeria, connect with key Asian markets through the LNG industry.

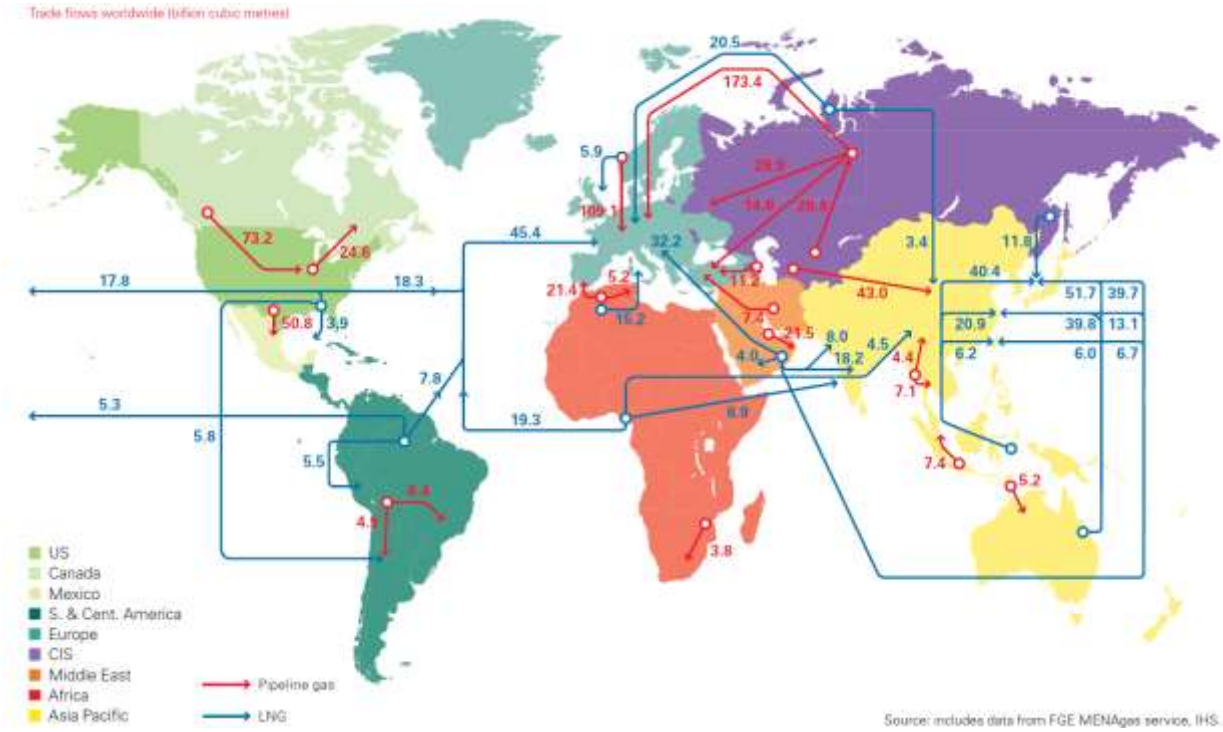

Figure 4-6: 2018 Major Natural Gas Trade Movement

5. Gas Utilisation Options

Global demand for natural gas is forecast to increase at an average rate of 1.6% over the next four years, with emerging Asian markets as the main engine for demand (International Gas Union, 2019). Global natural gas consumption growth has been primarily driven by changes in patterns of economic activity, energy intensity and energy source substitution.

Globally, the gas industry sector is set to replace power generation as the main driver of growth, with natural gas being used not only as energy source for processes, but also as feedstock for chemicals, including fertilisers in emerging economies and feedstock for petrochemicals. Natural gas use in transportation is also expected to grow strongly by 3.3% per annum predominantly within long-distance road haulage and marine, while gas demand in residential and commercial sectors will benefit from the ongoing coal-to-gas switch (International Energy Agency, 2019) (BP, 2019). Residential and commercial demand will also be driven by the desire to switch from electricity to more a reliable form of energy, such as natural gas.

The utilisation options for natural gas in South Africa are thus power generation, industrial co-generation, CNG or LNG vehicles, petrochemical synthesis, residential/commercial heating, and future exportation.

It is anticipated that the power and industry sectors will initially account for nearly 95% of the gas market (57% power sector and 37% industry sector), since these are the most prominent sectors forming part of the existing demand base, with transport making up the remainder of the market. Although transport could contribute a sizeable volume in future, it remains small relative to the existing gas landscape and is unlikely to anchor gas development.

5.1. Power Sector

More than 90% of South Africa's electricity is generated from coal and it is anticipated to remain the main fuel source for power generation.

Power generation has been clearly identified as the priority sector for gas utilisation in the draft IEP and approved IRP 2019, aiming to increase the national energy mix's natural gas contribution from 2.6% to 15.7% by 2030 (Department of Energy, 2016) (Department of Energy, 2019). The existing Open Cycle Gas Turbine (OCGT) peaking plants present an ideal opportunity for conversion to natural gas, with the potential to realize substantial cost savings of more than 30% from fuel source perspective.

Nationally, there are six OCGT plants currently utilising diesel as fuel source. These OCGT plants, with a combined installed capacity of nearly 4 GW, could be powered by natural gas and potentially be converted to closed cycle operations, presenting both a cheaper and cleaner source of energy with potentially higher energy output.

Further opportunities exist in converting mothballed coal fired power plants to run on natural gas. This opportunity will save substantial time and capital expenditure when compared with building new generation facilities and present the opportunity of recovering previously lost jobs when facilities were closed.

The power sector presents an immediate source of secure and growing natural gas demand, with attractive margins at low-risk as existing OCGT plants are ready to convert to Combined Cycle Gas Turbine (CCGT) plants, in addition to new gas-based thermal plants at various stages of development.

The Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP) was launched in 2020 to alleviate the existing short-term electricity supply constraint and to reduce extensive utilisation of diesel peaking generators. The RMIPPPP includes LNG as part of the Preferred Bidders' technology range and allows for 20-year Power Purchase Agreement (PPA)

terms. The demand created by the RMIPPPP presents opportunity for short-term gas supply. First power from the RMIPPPP is envisaged from August 2022 (South African Government, 2021).

The benefit of prioritising gas for power generation provides for large and concentrated volume of offtake, making the development of gas transmission infrastructure easier and more financially viable.

To ensure the gas-to-power sector's development can keep pace with demand and incentivize necessary investment, the regulatory framework to ensure financial viability exists for all parties is paramount. This applies to both the electricity as well as the gas sector. Cost reflective tariff and pricing, institutional and regulatory certainty, and ensuring gas security of supply will be the main features acting as gas-to-power demand drivers.

Power generation represents one of the most economically attractive, low-risk and urgent demand sectors for natural gas supplies. The financial viability of the sector must be secured in order to incentivize supply and new investment.

5.2. Non-Power Sectors

5.2.1. Industrial Sector

Low-risk industrial use is attractive because it can be expanded in an incremental fashion, primarily to supply domestic demand.

Low pressure pipelines can be established in industrial areas to supply natural gas to factories for heat in industrial processes. In these circumstances, gas will compete with other fuel sources, notably Residual Fuel Oil (RFO) and Liquefied Petroleum Gas (LPG). LPG and RFO industrial usage are currently limited due to associated cost and availability, respectively. Where infrastructure for pipeline gas can be provided to allow the cost differential to RFO and LPG to be sufficiently attractive to incentivize switching, industrial heating uses may present an additional source of low-risk incremental demand for natural gas. Industrial usage has appeared most successful where it has grown in incremental fashion rather than via focus on select 'champion' industries through proactive industrial policy. Textile, cement, steel, paper and fertilizer production facilities provide notable supplementary low-risk demand in a market where economic rationale for gas usage is the main driver.

For natural gas to become attractive, it would have to offer a cost advantage over LPG, after accounting for the significant capital required to establish urban distribution networks. Depending on the loads, this demand may be met through an offtake from gas transportation lines (for large offtakes) or local gas distribution networks or via combined heat and power

supplying a district heating network. Distribution of natural gas to smaller markets, outside pipeline networks, could also be achieved through CNG or LNG transport (virtual pipelines).

5.2.2. Transport Sector

Currently, energy consumption in the transport sector greatly depends on oil fuels. This dependency produces high levels of harmful emissions, making it necessary to increase the use of less polluting and more cost-effective alternative sources, such as natural gas.

Natural gas can be used in a pressurized state, known as Compressed Natural Gas (CNG), or in a liquified state, known as Liquified Natural Gas (LNG), for transportation as an alternative to petrol and diesel fuels.

The main constraints to natural gas transport are *(i)* the absence of infrastructure (including both compressors/cryogenic submerged pumps, which require reliable electricity supply, and a network of fuelling stations); *(ii)* the capital cost of converting; *(iii)* uncertainty over the future gas-oil price spread; and *(iv)* large storage space requirements. Targeting the conversion of dedicated fleets, rather than general conversion on a voluntary basis, helps reduce the impact of all these challenges, particularly by allowing for localized refuelling infrastructure to be developed.

Infrastructure, high capital costs and storage issues present barriers which may be addressed by concentrating on dedicated fleets in specific areas and providing financial support for conversion cost, possibly recouped through taxation on the natural gas supply.

Uptake of natural gas in the transport sector could be facilitated by providing fuel levy discounts and/or other subsidies.

Displacing diesel and/or petrol could however have considerable impact on the national fiscus and the South African Revenue Service's tax collection ability since natural gas attracts significantly less tax, primarily due to its lower price relative to liquid fuels.

5.2.2.1 Compressed Natural Gas

CNG use has proved popular in several markets where the cost of standard fuel options is high, which is particularly true among urban taxi and bus transportation fleets.

CNG for transportation could be incrementally rolled-out in other provinces, with the benefit of releasing LPG and oil products for other uses. Risks would be minimized by making CNG available in the first instance for dedicated taxis and goods transport fleets, with vehicles tuned to operate efficiently on CNG.

5.2.2.2 Liquified Natural Gas

At the moment, there is no alternative powertrain or fuel, other than LNG, that is economically attractive for long haul application. While the production and transport of LNG require greater technical expertise and significantly more capital compared to CNG, LNG cost savings are realized on refuelling infrastructure and operation. Greater flexibility also exists in the location and/or expansion of an existing stations since there is no need for natural gas pipeline access.

The International Maritime Organization (IMO) shipping's decarbonisation targets, IMO 2030 and IMO 2050, are also driving ship owners to switch to LNG as a shipping fuel.

5.2.3. Residential/Commercial Sector

Residential and commercial demand for gas through distribution networks is commonly accepted to require space heating demand due to cold climate conditions in order to be economically viable. In the absence of such demand in South Africa and with the widespread use of LPG for cooking, this is not recommended as a priority utilisation area for natural gas.

Residential and commercial distribution networks are seen either as uneconomic or long-term options.

5.2.4. Petrochemical Sector

Petrochemicals play a vital role in the global economy, having backward linkages with other industries in petroleum refining, natural gas processing and forward linkages with industries that deal in a variety of downstream products. The petrochemical industry uses a variety of hydrocarbon feedstock, including natural gas.

The petrochemical sector in South Africa serves as an existing consumer base requiring gas supply, below the sector's affordability threshold, in order to utilise domestic capacities already created and to obtain faster monetisation of natural gas.

5.2.5. Export Sector

If and when supplies from domestic gas production are able to sufficiently meet local demand, exports might present an option. Such gas exports would likely be in the form of LNG and would require a liquefaction facility and an export terminal.

Once domestic demand is adequately met, particularly for electricity generation, and sufficient gas becomes available to justify the construction of an LNG liquefaction facility and export terminal. Alternatively, it could be more beneficial to export electricity or any other commodity in high demand instead of gas. The final choice will be based on the expected margin to be

gained; the level of risk associated with an investment, and the potential wider economic benefits.

6. Gas Demand

6.1. Existing Gas Demand

Approximately 2.6% of South Africa's primary energy needs are sourced from natural gas.

The current natural gas consumption in South Africa is 0.15 tcf, with an average annual growth rate of 1.6% over the past decade owing to limited gas supply. The existing demand is restricted by the availability of natural gas and the gas economy's growth rate remains dependent on infrastructure and the development thereof (Business Unity South Africa, 2021). Another critical enabler for gas demand is the affordability of the gas, with various sectors exhibiting different affordability thresholds.

Existing gas demand nodes are primarily centred around Gauteng and Mpumalanga (Sasol's Secunda and Sasolburg operations), with industrial hubs in KwaZulu-Natal and PetroSA's GTL refinery in the Western Cape serving as coastal demand nodes (Sasol, 2021).

6.1.1. Gas Importation

Sasol Gas imports approximately 0.14 tcf of natural gas into South Africa annually via the ROMPCO pipeline, of which 0.10 tcf of natural gas is for internal use.

6.1.2. Gas Domestic Production

PetroSA's GTL refinery in Mossel Bay consumes nearly 0.014 tcf of natural gas annually, supplied from their FA platform.

Tetra4's existing CNG plant in Virginia, can produce up to 0.0001 tcf annually from one well, to its customer, Megabus.

The Sasol Secunda plant produces close to 0.018 tcf methane rich gas annually, which along with the remainder of imported natural gas from the ROMPCO pipeline, is sold to external clients.

6.2. Gas Demand Forecasting

Demand planning has two traditional approaches, namely top-down (purely economic drivers considered) and bottom-up (purely relying on the projected population numbers). Since cost-drivers do not play the most important role in developing economies and cannot take informal sector energy needs into account in the top-down approach, and the bottom-up approach cannot take energy shortages and development subsidies into account, neither the top-down nor the bottom-up demand planning tools will suffice for developing regions such as Sub-Saharan Africa.

The Long-range Energy Alternatives Planning (LEAP) modelling tool allows for the combination of both the top-down and the bottom-up assessment tools, therefore allowing an assessment of the total system inputs for a developing region.

Two development scenarios for Sub-Saharan Africa (SSA) were considered (Ouedraogo, 2017):

- **Reference Scenario**, which is the expected natural gas demand under the **Business As Usual Scenario** with the main purpose of enabling quantification of all existing policies. The reference scenario is associated with an economic development that will follow past trends, a continuation of development of technology and science progress, a smooth development of urbanisation and industrialisation, and a gradual development of the transport sector with population growth rate, urbanisation, and income progress. The natural gas demand in 2040 is forecast to reach nearly 1.38 tcf in SSA, with an average annual growth rate of 6.5%; and

- **Accelerated Energy Access (AEA) Scenario**, which assumes a significant improvement in energy access. This scenario models the African Development Bank's Energy New Deal for Africa that targets universal access by 2025 in Africa. Natural gas consumption is forecast to reach 11.89 tcf in 2040, with an initial average annual growth rate of 22% for SSA until 2025, followed by 0.5% thereafter. This scenario illustrates the most ambitious approach, but this rate has not yet been met.

Overall, natural gas demand under each scenario is predicted to increase steadily until 2040, but at different growth rates. The natural gas demand forecasts are graphically depicted in Figure 6-1 (Ouedraogo, 2017).

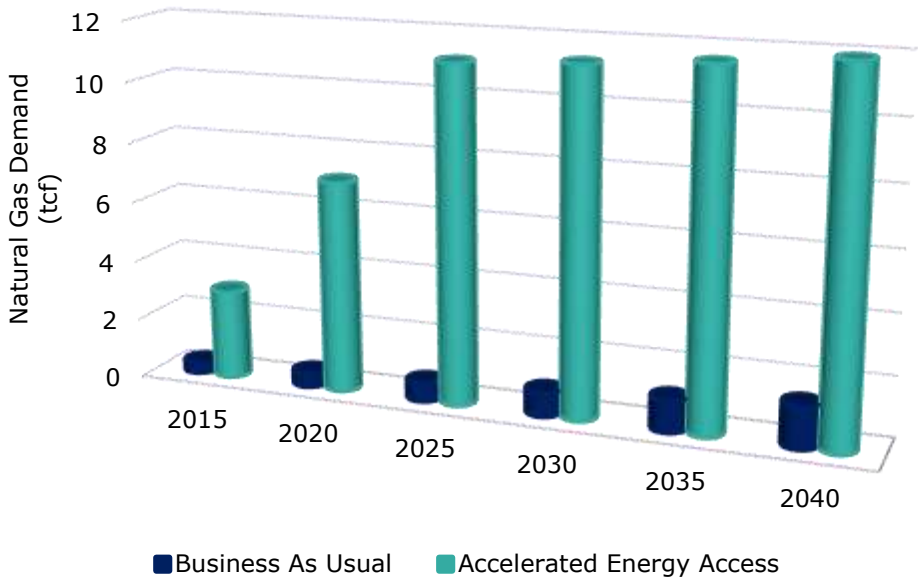

Figure 6-1: SSA Natural Gas LEAP Forecast

The Business As Usual and Accelerated Energy Access scenarios represent alternative development pathways and is indicative of the lower and upper limits of future natural gas demand in SSA, respectively.

6.3. Future Gas Demand from Power Sector

To meet the National Development Plan for South Africa by reducing the power generation's dependency on conventional coal, more gas-to-power facilities must be developed (Department of Energy, 2016) (National Planning Commission, 2012). To enable this development, the natural gas distribution network will have to be upgraded to meet the demand where it is needed.

Distribution pipelines (most economical option from source to consumers) to the following gas-to-power generation facilities are required (Department of Energy, 2019):

- Avon OCGT (KZN);
- Dedisa OCGT (EC);
- Ankerlig (WC);
- Gourikwa (WC);
- Acacia (WC); and
- Port Rex (EC).

Gas could play a crucial role in moving South Africa towards transactive energy, where utilities move towards customer centric demand, in that grids become less passive and deterministic, and more active and stochastic, as it has features which are flexible and modular enabling a decentralised system. The following coal-fired power stations are reaching end of life cycle before 2030 and distribution pipelines to facilitate partial or complete conversion to natural gas are required (Department of Energy, 2019):

- Arnot Power Plant (MP);
- Camden Power Plant (MP);
- Grootvlei Power Plant (MP);
- Hendrina Power Plant (MP);
- Kendal Power Plant (MP); and
- Kriel Power Plant (MP).

The opportunity associated with partially or completely converting mothballed coal fired power plants will save substantial time and capital expenditure when compared with building new generation facilities and present the opportunity of recovering and/or preventing associated job losses.

The City of Tshwane is also planning to revive plans to lease and upgrade its two power stations:

- Rooiwal Power Plant (GP); and
- Pretoria West Power Plant (GP)

with the aim of transforming the feedstock usage from anthracite (a grade of coal that is more profitable to export) to natural gas (IOL, 2019).

6.4. Future Gas Demand from Non-Power Sectors

6.4.1. Petroleum Sector

South Africa has a sizeable capital stock and management capacity to produce fuel from gas. Unfortunately, South Africa is a net importer of petroleum products, indicating a lack of local production capacity or efficiency. PetroSA's purpose-built GTL refinery, with a design capacity of 45,000 bbl/day, is currently limited to one reformer and one synthol train mode because of the declining gas reserves.

The national petroleum demand for 2020 was approximately 23,185 ML, with South Africa currently producing approximately 2% of its petroleum products from gas, 20% from coal and 78% from local crude oil refineries (which relies on imported crude oil), as illustrated in Figure 6-2 (Department of Energy, 2021) (SAIPPA, 2021).

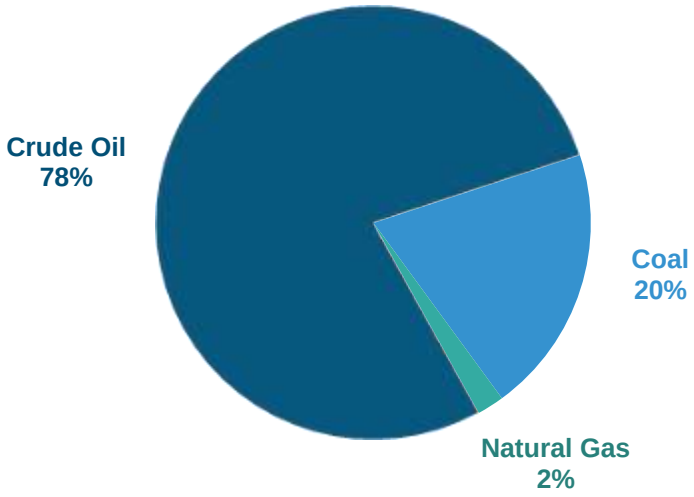

Figure 6-2: South Africa's Petroleum Product Resources

6.4.2. Transport Sector

South Africa has been in the backend of the global revolution to find a cleaner, environmentally friendlier, and mostly, a more economical source of fuel in the public transport sector.

Gas is a cheaper and cleaner alternative to traditional fuels of diesel and petrol and its availability in South Africa will not only provide a cheaper, more cost-effective fuel alternative, the additional environmental benefits will also impact the country's economic future.

Focusing on public transport fleets will allow for refuelling from the same station since these fleets run circular routes.

6.4.2.1 Taxi Industry

The taxi industry is the most important part of South Africa's public transport system. The taxi industry employs more than 600,000 people and transports over 15 million commuters per day, according to the taxi council. Commuter utilization of taxis, as their daily mode of transport, has increased by 25% over the past five-year period, representing 75% of all public transport. Taxis are the backbone of South Africa's public transport, and critical for lower-income groups to commute to work, to consider job opportunities and to link people with services.

There are approximately 250,000 minibus taxis currently doing business in South Africa, consuming close to 3 billion litres of fuel annually (SA Taxi, 2018). Most of these taxis are operating in Gauteng, followed by KwaZulu-Natal, Mpumalanga and the Western Cape. Faced with rising petrol prices which lead to fare hikes for millions of commuters, the multibillion-rand taxi industry is looking at gas as an alternative source of fuel.

A pilot study conducted by CNG Holdings, regarding the potential fuel cost saving associated with the conversion, documented a fuel cost saving of nearly 44% (The Citizen, 2019).

The initial capital expenditure is recovered in lower fuel prices, with savings ranging between 24% - 44% depending on the route operating conditions, level of petrol displacement and efficiency. To date, over 1,200 taxis have been successfully converted in South Africa, leaving a huge portion of the transport industry to be leveraged.

6.4.2.2 Bus Industry

According to the South African Bus Operators Association (SABOA), there are approximately 25,000 busses in South Africa, of which 19,000 are involved in public transport. These busses travel collectively nearly 1.4 billion kilometres annually, consuming close to 506 million litres of diesel. The bus industry provides direct employment for approximately 34,200 people throughout the country, with nearly 171,000 people indirectly dependent on the industry for their livelihood (Arrive Alive, 2019) (Megabus, 2016) (SABOA, 2019).

The City of Johannesburg was one of the first cities in Sub-Saharan Africa to run a fleet on CNG converted busses and have 180 dual-fuel CNG operated busses. The City of Tshwane's Tshwane Rapid Transit (TRT) system now boasts a fleet of 80 busses that are dedicated natural gas busses. Megabus, a Unitrans subsidiary, has 10 CNG buses operational in their Free State fleet.

A pilot study conducted by Cape Advanced Engineering indicated a 19.2% reduction in the fuel operating cost for a dual-fuel bus (71% diesel substitution) compared to a standard diesel-operated bus, in addition to increased engine life expectancy and maintenance cycles (Cape Advanced Engineering, 2014).

6.4.3. Industrial Sector

The South African Industrial Gas Users Association's (IGUA-SA) members consume approximately 0.04 tcf annually. IGUA-SA current members are ArcelorMittal, Consol, Mondi, PFG Building Glass, Ceramic Industries, Tronox, Columbus Stainless, South32, ABInBev, Lanxess and Illovo. These industrial companies combined economic contribution amounts to more than R 150 billion per annum, providing employment for over 46,000 South Africans. An additional 0.007 tcf is consumed by smaller enterprises, households, hospitals and the transport sector annually (IGUA-SA, 2019).

There is an existing disconnect between stable natural gas supply and the growing demand for gas. The industrial sector consumes approximately 0.04 tcf annually but has an actual gas demand of 0.11 tcf (IGUA-SA, 2019). There is an established market within the industrial sector with 0.07 tcf demand to be leveraged annually.

7. Gas Infrastructure

7.1. Existing Infrastructure and Short-Term Plans

7.1.1. Transmission Network

Natural gas at present is almost entirely transported to customers via transmission, distribution and reticulation pipelines, as depicted in Figure 7-1. Appendix C contains maps depicting the provincial natural gas pipeline infrastructure (NERSA, 2019).

Figure 7-1: Main Natural Gas Transmission and Distribution Pipelines

The main natural gas transmission pipelines are:

- 1,080 km transmission pipeline network owned and operated by Sasol Gas;
- 865 km transmission pipeline from Mozambique to Secunda owned by ROMPCO;
- 573 km Lilly transmission pipeline owned by Transnet running from Secunda to Durban (methane rich gas transmission pipeline); and
- ±100 km pipeline owned by PetroSA for the transmission of gas for own use to GTL plant in Mossel Bay.

The ROMPCO pipeline was recently upgraded to 0.19 tcf annual capacity. Sasol Gas has an annual transmission capacity of nearly 0.13 tcf of natural gas and 0.03 tcf of methane rich gas.

7.1.2. Distribution Network

7.1.2.1 Sasol Gas Owned Network

Sasol Gas has 355 km distribution pipelines from Secunda that connects Pretoria, Johannesburg, and Sasolburg, as well as a distribution network that links off the Transnet gas transmission pipeline to customers in KZN.

Gauteng's inland distribution network is fed at a pressure of 4,500 kPa. The distribution network has an annual capacity of 0.07 tcf. These pipelines supply the various low-pressure distribution areas as well as some direct customers. Where these lines enter the various distribution areas, a pressure reduction station reduces the pressure to 625 kPa.

Mpumalanga's distribution network receives methane-rich gas produced and supplied by Sasol Synfuels. The distribution network supplies the Secunda-Witbank-Middelburg pipeline. The normal maximum operating pressure for this pipeline is 3,000 kPa and the annual capacity of this distribution network is 0.01 tcf.

KwaZulu-Natal's distribution network receives the same methane-rich gas supplied to Mpumalanga's distribution network, via Transnet's Lilly pipeline. The operating pressure of the pipeline is 5,300 kPa, with a maximum operating pressure of 5,900 kPa, and an annual network capacity of 0.02 tcf.

7.1.2.2 Spring Lights Gas Owned Network

Spring Lights Gas (SLG) provides industry with methane rich gas through an extensive pipeline network directly from the Lilly pipeline in KZN. SLG has recently expanded into supplying CNG to clients who are not connected to the piped gas network, via virtual pipelines, with Hulamin being their first large client. SLG has obtained a trading license for Gauteng and will be expanding their operations into the province.

7.1.2.3 CNG Holdings Gas Network

CNG Holdings, subsidiary NGV Gas, has a CNG public filling station at Langlaagte, Johannesburg, as well as an in-house filling station at the City of Johannesburg's Braamfontein depot (CNG Holdings, n.d.). CNG Holdings also established a mobile CNG filling station to refuel the City of Tshwane's CNG rapid transit buses and is constructing a permanent CNG filling station at the bus depot. CNG Holdings also has a mother station, with the capacity to compress 0.002 tcf annually, adjacent to the Sasol and Egoli Metering Stations, as well as retrofit filling stations in Dobsonville, Soweto.

7.1.2.4 Novo Energy Gas Network

Novo Energy has launched its large-scale Natural Gas Compression (NGC) facility at the Highveld Industrial Park in eMalahleni, Mpumalanga (MechChem Africa, 2019). The eMalahleni NGC facility is Novo's thirteenth and largest facility, with established facilities in the greater Johannesburg area.

7.1.2.5 Tetra4 Gas Network

Tetra4 supplies, installs and maintains fuel storage and dispensing equipment at "client-owned depots" to make natural gas more accessible to the transport industry. Tetra4 currently supplies ten dedicated natural gas buses to a company in Virginia, in addition to a major South African conglomerate with CNG for 15 heavy-duty trucks in the form of diesel dual fuel.

7.1.2.6 Delta Natural Gas Energy Network

Delta Natural Gas (DNG) Energy has received final authorisation from Transnet National Ports Authority to begin ship-to-ship bunkering operations in the Port of Coega, in the Eastern Cape. The next phase requires finalisation of terminal infrastructure at Algoa Bay and delivery of the storage and bunkering equipment. The deployment of the 125,000 cbm floating storage unit is anticipated to enable DNG to cater to the emerging marine LNG demand, coupled with land-based opportunities in the mining, industrial and transport sectors (Engineering News, 2020) (BunkeringSpot, 2021).

7.1.3. Reticulation Network

7.1.3.1 Egoli Gas Owned Network

Egoli Gas has a 1,200 km high pressure gas reticulation network and another 2,000 km low pressure gas reticulation network within the greater Johannesburg Metropolitan area. The high-pressure line is operated at 20 kPa and forms the backbone of the system, while the low-pressure line feeds domestic demand at 3 kPa.

8. Regulatory Framework

The Natural Gas Regulatory Framework establishes policies for the monetisation of natural gas (both associated and non-associated gas) in existing and new concessions.

This section offers an overview of the key legislation and regulatory structure governing the natural gas sector in South Africa.

8.1. South Africa Regulatory Overview

South Africa has the most developed regulatory framework for downstream gas in Southern Africa.

8.1.1. Established Regulatory Framework

The South African White Paper on Energy Policy (1998) states that the government is committed to the development of the gas industry.

The Gas Act (48/2001) provides regulatory framework for the construction and operation of gas transmission, storage, distribution, liquefaction, and re-gasification facilities, as well as gas trade.

The Mineral and Petroleum Resources Development Act (28/2002) and the International Trade and Administration Act (71/2002) act as frameworks for gas regulation in South Africa.

The National Environmental Management Act (107/1999) provides the legislative environmental management in South Africa, defining principles for decision-making on matters affecting the environment. Under the National Environmental Management Act (107/1998) companies are required to make financial provision for the rehabilitation and management of potential negative environmental impacts. Exploration and production activities cannot commence without environmental authorization granted in terms of the National Environmental Management Act (107/1999), prior to the granting of which an environmental impact assessment investigating the potential impact of the proposed activity must be conducted.

The Draft Gas Amendment Bill (2020) is supportive and facilitative of investment in development of integrated energy projects, including gas-to-power projects. The Bill will largely introduce a mechanism that allows the Minister of Mineral Resources and Energy to direct the development of new gas infrastructure including pipelines, storage, and regasification facilities for imported liquefied natural gas. The Bill will also encompass the midstream elements of the gas value chain, while upstream oil and gas legislation, responsible for regulating the exploration and production of oil and gas, is under development.

The import of natural gas is regulated primarily by the International Trade Administration Act (71/2002). A permit is required in order to import petroleum gas and other gaseous hydrocarbons. Bearing in mind that South Africa does not currently export natural gas, there is currently no legislated position on the export of natural gas. Furthermore, the Gas Act (48/2001) requires an owner of an operation involving the importation of gas to register with the Regulator.

8.1.2. Gas Regulator

Gas regulatory functions are performed by the National Energy Regulator of South Africa (NERSA). NERSA regulates the electricity, piped-gas and petroleum pipeline industries, in addition to being the competent licensing authority under the Petroleum Pipelines Act (60/2003) and the Gas Act (48/2001). The Gas Act (48/2001) is currently under review.

NERSA is mandated to monitor and approve piped-gas transmission and storage facilities but is not currently mandated to regulate distribution tariffs. Gas distribution tariffs will however be regulated in future once the Gas Amendment Bill (B9-2021) is enacted.

8.1.3. Domestic Gas Policies

The principal legislation governing the exploration and production of natural gas is the Mineral and Petroleum Resources Development Act (28/2002).

Petroleum resources belong to the nation while the State, via the Minister of Mineral Resources and Energy acts as the custodian thereof, with the responsibility of regulating and promoting petroleum development in South Africa. The Minister of Mineral Resources and Energy is empowered to grant or refuse applications for reconnaissance permits, technical cooperation permits, exploration rights and production rights and may initiate "licensing rounds".

The Petroleum Agency of South Africa (PASA) is responsible for promoting and regulating exploration for, and exploitation and production of petroleum. In general, it performs an advisory and administrative role which includes receiving, evaluating and making recommendations to the Minister of Mineral Resources and Energy on applications for petroleum permits and rights and monitoring compliance with permits and rights.

NERSA has the mandate to set the maximum prices for gas distributors, and all classes of customers, where there is inadequate competition in the gas industry.

8.1.4. Enablers

The fiscal regime that applies to the upstream gas industry in South Africa consist primarily of corporate income tax and royalties. The Tenth Schedule to the Income Tax Act (58/1962) deals with the taxation of upstream exploration and production activities and has favourable tax provisions for gas companies. A gas company may deduct all expenditures and losses incurred with respect to exploration and post-exploration. A further deduction is permitted over and above the expenditure incurred, which includes 100% of all capital expenditures incurred in respect of exploration activities and 50% of all capital expenditures incurred in respect of post-exploration activities. As a result, a gas company may recognize a total deduction equal to 200% and 150% of its capital expenditures related to exploration and post-exploration, respectively.

The Mineral and Petroleum Resources Royalty Act (28/2008) provides for the imposition of a royalty on the "transfer" of mineral resources extracted from within South Africa.

Royalties are payable when mineral resources extracted from within South Africa are "transferred", which includes the disposal or consumption thereof. Royalties are calculated in terms of a particular formula and the maximum royalty percentage is capped at 5% for refined mineral resources and 7% for unrefined mineral resources.

The Carbon Tax Act (15/2019) aims to provide for the imposition of a tax on the carbon dioxide (CO_2) equivalent of greenhouse gas emissions and provides significant tax-free emission allowances.

8.1.5. Established Bilateral Agreements

South African Government signed a bilateral investment treaty (1997) and a cross-border gas trade agreement (2001) with Mozambique. A bi-national gas commission was also established to oversee gas movement between Mozambique and South Africa.

To facilitate trade of natural gas between Namibia and South Africa, a bilateral trade agreement was signed in 2003.

A Cooperation Agreement was signed between the Government of the Republic of South Africa and the Government of the Republic of Angola in the field of Petroleum.

The bilateral trade agreement between South Africa and Zimbabwe was terminated on 20 November 2018 and the two countries are now trading under SADC Free Trade Area. Both countries are participating in Tripartite Free Trade Area and African Continental Free Trade Area negotiations.

8.1.6. Legislative Gaps, Overlaps and Barriers

Even though South Africa has one of the most regulated natural gas sectors, legislation still contains weak enforcement mandates.

The Petroleum Agency of South Africa regulates gas exploration, production and prices. Reconnaissance, exploration and production rights are all controlled by the Mineral and Petroleum Resources Development Act (28/2002). Gas production and importation is registered at NERSA in terms of the Gas Act (48/2001) and Piped Gas regulations were promulgated to set out process and procedure to enhance the Gas Act (48/2001). Local Government (municipal governance), in conjunction with gas sector players, are responsible for reticulation of gas, but NERSA monitors the gas prices. As a result of several regulating bodies playing a part in the administration and management of activities in the gas sector, and the risk of confusion or delay

to society and players in the gas market, streamlining of regulatory processes to facilitate development in the gas industry should be considered.

Environmental legislation is of particular importance, however adherence to environmental regulations (National Environmental Management Act (107/1998): Environmental Impact Assessment Regulations) can form a barrier to entry as the requirements are time consuming and expensive to fully comply, including additional municipal and national authorisation requirements based on the Spatial Planning and Land Use Management Act (16/2013).

9. Gas Economy and Roadmap

Natural gas will play a very important role in South Africa in the future and as the country's dependency on natural gas grows, the domestic infrastructure will need to be developed. The roadmap sets out a high-level agenda for gas sector reforms.

9.1. National PESTEL Analysis

The PESTEL analysis is a tool used for environmental and market analysis and furthermore used to support strategic decision making.

The PESTEL analysis aims to address all the political, economic, social, technological, environmental and legal factors, as illustrated in Figure 9-1. The PESTEL dimensions were researched as part of the macro-economic analysis to establish the current dimensions that could impact national natural gas development.

The main objective of the PESTEL analysis was to assess South Africa's business environment relating to the global market and to provide a structure for investigating and analysing the external marketing environment. South Africa is considered to be one of the most developed countries in Africa and plays a considerable role in the African economy and politics.

9.1.1. Political Factors

Under the Copenhagen Accord, South Africa committed to reduce emissions below BAU by 34% in 2020, and by 42% in 2025.

The government is currently both promoting and supporting the development of the gas market in South Africa, with the Integrated Resource Plan (IRP 2019), setting out a new direction in energy sector planning, which includes increased adoption of natural gas. Eskom's ongoing financial solvency and plant reliability issues continue to expose the country's future to unreliable and unsecure energy supply. Urgent decisions on structural changes are required in order to address security of energy supply.

The government's current state of support has enablers as discussed in Section 8.1.4 which will aid in the development of the natural gas market in South Africa.

International political relationships and agreements will impact the global collaboration, creating possible joint ventures across borders and comprehensive collaboration efforts in the industry, including, among other, production, technical services, distribution, sourcing, etc.

There are no signs of policy-driven emissions reductions in the near future for emissions-intensive subsectors as steel production and mining in context of the ongoing economic stagnation in South Africa.

South Africa has several natural gas opportunities for local natural gas production, either from conventional (onshore/offshore) or unconventional (shale gas/coal bed methane) sources. The presence of significant amount of gas reserves in a country can increase corruption, which is one of the side effects known globally as the "resource curse", presenting a potential barrier for foreign gas companies to invest.

The South African political environment is often clouded by mismanagement, political intolerance and populist protests, which could slow down natural gas development.

9.1.2. Economic Factors

Political stability and policy certainty are a pre-requisite for any country's economic growth. In South Africa, political stability can ignite economic growth and generate much-needed employment, especially for the millions of young people who are neither in education nor employment.

Covid-19 is continuing to have a major impact on South Africa's economy, due to external demand and domestic activity. South Africa's annual real gross domestic product (GDP) decreased by 7.0% in 2020, following an increase of 0.2% in 2019. This was primarily led by decreases in manufacturing; trade, catering and accommodation; and transport, storage and communication sectors, while the agriculture, forestry and fishery industry increased by 13.1% in 2020. South Africa's GDP did however increase at an annualised rate of 6.3% in the fourth quarter of 2020. The World Bank projects 2021 GDP growth to rebound to 3% in 2021.

Given population growth, GDP per capita has been close to nil since 2014, leaving little room to reduce poverty. Given the severe economic contraction due to the pandemic in 2020, the World Bank estimates poverty to increase by 2 million people.

Implementation of prudent macroeconomic policies together with structural reforms to raise potential growth and lower the cost structure of the economy remains urgent.

Investment prospects will continue to be limited in the absence of structural reforms and the escalation of trade tensions could have further negative impacts.

The private sector is currently held back in its long-term investment in gas infrastructure due to regulatory uncertainty surrounding the continuance of relative tax benefit of natural gas fuels, which are VAT-ed, and conventional fuels, which are subject to fuel taxes. High upfront investments costs also provide an obstacle as private-sector finance is difficult to obtain in practice.

A weak economy will cause new corporations to be cautious when thinking of expanding business into South Africa. It also makes it more difficult for businesses within South Africa to branch out.

Strengthening investment, including foreign direct investment (FDI), will be critical to propel growth and create jobs. The development and expansion of the gas market in South Africa will attract various new industries and generate numerous new opportunities. These new industries and opportunities will stimulate economic growth through foreign investments, job creations, etc.

Standard & Poor's credit rating for South Africa stands at BB- with stable outlook. Moody's credit rating for South Africa was last set at Ba2 with a negative outlook. Fitch's credit rating for South Africa was last reported at BB- with negative outlook. The credit rating decisions reflect the high and rising government debt, which was exacerbated by the economic shock triggered by the Covid-19 pandemic.

The Centre for Risk Analysis report notes a risk for further currency weakness, which means that South Africa may yet drift into a stagflationary environment, defined as persistent high inflation combined with high unemployment and stagnant demand in a country’s economy. The results of the Quarterly Labour Force Survey for the second quarter of 2021, released by Statistics South Africa, indicate that the official unemployment rate increased by 11.1% to 34.4% compared to the second quarter of 2020.

The annual inflation rate in South Africa rose to 3.2% in March 2021, slightly up from 2.9% in February 2021. This is in line with market expectations and moving above lower band of the South African Reserve Bank's target range of 3% to 6%. The projections for 2021 and 2022 declined by 0.3%, forecast to average at 3.9% and 4.2%, respectively.

South Africa is currently more dominant in the midstream to downstream sectors of the gas value chain. Total’s latest Brulpadda and Paddavissie discoveries off the southern Cape coast, Renergen’s exploration activities in Virginia and the southern Karoo Basin’s shale gas create the opportunity for South Africa to move into the upstream sector of the gas value chain. The shift into the upstream sector will have a significant economic benefit for the country, since most

costs in the value chain are within the upstream sector due to the high capital expenditure associated with exploration and production activities.

Treasury could also benefit from using natural gas as transport fuel, as these could be locally produced as opposed to conventional fuels which are imported at the marginal level (or manufactured from imported crude oil, which represents 90% of their manufactured value). The transport sector conversion would present a significant increase in local economic activity, with associated forex savings. Displacing diesel and/or petrol could however have considerable impact on the national fiscus and the South African Revenue Service's tax collection ability since natural gas attracts significantly less tax.

Global decarbonisation strategies/pathways conclude that economy-wide fossil fuel consumption must drastically decline over the next several decades. The low-carbon energy transition provides a unique opportunity for gas in the short- and medium-term to support the transition to a decarbonized economy.

9.1.3. Social Factors

The development of the gas sector will enable social upliftment on a national level. The following factors will form part of the social upliftment:

- Job creation;
- Skills development (skilled and semi-skilled);
- Training and education opportunities (partnerships with FET's and training colleges);
- Poverty eradication and crime reduction (increase wages, etc.); and
- Improved quality of life.

The expansion of the gas market will lead to an increase in local market opportunities, where companies and individuals providing services and products are created and/or are able to upscale, and eventually even export their services or products. This creates a multiplier effect which comes about because injections of new demand for services and products into the circular flow of income stimulate further rounds of spending. The multiplier effect includes both direct opportunities and indirect (spin-off) opportunities.

The depleted rand currency and high unemployment could stifle the rising interest in entrepreneurship.

Globally, there has been an increasing awareness and focus on more environmentally friendly fuels, like natural gas, which is considered the cleanest fuel among fossil fuels.

9.1.4. Technological Factors

The development of the gas market will drive technology and innovation within South Africa's energy sector. The technology solutions and innovations will result from among other, research and development, skill transfers and collaborations with technology and innovation leaders. These technological and innovative solutions will provide additional opportunities and increase South Africa's energy sector's competitiveness within the African market.

The main barriers that the gas industry faces in adopting a new technology are:

- Uncertainty over returns;
- Skill shortages;
- Development cost;
- Uncertainty over the time to get to market;
- Insufficient funding;
- Uncertainty over gas prices; and
- Stringent regulations.

9.1.5. Environmental Factors

The entire gas value chain, from exploration to final use, affects both people and animals, as well as the earth's plants, soil, air and water. The exploration, processing, and transportation of natural gas can potentially impact the environment negatively through disturbance of land and ecosystems, groundwater contamination, gas emissions, waste management, spills, and excessive energy and water usage.. The negative environmental aspects challenge the industry's social license to operate which hinges on safety, minimum environmental impact, and maximum economic benefits.

However, natural gas is a cleaner fuel source compared to its alternatives. The development of natural gas will therefore reduce pollution and improve the general society's health conditions.

9.1.6. Legal Factors

Minerals and Petroleum Resource Development Act (28/2002) governs the acquisition, use and disposal of mineral rights and entrenches state power and control over the mineral and petroleum resources of the country.

South Africa encourages Foreign Direct Investment, although there are some restrictions on foreign shareholders.

B-BEE is a government initiative to promote economic transformation in order to enable meaningful participation in the economy by black people. Essentially, the practical working of broad-based BEE (B-BBEE) requires a business to ensure that it measures its broad-based BEE

empowerment status based on the Amended Codes of Good Practice. Unrelated mining activities are required to adhere to the BBBEE regulation and BBBEE influences the ownership, management control, skills development, enterprise and supplier development, as well as the socio-economic development subsections of the business.

The aim of the National Environmental Management Act (107/1998) is to provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote cooperative governance and procedures for co-ordinating environmental functions exercised by organs of state; to provide for certain aspects of the administration and enforcement of other environmental management laws; and to provide for matters connected therewith.

The aim of the Occupational Health and Safety Amendment Act (181/1993) is to provide for the health and safety of persons at work and for the health and safety of persons in connection with the use of plant and machinery; the protection of persons other than persons at work against hazards to health and safety arising out of or in connection with the activities of persons at work; to establish an advisory council for occupational health and safety; and to provide for matters connected therewith.

The introduction of natural gas into South Africa's mainstream energy supply is an important step in the fulfilment of one of the major objectives of the White Paper on Energy Policy. The Gas Act (48/2001) aims to promote the orderly development of the piped gas industry, establish a national regulatory framework and establish a National Gas Regulator as the custodian and enforcer of the national regulatory framework.

The National Energy Regulator Act (40/2004) combines the non-technical aspects of the Electricity Regulation Act (4/2006), Gas Act (48/2001) and Petroleum Pipelines Act (60/2003) and repeals these provisions from the three Acts and establishes a National Energy Regulator to administer all three Acts and related legal instruments (regulations, levies).

After the establishment of the National Energy Regulator, the Department of Mineral Resources and Energy has promulgated the Piped Gas Regulations (2007) to promote the orderly development of the piped gas industry. A national Gas Master Plan is under development. Its objective is to provide the government with a blueprint for the development of infrastructure for future gas market developments. It is the Department of Mineral Resources and Energy's intention to coordinate natural gas infrastructure development within South Africa via this plan.

The South African natural gas regulatory overview is provided in Section 8.1.

Figure 9-1: PESTEL Analysis' Dimension

9.2. National SWOT Analysis

A SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats) for the national development of natural gas was undertaken to assess associated internal and external attributes, as illustrated in Figure 9-2.

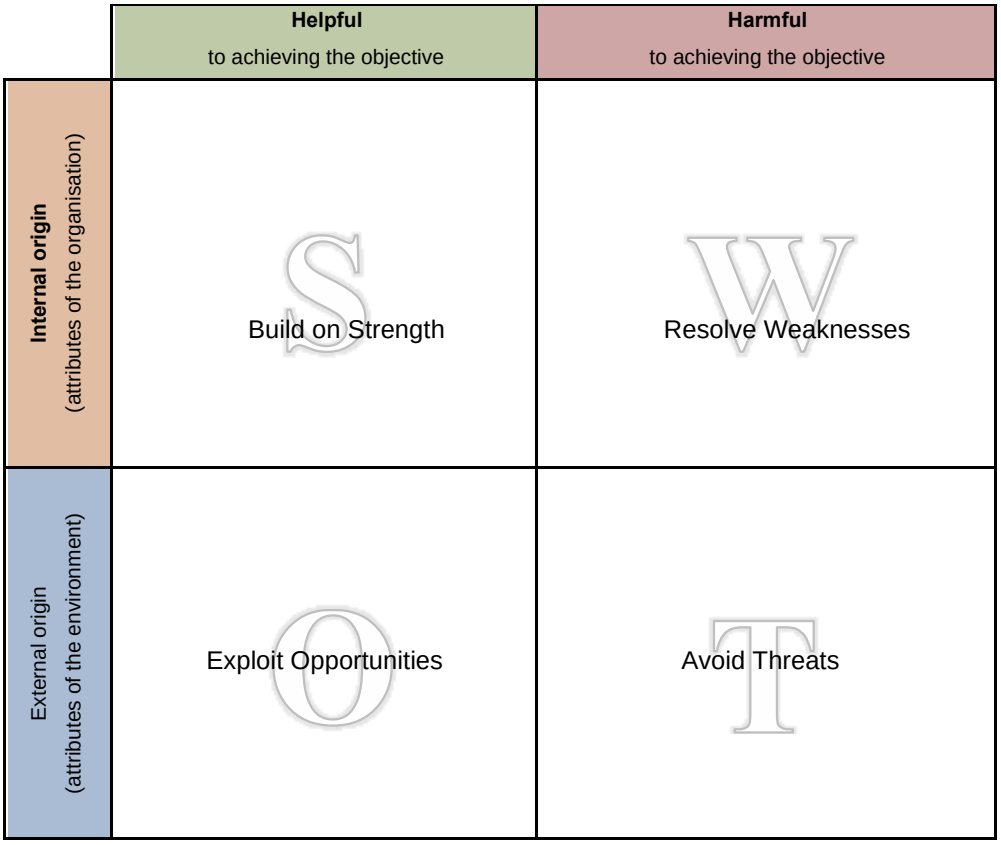

Figure 9-2: SWOT Analysis' Dimensions

The purpose of this SWOT analysis is to:

- Identify the opportunities and threats facing national natural gas development as a result of the situations, trends and events highlighted but not limited in the macro-environment; and
- Identify the country's strengths and weaknesses that have strategic implications in the context of the current and future conditions in the macro-environment.

SWOT analysis in Table 9-1 identifies the trends, events and strategic implications in the current and future conditions considering the macro-environment.

Table 9-1: National Gas Value Chain SWOT Analysis

Strengths	• Multiple indigenous reserves available. • Existing gas infrastructure available in proximity to Mozambique and Tanzania. • Gas Import - Significant regional gas discoveries (established trade agreements) • Political support from SA government as a whole and Operation Phakisa ocean economy for the gas market development. • SA government's forum (led by the Department of Trade, Industry and Competition) to monitor progress on the developments of various master plans, including gas master plan.
Weaknesses	• Minimal gas infrastructure and distribution channels. Gas infrastructure is concentrated around existing demand nodes (GP, MP and KZN). • Economies of scale – To enable competitive pricing a minimum scale of new entries are required. • Recoverability of proven indigenous reserves. • Government policy – regulations and licensing requirements. • Regulatory uncertainty - sectoral regulatory requirements and related processes not streamlined. • Lead time to supply. • Small pool of highly skilled local gas experts – especially in the short-term. • Lack of CNG usage in heavy duty public road transport due to gas supply, refuelling infrastructure and technical limitations; high conversion cost. • Lack of Road Accident Fund levies imposed on CNG/LNG as a public transport fuel. • Fragmented demand (no economies of scale; high landed cost)
Opportunities	• Gas market development and expansion will attract new industries (decarbonisation). • The gas market will stimulate national and regional growth, economic development, and social upliftment. • Job creation, skills development, diversity of workforce and improved living conditions through the development of the gas market. • Improve the energy security, national self-reliance and the energy diversity mix in SA. • LNG bunkering services. • Cleaner road/rail fuel alternative - Reduction of air pollution and health effects.

Threats	• Large upfront capital requirements for new gas markets or converting existing operations. • Switching costs to convert existing markets. • Limited local availability. • Intense competition from traditional fuel sources and renewable sources. • Political uncertainty, monopolies, mismangement and fraud.

9.3. Gas Balance

9.3.1. Role of Gas in National Development

The National Development Plan (NDP) identifies natural gas as a viable alternative to coal. The NDP further provides as one of the infrastructure priorities the construction of infrastructure to import LNG and increasing exploration to find domestic gas feedstock. Conventional and unconventional natural gas should play a more prominent role in South Africa's future energy mix, both in the electricity sector and in the liquid fuel sector (National Planning Commission, 2012).

In support of the vision for the South Africa gas programme, the Department of Mineral Resources and Energy has started developing, through its Independent Power Producer Office (IPPO), a gas-to-power IPP procurement programme. This programme will serve as an anchor for the gas market infrastructure development in South Africa. Furthermore, the RMIPPPP could serve as a catalyst for early LNG development.

The introduction of large-scale gas in the South African economy will lower the country's carbon emissions, not just from electricity generation but also from other energy sectors, including the transport sector.

The economy of South Africa can capture real benefit from developing natural gas resources, generating employment (directly and indirectly), increasing GDP (directly and indirectly), increasing foreign direct investments and with potential future exports, increase the inflow of foreign currency, stemming both from the extraction and utilization of natural gas.

9.3.2. Gas Allocation Guiding Principles

Prioritization of gas allocation and gas-related infrastructure investments should be guided by a fixed criterion.

9.3.2.1 Project Priorities

Projects focused on gas-to-power and gas-to-liquid conversions should initially be given a higher priority than others, due to the large volume of natural gas these facilities will require.

In addition to the gas conversion projects, supplying gas to industry should also be prioritized to service the existing unmet industrial gas demand and the expected depletion from 2025.

However, this prioritization should be a general guideline, as market conditions may change over time and should not deter promoters of projects from submitting project proposals that will generate other products.

9.3.2.2 Gas Price

The price of natural gas for domestic consumption should encourage its competitive use for transportation, industrial co-generation and commercial heating. The pricing regime must ensure that the price reflects efficient business operations, allowing for a fair return on investment, ensuring stability in order to promote efficient consumption of natural gas in the economy and encourage further investment to satisfy future demand. Switching from other forms of primary energy to natural gas should offer reduction in input cost for future gas consumers.

9.3.2.3 Gas Quantity

The volume of gas should be sufficient either by itself or in combination with other developers to support construction of gas infrastructure to the proposed facility.

Variations in gas demand and supply, periodically or extended, affect the pace of infrastructure investment. Stability of supply, which includes supply quality, reliability and price, is pivotal to competitiveness and overall project prosperity. Balancing supply and demand should be one of the main considerations for infrastructure planning and investment.

Development of the Gas Master Plan should therefore include supply options, demand forecast, infrastructure development, gas prices, and economic impact as minimum output variables. Optimization of gas infrastructure development, given various supply-demand scenarios should be at the heart of gas master planning.

9.3.2.4 Project Development Timeframe

Prioritization should be given to projects that can be constructed and come into operation as soon as gas is made available, in addition to projects utilizing domestic natural gas reserves. Development risk analyses and management plans should be considered to determine timeframe confidence levels.

9.3.2.5 Project Location

Prioritization should be given to projects located near population centres to maximize the potential for local labour and growth in surrounding support industries. Project locations allowing for common use of facilities, eliminating duplication of investments should be prioritized to ensure a competing edge in the global market.

Prioritizing major routes for the location of CNG and/or LNG filling stations could encourage widespread adoption, especially for long haul fleets. Locations along national and regional road networks, including national and regional intersections, are commonly-recommended sites at which to build refuelling stations.

9.4. Gas Economics

9.4.1. Mode of Transport

Traditionally, natural gas has been transported safely, reliably and economically via pipelines, however not all new gas reserves are conveniently located as attention shifts to more isolated large gas reserves.

Several solutions for exploiting gas reserves are available, as depicted in Figure 9-3. Some of the solutions are fully commercial and mature technologies, while other are still in the research and development phase.

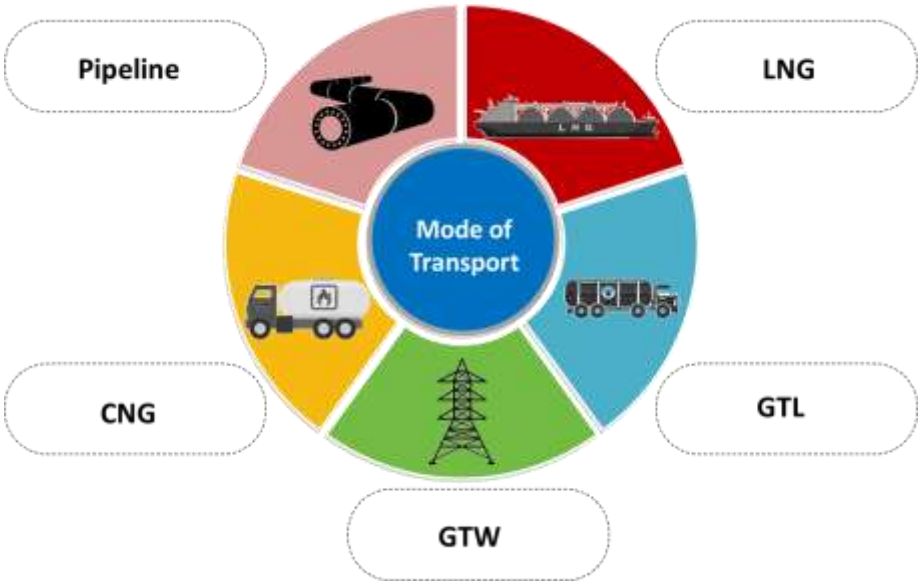

Figure 9-3: Methods of Moving Natural Gas to Market

Transport costs drive the price of natural gas due to the distance between source of supply and market. The economical mode of transportation of natural gas from source to market is predominantly dependent on the volume and distance, as illustrated in Figure 9-4 (Mokhatab, Mak, Valappil, & Wood, 2014).

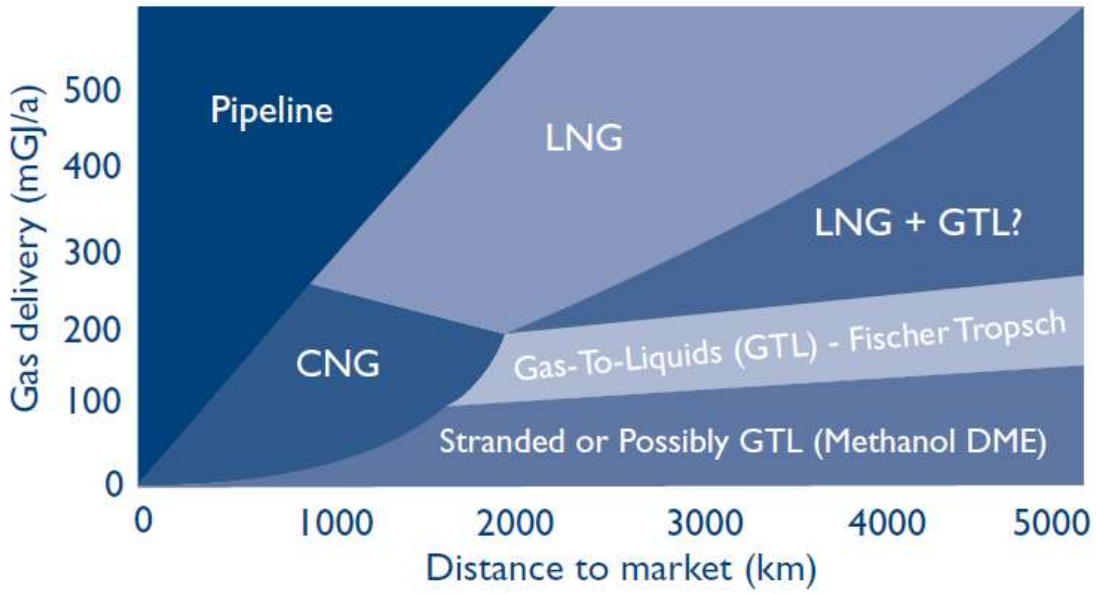

Figure 9-4: Natural Gas Transport - Volume vs. Distance

9.4.1.1 Pipelines

Pipelines are a very convenient method of transport. Once the pipeline diameter has been selected, the quantity of gas that can be delivered is fixed by the operating pressure, although an increase in quantity can be achieved through the addition of compressors along the line, as well as extra pipelines in the form of loops. The installation costs of pipelines are largely dependent on the distance, with cost being nearly proportional to distance. Transporting costs by pipeline are viable for distances up to 3,000 km, as a rule of thumb.

9.4.1.2 LNG

LNG is becoming a major gas export method worldwide. Cooling natural gas to -162 °C turns the gas into a liquid and reduces its volume by 600 times. LNG is easy and economical to ship when high volumes are required, and the reserve is in excess of 2,000 km from the market. LNG transported by maritime transport is received by a primary LNG terminal, which can be onshore or a floating storage and regasification unit (FSRU). LNG transport offers economics, flexibility and security of supply advantages, specifically for long-distance transport. LNG

economics differ from piped gas due to the material costs involved in liquefaction, shipping and regasification.

Small-scale LNG presents a niche but nascent industry that could supply end-users in areas where traditional infrastructure does not exist, or to consumers requiring liquid fuel such as road transportation, off-grid power generation and bunkering.

9.4.1.3 CNG

Natural gas can be transported in containers at high pressure. These CNG systems make transport possible either for stranded gas or for smaller quantities of associated gas. CNG transport systems are more flexible and can cope with variable gas supplies.

9.4.1.4 Gas-to-Wire (GTW)

Where the transported gas's destination is fuel for electricity generation, the opportunity exists to generate electricity at the source and transport by cable to the destination.

9.4.1.5 Gas-to-Liquid (GTL)

In GTL transport processes, the natural gas is converted to a liquid, such as syncrude methanol, ammonia, etc. and transported in a suitable tanker to the appropriate markets.

9.4.2. Trade Viability

Table 9-2 and Table 9-3 consider the most viable options for natural gas trade, either via natural gas pipelines or LNG importation, for Southern African Development Community (SADC) countries and Non-SADC countries respectively. The viability is based on the prices, supply and production statuses and new developments.

Table 9-2: Natural Gas Trade Viability – SADC Countries

Country		Advantage / Disadvantage	Viability	Mode of Transport
SADC Countries	Angola	• Restricted production • Majority committed volumes • Cooperation Agreement	Viable (unfavourable)	LNG
	Botswana	• Close proximity • Proven commercial reserves in the short-term • Initial gas already allocated (100 MW CBM-to-power project)	Viable (unfavourable)	Pipeline
	Mozambique	• Close proximity • Uncommitted volumes • Large gas discoveries and projects under development • Bilateral trade agreements • Existing pipeline infrastructure (ROMPCO) • Geopolitical risks	Viable	Pipeline LNG
	Namibia	• Close proximity • Large gas discoveries • Undeveloped gas fields • Bilateral trade agreements • Preference for local gas allocation • Marginal economic and commercial transport viability results	Viable (unfavourable)	Pipeline

	Tanzania	• Close proximity • Uncommitted volumes • Large gas discoveries and projects under development • Current gas extracted allocated for domestic use	Viable	LNG

Table 9-3: Natural Gas Trade Viability - Non-SADC Countries

Country		Advantage / Disadvantage	Viability	Mode of Transport
Non-SADC Countries	Australia	• 2nd Largest global LNG exporter • Predominantly serve the Asia Pacific region • Proximity to South Africa	Viable	LNG
	Malaysia	• Large export volumes • Predominantly serve the Asia Pacific region • Existing LNG trade corridor does not pass by SA's coastline	Viable (unfavourable)	LNG
	Nigeria	• Close proximity • Short-term LNG export capacity increase projects • Existing LNG trade corridor passing by SA's coastline	Viable	LNG
	Portfolio Suppliers	• Vast reserves/resources • Security of supply	Viable	LNG
	Qatar	• Largest global LNG exporter • Established long-term SPAs	Viable	LNG

	Russia	• Increased production • Have vast proven reserves • Geopolitical risks	Viable	LNG
	US	• Large export volumes • 45% Natural gas production increase recorded in 2018 • Existing LNG trade corridor passing by SA's coastline	Viable	LNG

9.4.3. Supply and Demand Scenarios

South Africa will need to complement demand from the power sector with industry and transport demand to result in volumes required for scale. Affordability remains critical to unlock domestic gas demand.

Varying timelines between demand, supply and trade infrastructure development will require complementary outcomes to bridge the timeline gap.

Three supply sources of natural gas are available to South Africa:

- Piped natural gas from neighbouring countries;
- Imported LNG; and
- Domestic natural gas, either from conventional or unconventional reserves.

Piped gas is higher credit risk compared to LNG and needs to be competitive for both the seller and the buyer considering the alternative of importing LNG (Standard Bank, 2019).

Initial gas demand and the development of a gas market will likely be stimulated by LNG-based gas supply, creating larger anchor demand that would trigger investments into additional gas infrastructure. Following this, related investments into indigenous conventional (offshore) and unconventional (onshore) gas explorations will occur, supplemented with increasing volumes of imported piped gas.

Mozambique presents a clear opportunity for gas trade given volumes and proximity. Various infrastructure options could possibly make trade feasible with the most likely infrastructure options being pipeline and LNG.

Uncommitted transmission pipeline capacity could potentially be utilized for tie-ins from reserves to gas markets within the area. Utilizing existing available infrastructure will not only minimize the upfront capital outlay required but also reduce social and environmental impacts.

9.4.3.1 Power Sector

Figure 9-5 depicts the location of identified power stations (coal-fired power stations reaching end of life cycle before 2030 and existing diesel-fired power stations) in relation to existing gas transmission infrastructure and potential regional suppliers (Eskom, 2019).

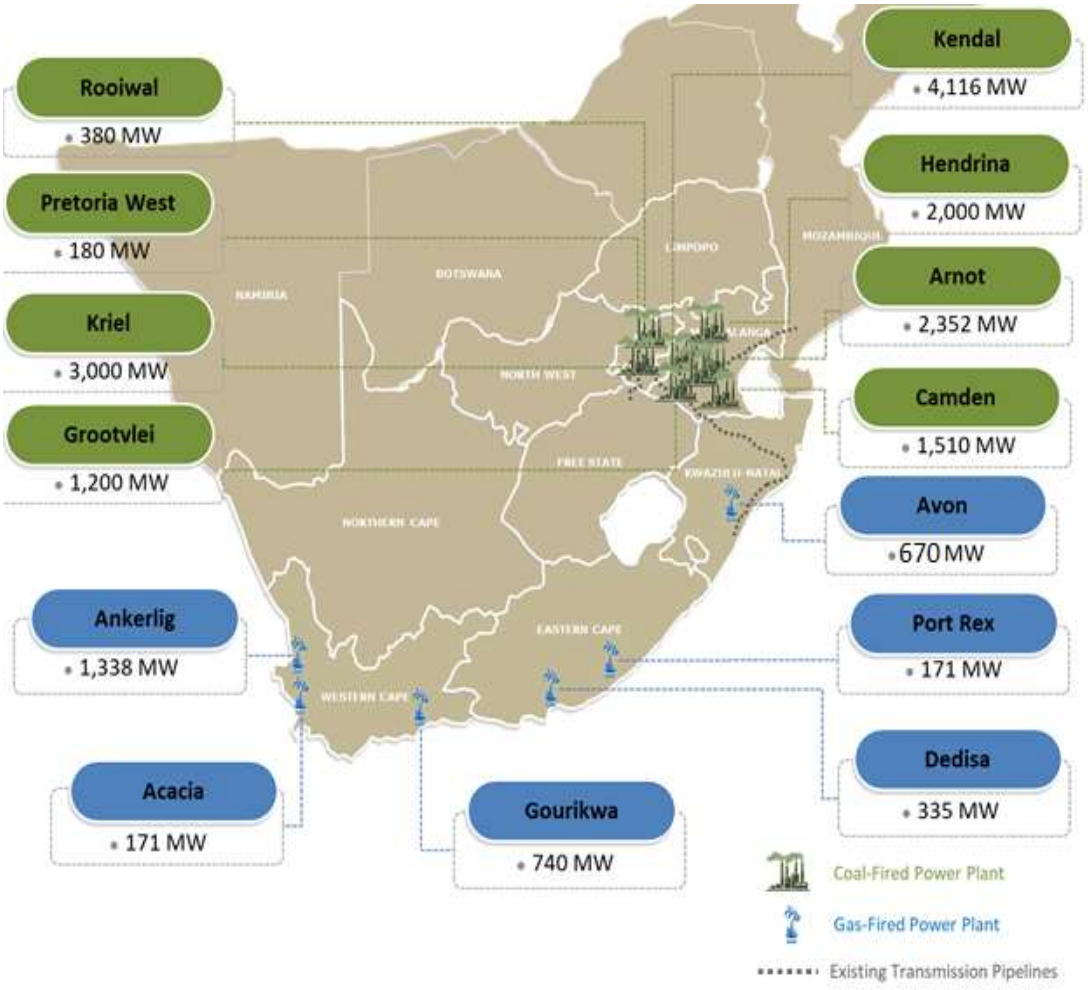

Figure 9-5: Power Sector Supply and Demand Map

9.4.3.1.1 Coal-Fired Power Stations

Most of the earmarked coal-fired power stations are located in Mpumalanga. According to NERSA, the last reported uncommitted capacity in the Secunda-Witbank-Middelburg

transmission pipeline was nearly 0.0053 tcf and the ROMPCO pipeline has 0.014 tcf uncommitted capacity in the Mozambique-Secunda transmission pipeline (ROMPCO, 2017) (NERSA, 2017).

Supplying the coal-fired power stations with natural gas sourced from Mozambique, connecting to the existing ROMPCO and Sasol pipelines, presents as the most feasible short-term supply opportunity. Alternatively, LNG imported at the Port of Richards Bay could supply the coal-fired power stations either via South Africa's existing "heavy haul" coal railway network, connecting the Port of Richards Bay to the coal mining areas in Mpumalanga, or by reversing Transnet's Lilly pipeline's flow direction and connecting to the existing infrastructure in the immediate area.

Even though Botswana is in proximity to the coal-fired power stations, the uncertainty regarding CBM volumes and the initial available gas volumes will likely be too small to justify initial pipeline infrastructure development investments.

Zimbabwe's proximity to the coal-fired power stations in Mpumalanga presents an opportunity for potential supply either through a new build pipeline or utilizing the twin existing Harare-Beira pipeline route to tie into the ROMPCO pipeline. The gas fields remain undeveloped and the prospective resource relates to undiscovered accumulations which have both a risk of discovery and a risk of development.

9.4.3.1.2 Diesel-Fired Power Stations

Transnet's Lilly Pipeline provides access to natural gas both northwards to Gauteng, as well as southwards to Durban, with a maximum capacity of 0.02 tcf. The uncommitted capacity (FY2021/21) of the Lilly Pipeline is 0.005 tcf (Transnet, 2021).

Transnet's Lilly Pipeline passes by the Avon Peaking Power Plant in KwaZulu-Natal and the potential exists to utilize the Lilly Pipeline. Additional gas will have to be secured and introduced into the pipeline in the KwaZulu-Natal region, since the transmission pipeline capacity is already constraint in the Secunda-New Castle section. Richards Bay is the closest South African port to Mozambique, which is in the process of unlocking its substantial offshore gas reserves (Club of Mozambique, 2019).

Coega embodies an optimal geographic location to support gas markets both to the east and west coasts and offers a strong integrated logistics corridor for the delivery of gas to the hinterland. LNG importation at Coega and subsequent pipeline distribution could potentially service the gas-to-power generation facilities in the Eastern and Western Cape.

Natural gas supply from Namibia to the Cape region is unlikely, despite the Kudu gas field's potential, since it remains unclear whether the Kudu gas field will be developed given the current funding uncertainties.

Importing LNG into the west coast of the Western Cape, specifically Saldanha Bay, could potentially supply Ankerlig and Acacia power generation facilities, serving as key gas customers in the area (Deloitte, 2015) (Western Cape Government, 2019).

9.4.3.2 Non-Power Sector

LNG could potentially be a more suitable option to fulfil pockets of demand along the coastal areas before the needed scale is reached to support a pipeline. A common approach to LNG importation infrastructure could be considered, whereby all three potential ports (Richards Bay, Coega and Saldanha Bay) receive natural gas over time, but with different transmission and distribution infrastructure requirements. A phased approach to ports development will benefit infrastructure investment in the medium to long term.

Once import terminals and anchor gas customers (gas-to-power generation facilities) are in place, there could be potential to extend the gas distribution network to serve energy users in some of the key industrial nodes. The network could subsequently be extended further to provide gas as an alternative energy source to households and in transport applications. Until pipeline infrastructure is expanded, natural gas transportation by way of rail and truck can be considered.

9.4.4. Potential Natural Gas Corridors

In 2014, the South African government announced Operation Phakisa in order to stimulate the country's blue economy and create an enabling environment to give industry the comfort to invest in this capital-intensive sector.

The aim of the Strategic Environmental Assessment (SEA) for the development of a gas pipeline network for South Africa is to identify and pre-assess environmental sensitivities within suitable gas routing corridors. It is envisaged that the development and operation of a gas pipeline infrastructure would follow a streamlined environmental authorization process or would be exempt from environmental authorization within the corridors identified through the SEA process.

The natural gas corridors included in SEA, with the exception of the Shale Gas corridor, is depicted in Figure 9-6. Gas infrastructure development within these identified corridors should be considered to avoid development delay resulting from environmental authorizations.

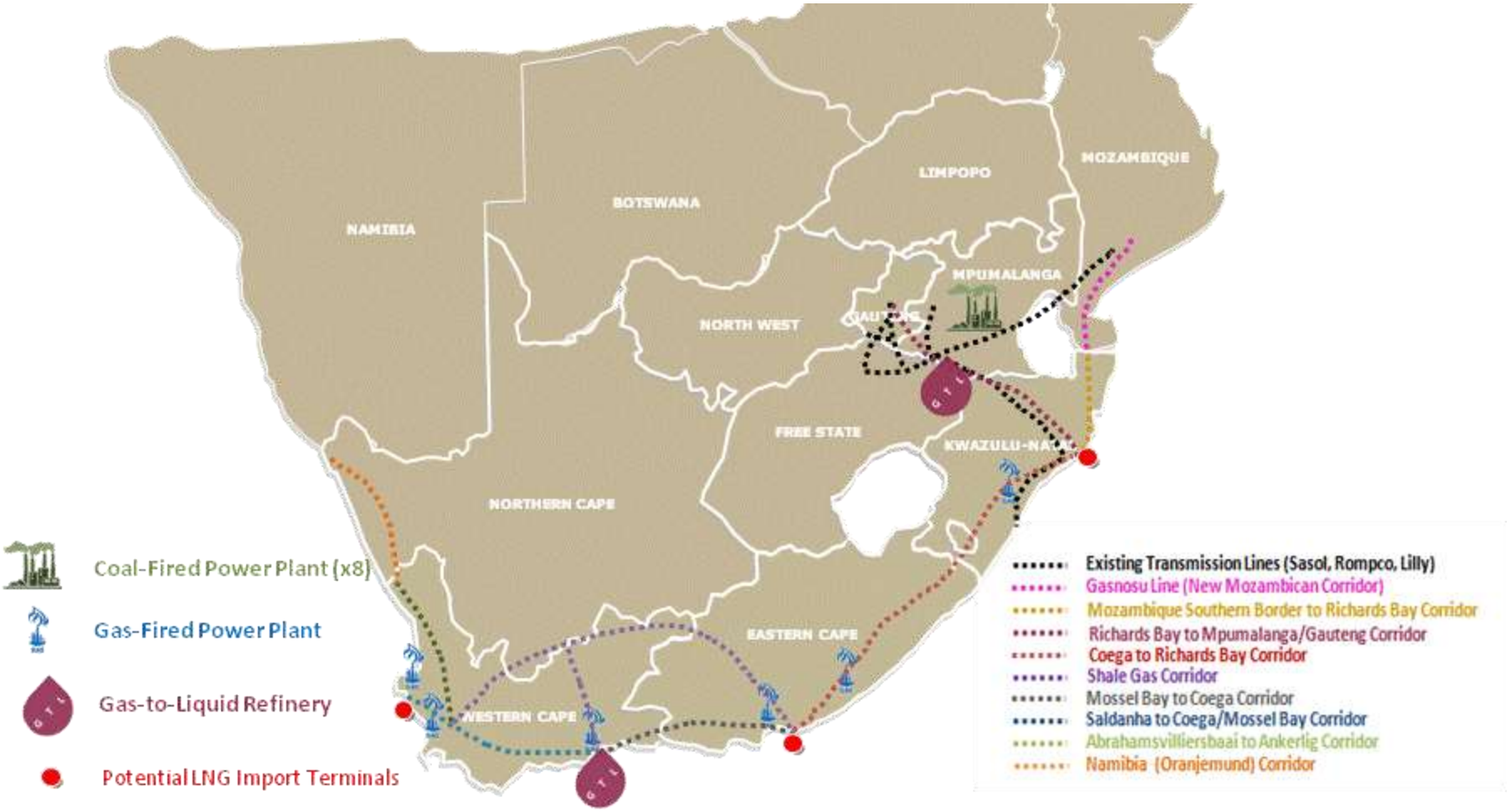

Figure 9-6: Potential Natural Gas Corridors

Document Title	Document Classification	Status	
Base Case Document	NEDLAC Consultation Document	First Draft	

9.4.5. Natural Gas Trading Hubs

The Dutch Transfer Title (TTF), Britain National Balancing Point (NBP) and United States Henry Hub (HH) are currently the only gas trading hubs classified globally as liquid. Gas prices in these trading hubs are largely determined by the interplay between supply and demand. Due to large trading volumes, clear pricing transparency and high liquidity, these trading hubs serve as good benchmark hubs for natural gas spot pricing, while Japan Korea Marker (JKM) Platts is establishing itself as a credible LNG benchmark price assessment for spot physical cargoes.

The historic hub pricing is summarised in Figure 9-7 (IEA, 2020).

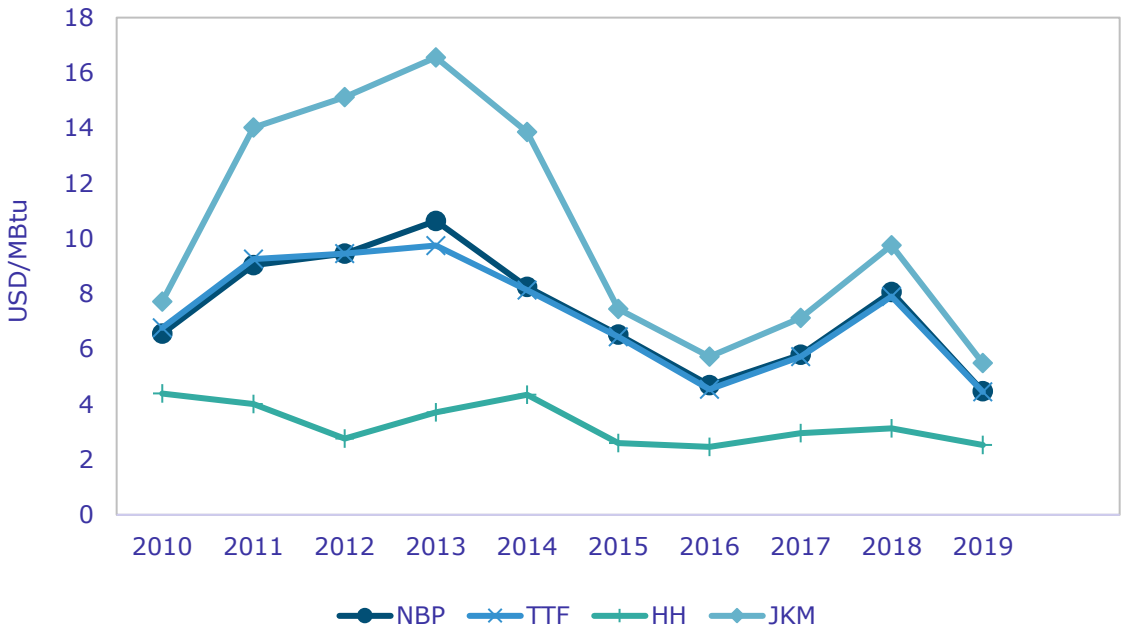

Figure 9-7: Natural Gas and LNG Spot Price Statistics

9.4.6. LNG Landed Cost

The producing domestic gas fields in South Africa are either for own-use (Petro SA's Ikhwezi project) or have signed take-off agreements (Tetra4's Virginia gas field). Potential domestic gas fields are expected to start production earliest 2028, with the Brulpadda gas field presenting the most bankable supply option.

Importation of natural gas presents the only immediate option to meet South Africa's short-term natural gas demand. Regionally, importation of natural gas via pipelines could be feasible while monetization in South Africa will require the development of LNG import facilities.

LNG landed price refers to the price that is received at the regasification terminal and are determined by a netback price for a producer at a defined location. Approximately 80% of the landed cost relates to upstream costs in the supply chain, with shipping costs varying depending on the distance between source and destination market. The location of South Africa relative to the gas trading markets suggests that the Asian and European markers will be the most relevant markets for future LNG pricing in South Africa. Figure 9-8 shows the estimated world LNG landed prices, based on a netback calculation (Federal Energy Regulatory Commission, 2021). Refer to Appendix D for historical data.

Figure 9-8: World LNG Estimated Landed Prices – March 2021

According to Standard Bank commercial observations, there are no limitations on South Africa buying LNG on commercial terms and the limited shipping distances from Mozambique, Angola and Nigeria will aid in securing good landed prices. Since South Africa's high demand period is the opposite season to the Northern Hemisphere's winter peak, South Africa could make competitive LNG purchases and take risks on spot pricing (Standard Bank, 2019).

The anticipated landed LNG pricing from the United States is estimated at US$6.50/MMBtu, while the LNG secured from Mozambique is expected to cost around US$7.07/MMBtu, with associated regasification cost estimated at US$0.60/MMBtu (~135,000 m^3 capacity) (Standard Bank, 2019).

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Appendix A: Exploration and Production Activities and Rights Holder

South Africa is potentially endowed in natural gas resources (figure A-1). The Petroleum Agency SA estimates that the country potentially holds 29 trillion cubic feet (tcf) of prospective gas resources on the south coast, and at least 4 tcf discovered gas resources. Estimates for the West Coast and East Coasts are 22 tcf and 8 tcf of prospective gas resources respectively. At least 500 billion cubic feet of gas is already discovered on the West Coast. Furthermore, the Agency estimates the country to have some 209 tcf of prospective shale gas resources, 1.3 tcf of biogenic gas, of which 139 bcf has already been discovered, and 22 tcf of coal bed methane of which 8.4 tcf is already discovered resources.

Total Energies Exploration and Production South Africa and Joint Venture partners (Qatar Petroleum, Canadian Natural Resources International, and Main Street) in Block 11B/12B on the south coast have begun to demonstrate this potential. The JV Partnership drilled two gas exploration wells in 2019 and 2020 in deep-water offshore Block 11B/12B on the South Coast of South Africa, some 175km to Mossel Bay. The 2 wells discovered circa 3 trillion cubic feet (tcf) of gas and associated condensate. The discovery has proven the existence of a deeper play, and working petroleum system on the south coast, and has affirmed South Africa as a prospective and emerging petroleum province.

There are a number of gas discoveries in the country that are either in development or near development, offshore and onshore. The estimates of gas resources and timelines to first gas shown in Table 1 below are those of the Petroleum Agency SA and should not in any way be construed as confirmation from the Operators/and or JV partners:

Table A - 1: Estimates of Gas Resources and Timelines to First Gas

Project	Approximate Contingent Reserves	Targeted First Gas Date
Brulpadda/Luiperd Development	~ 3 tcf	End 2025
Ibhubesi Gas Field	~ 504 bcf	2025
Virginia Gas	~ 215 bcf	Beginning 2022
Lephalele CBM	~ 3.5 tcf	2024/25
Amersfoort Gas	~ 3.2 tcf	Pilot: 2022, Full scale:2024/25

Brulpadda/Luiperd Development

TotalEnergies are currently finalizing the Field Development Plan (FDP) Concept for the Block 11B/12B Brulpadda and Luiperd discoveries which will accompany their application for a Production Right at the Petroleum Agency SA expected in November 2021. The first phase planned development will consist of the drilling of at least 3 gas producing wells in Luiperd, and the construction of subsea pipelines that will connect the wells to the existing state owned and PetroSA operated F-A Gas Production Facility. First gas from the first phase development is expected by the end of 2025 to supply to the gas-to-liquid (GTL) refinery and for power generation.

The second phase of the project envisages the drilling of up to 17 wells, and the construction of an additional gas production facility to process more than double the gas and condensate volumes that the existing F-A gas production platform can process. After this full field development there will be sufficient indigenous gas and condensate to supply other potential gas markets, including up to 2000MW gas-to-power electricity generation and/or supply of gas as a feedstock to the petrochemicals manufacturing industry.

Ibhubesi Gas Development, West Coast

The Block 2A which holds the Ibhubesi discovered gas fieldis situated offshore the West Coast and has estimated reserves (2P) of 540 Bcf and up to 1.3tcf. There is a Production Right over Block 2A held by Sunbird Energy (76%) and PetroSA (24%). The Production Right is currently in the Gas Market Development Period, which suspends the Production Right for a period of 5 years to allow the Production Right holders to find a market for the gas. First gas from the Ibhubesi gas field is envisaged by 2025. The development concept for the field includes three main options:

- **Gas-To-Wire -** Phased development to generate power offshore on a floating platform connected directly to the power grid.
- **Onshore LNG -** Phased development to export gas to shore via a multiphase pipeline to produce domestic LNG onshore.
- **Onshore Gas-To-Power IPP -** Phased development to export gas to shore via a multiphase pipeline and generate power onshore.

Virginia Gas

The Renergen/Tetra 4 Virginia gas development in the Free State, which has a gas resource estimated of some 215 billion cubic feet (bcf) of discovered natural gas and 7.2 bcf of helium is already in production at a pilot scale, supplying compressed natural gas to the Mega bus company to run their busses. Field development is currently underway with a 52 km gas pipeline already completed, and gas from some 16 wells is expected by the beginning of 2022 to be monetised as Liquified Natural Gas (LNG). The LNG and Helium processing facility is under construction.

Lephalele CBM Project

The Anglo Coal Bed Methane project in Lephalele, Limpopo, is situated within the Waterberg coal field, and has an estimated discovered gas resource of 3.5 tcf. Some 113 exploration wells and 10 production wells have already been drilled in the block, and first gas is expected by 2024/25. The gas will be used to run Anglo Mining Trucks that are currently operating on diesel as fuel in South Africa and Botswana.

Amersfoort Project

The Afro Energy Amersfoort project with its estimated natural gas resources of 3.2 tcf is another development that is expected to start flowing gas at a pilot scale level by April/May 2022. Full scale

production is expected to be achieved by 2024/25 to be commercialised as LNG or piped gas for gas-to-power.

Figure A - 1: South Africa's Oil and Gas Potential

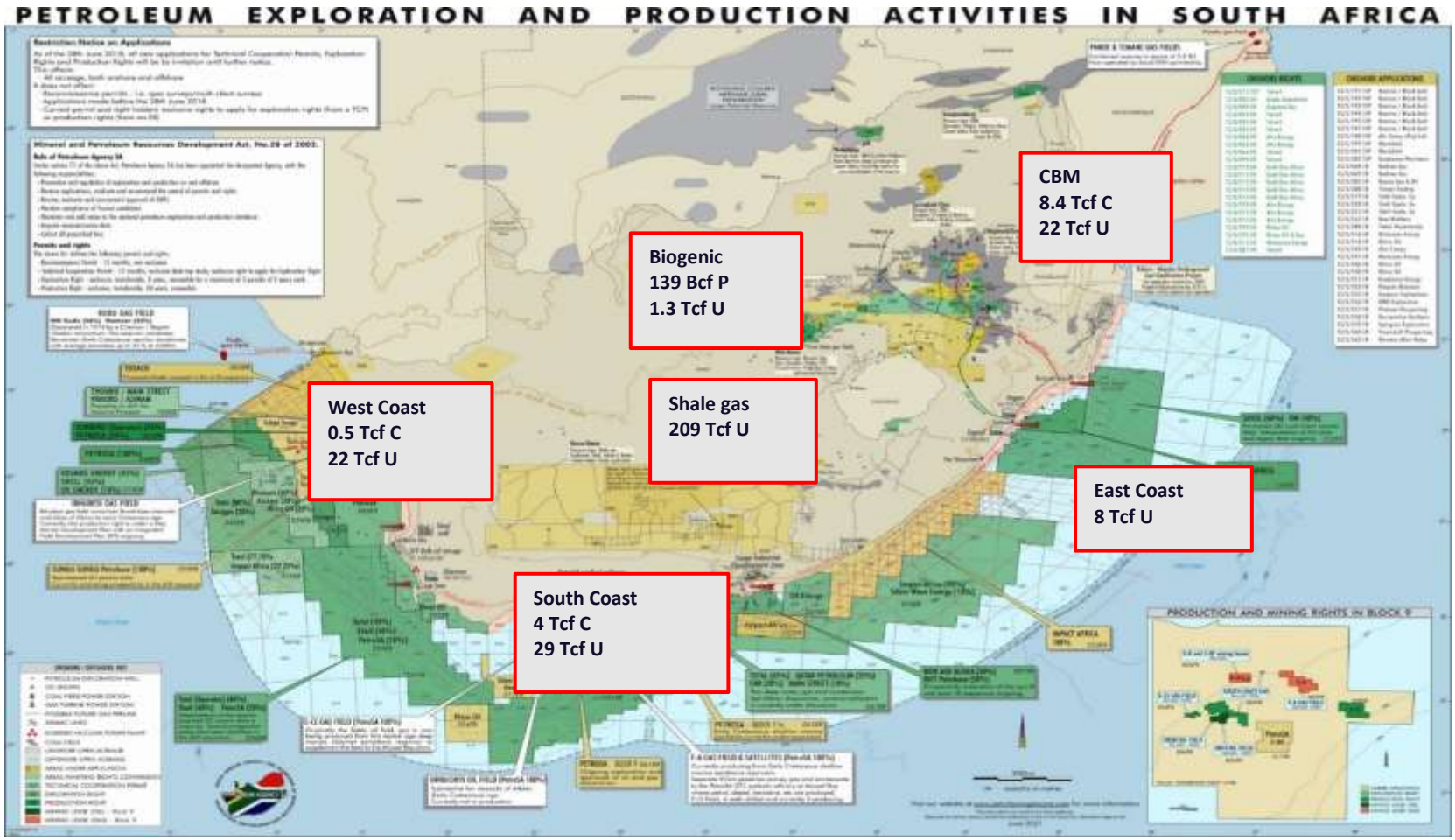


Table A - 2: Onshore Natural Gas

Reference Number	Rights Holder	Area	Type of Petroleum
12/3/009	Inert Gas Industries	Heilbron, FS	Natural Gas
12/3/027	Tetra4 (Pty) Ltd	Evander, MP	Natural Gas
12/3/029	Tetra4 (Pty) Ltd	Virginia, FS	Natural Gas
12/3/031	Tetra4 (Pty) Ltd	Evander, FS	Natural Gas
12/3/032	Tetra4 (Pty) Ltd	Virginia, FS	Natural Gas
12/3/033	Tetra4 (Pty) Ltd	Virginia, FS	Natural Gas
12/3/034	Tetra4 (Pty) Ltd	Virginia, FS	Natural Gas
12/3/038	Afro Energy (Pty) Ltd	Amersfoort NWS, MP	Natural Gas
12/3/064	Tetra4 (Pty) Ltd	Virginia, FS	Natural Gas
12/3/094	Tetra4 (Pty) Ltd	Virginia, FS	Natural Gas

Reference Number	Rights Holder	Area	Type of Petroleum
12/3/056	Afro Energy (Pty) Ltd	Amersfoort Extension, MP	Natural Gas
12/03/002	Anglo Operations Limited	Lephalale, LP	Natural Gas
12/03/068	Badimo Gas (Pty) Ltd	Waterberg, LP	Natural Gas
12/03/069	Badimo Gas (Pty) Ltd	Aliwal North, EC	Natural Gas
12/3/262	Booi Brothers (Pty) Ltd	Mutale and Malamulele, MP	Natural Gas
12/3/210	Gold One Africa (Pty) Ltd	Henneman, FS	Natural Gas
12/3/211	Gold One Africa (Pty) Ltd	Henneman, FS	Natural Gas
12/3/212	Gold One Africa (Pty) Ltd	Henneman, FS	Natural Gas
12/3/213	Gold One Africa (Pty) Ltd	Henneman, FS	Natural Gas
12/3/214	Gold One Africa (Pty) Ltd	Henneman, FS	Natural Gas
12/3/270	Afro Energy (Pty) Ltd	Volkrust, FS	Petroleum and Gas

Reference Number	Rights Holder	Area	Type of Petroleum
12/3/271	Afro Energy (Pt) Ltd	Amersfoort, MP	Petroleum and Gas
12/3/272	Afro Energy (Proprietary) Ltd	Secunda, MP	Petroleum and Gas
12/04/007	Tetra4 (Pty) Ltd	Virginia, FS	Natural Gas

Table A - 3: Offshore Natural Gas

Reference Number	Rights Holder	Area	Type of Petroleum
12/3/061	PetroSA	Block 9 & 11A	Oil, Gas and Condensate
12/3/105	Thombo Petroleum, Main Street, Simbo, Azinam, Panoro	Block 2B, NC	Oil and Gas
12/3/154	Impact Africa Limited	Blocks 2932C and others, Zululand Basin	Oil and Gas
12/3/201	NewAge/Rift Petroleum	Blocks 3426A and others, Algoa Gamtoos	Oil and Gas
12/03/067	CNR; Total, Qatar & Main Street	Block 11B/12B	Oil and Gas
12/3/224	PetroSA/Anadarko	Block 5/6 and Block 7	Oil, Gas and Condensate
12/3/223	Sungu	Mid Orange Basin	Oil and Gas
12/3/236	Sasol / Eni	Blocks 2933 and others, East Coast KZN	Petroleum
12/3/275	Silverwave Energy Pte	Blocks 2834, 2835 and others	Petroleum and Gas
12/3/276	Silverwave Energy Pte	Blocks 3229D, 3230 and others	Petroleum and Gas

Reference Number	Rights Holder	Area	Type of Petroleum
12/3/277	Silverwave Energy Pte	3519B, 3519D and others	Petroleum and Gas
12/3/231	Total E and P South Africa (Pty) Ltd	Deep Offshore South Outeniqua Basin	Petroleum and Gas
12/3/257	OK Energy Limited/Equinor, Total	Eastern Algoa Basin, Offshore, EC	Oil and Gas
12/3/252	Impact Africa Limited	Transkei Margin and the Deep Water Algoa Basin, Offshore	Oil and Gas
12/3/274	OK Energy Limited, Kosmos/Shell	Ultra-Deep – Offshore NC	Petroleum
12/3/339	Ricocure (Pty) Ltd, Azinam Limited & Africa Oil SA Corp.	Block 3B/4B, Offshore, West Coast	Petroleum
12/3/343	Sezigyn (Pty) Ltd	Deep Western Orange Basin, Offshore, West Coast	Petroleum
12/3/347	Ricocure (Pty) Ltd & Azinam Limited	Orange Basin, Offshore	Petroleum
12/3/335	Impact Africa Limited/Total E&P South Africa B.V	OBW, Offshore	Petroleum
12/04/003	Sunbird/Forest/PetroSA	Block 2A - Offshore	Oil and Gas

Reference Number	Rights Holder	Area	Type of Petroleum
12/04/002	PetroSA	South Coast Gas	Oil and Gas
12/04/004	PetroSA	Sable Field	Oil and Gas
12/04/008	PetroSA	FO Field	Oil and Gas
12/04/005	PetroSA	FA-EM	Oil and Gas
12/04/006	PetroSA	Oribi	Oil and Gas

Appendix B:
Natural Gas Licensees

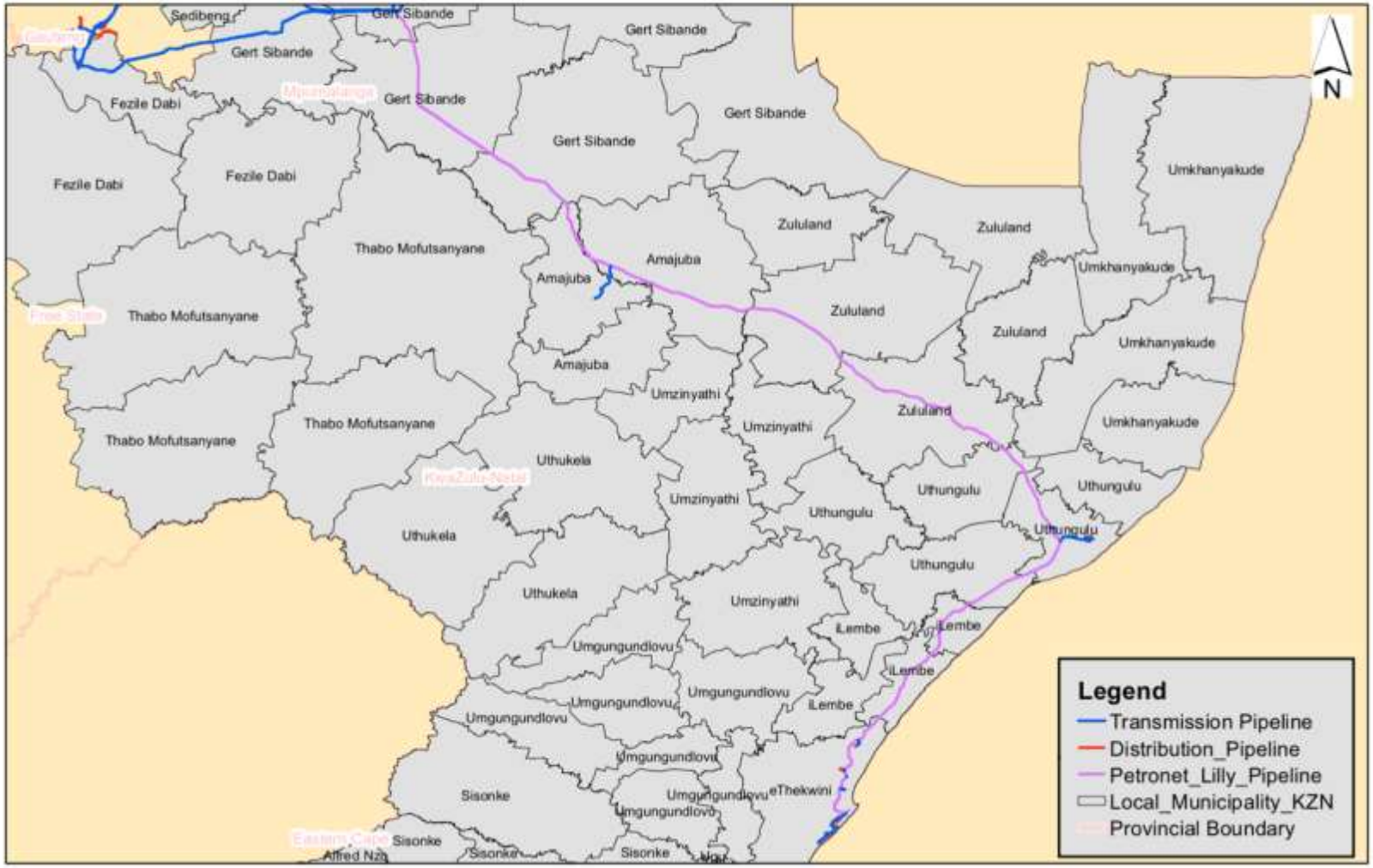
Table B - 1: Natural Gas Licensees

Type	Holder
Import Permit	Sasol Gas
	Kwande Gas
	Volco Power (Pty) Ltd
	FFS Refinery (Pty) Ltd
Transmission Licence	Sasol Gas
	Transnet
	ROMPCO
	Iliza Gas
	AB InBev
	Zemvelo
	Phambili
	PFG (Pty) Ltd
	SLG/SLG-CNG
	Nampak
Distribution Licence	SLG/SLG-CNG
	Sasol Gas

Type	Holder
Trading Licence	Sasol Gas
	Kwande Gas
	SLG/SLG-CNG
	NOVO Energy
	Tetra4
	VGN / NGV
	Reatile / Egoli Gas
	Evraz
	Tetra4
	Egoli Gas

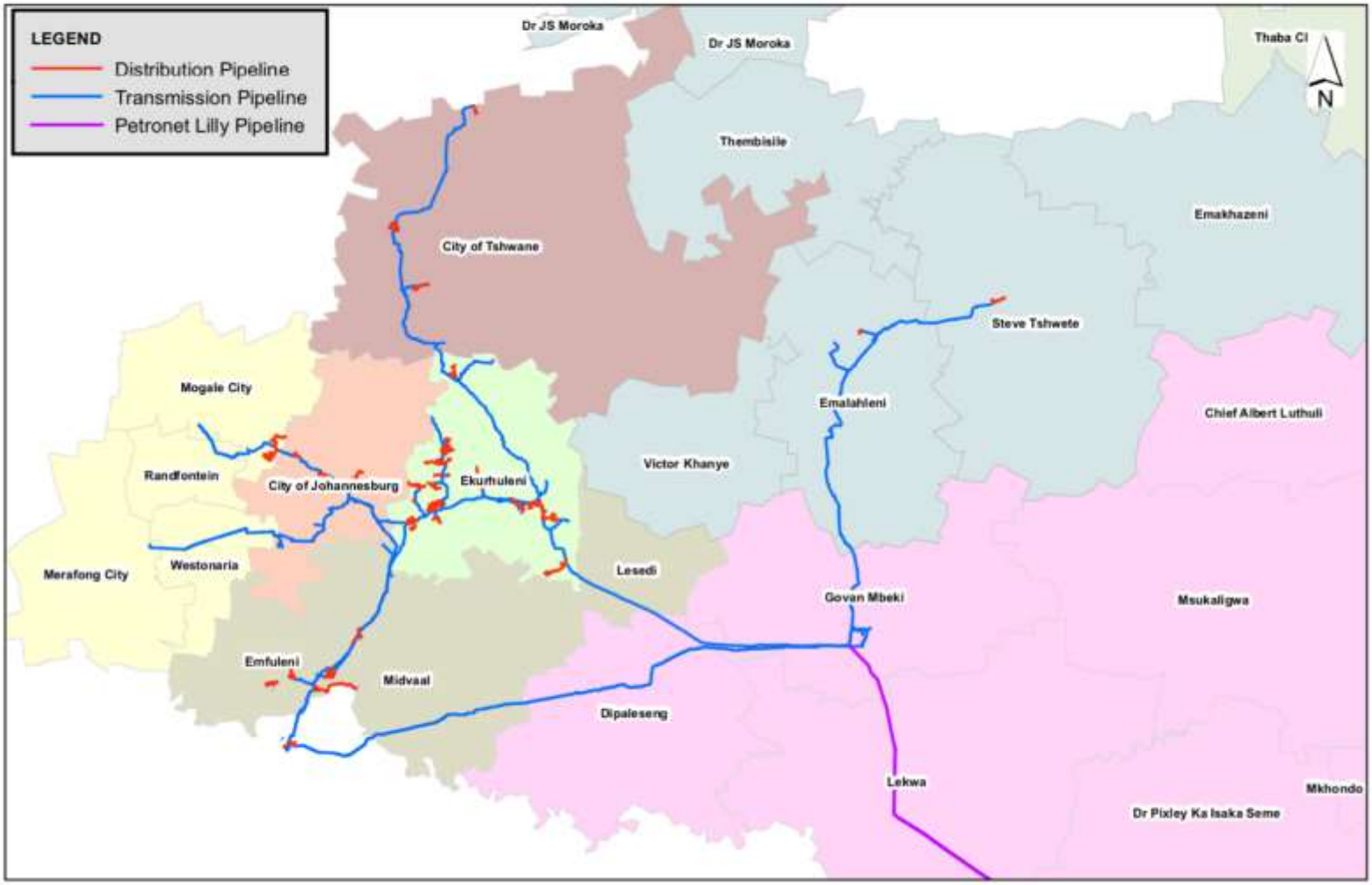
Appendix C:
Natural Gas Pipeline Infrastructure

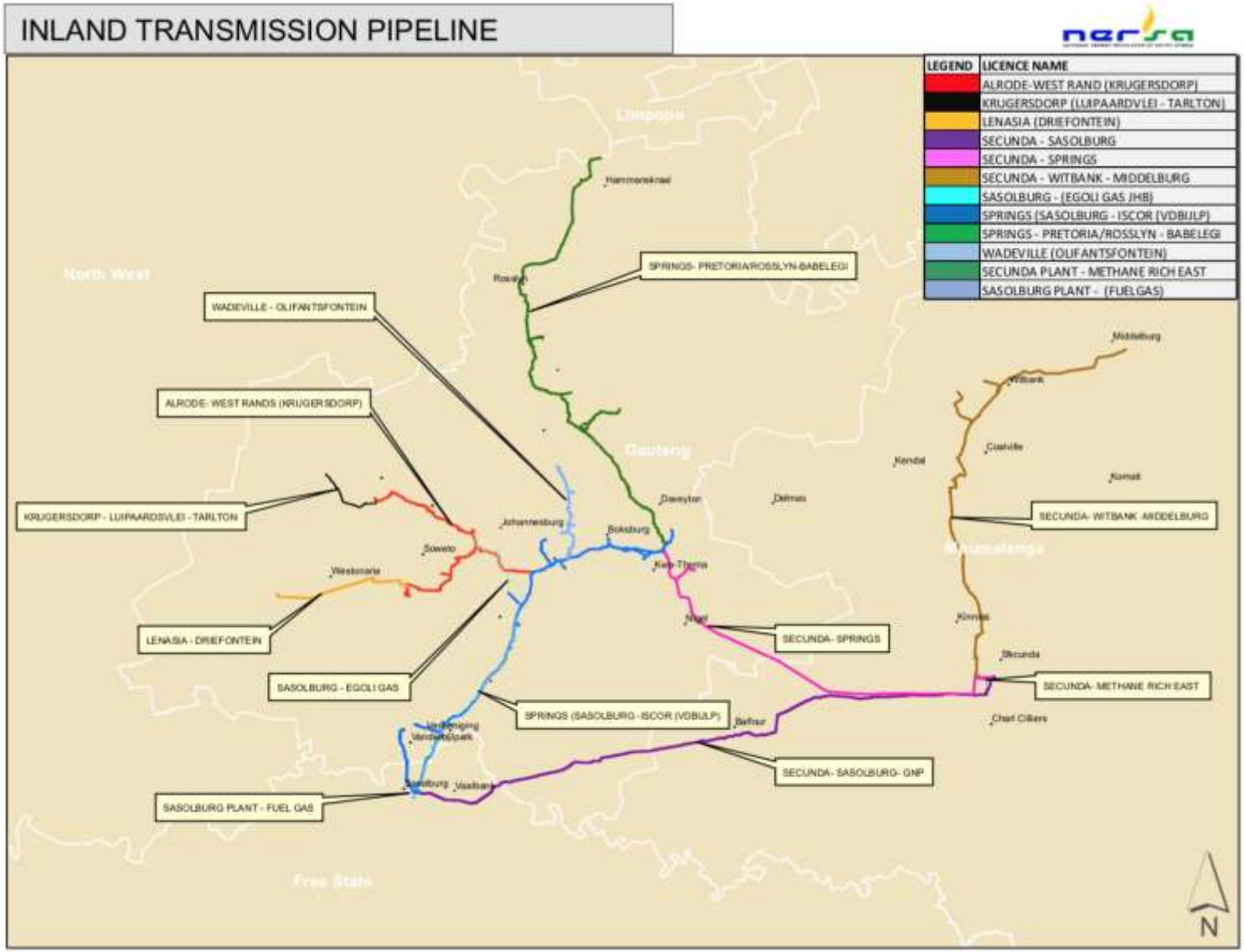
TRANSMISSION GAS PIPELINE- KZN



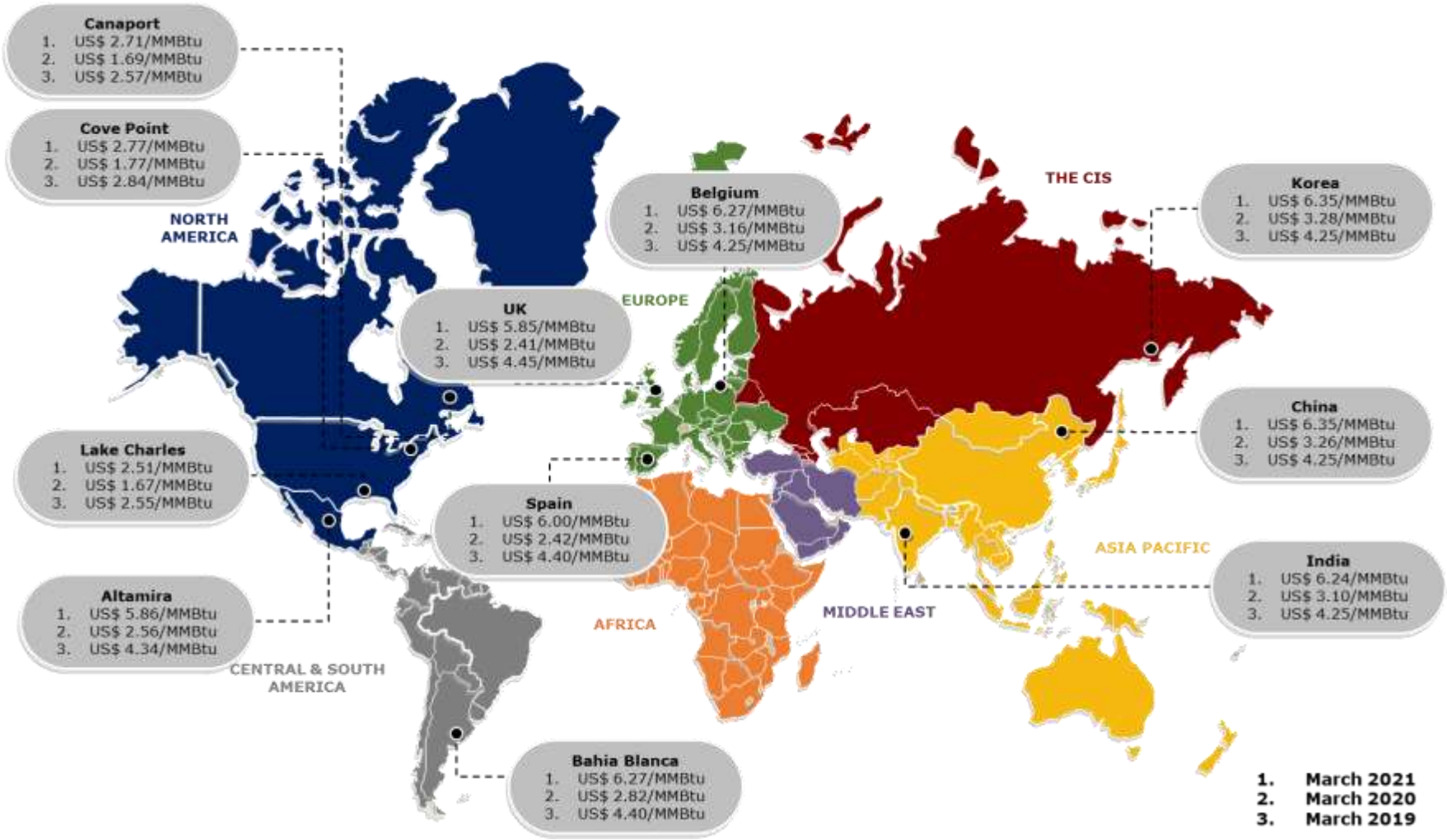
DISTRIBUTION GAS PIPELINE- INLAND

MUNICIPAL OVERVIEW- INLAND GAS PIPELINE




INLAND TRANSMISSION PIPELINE
LEGEND
LICENCE NAME
ALRODE-WEST RAND (KRUGERSDORP)
KRUGERSDORP (LUIPAARDVLEI - TARLTON)
LENASIA (DRIEFONTEIN)
SECUNDA - SASOLBURG
SECUNDA - SPRINGS
SECUNDA - WITBANK - MIDDELBURG
SASOLBURG - (EGOLI GAS JHB)
SPRINGS (SASOLBURG - ISCOR (VDBIJLP)
SPRINGS - PRETORIA/ROSSLYN - BABELEGI
WADEVILLE (OLIFANTSFONTEIN)
SECUNDA PLANT - METHANE RICH EAST
SASOLBURG PLANT - (FUELGAS)
Limpopo
North West
Gauteng
Free State
Mpumalanga
SPRINGS- PRETORIA/ROSSLYN-BABELEGI
WADEVILLE - OLIFANTSFONTEIN
ALRODE- WEST RANDS (KRUGERSDORP)
KRUGERSDORP - LUIPAARDSVLEI - TARLTON
LENASIA - DRIEFONTEIN
SASOLBURG - EGOLI GAS
SECUNDA- WITBANK- MIDDELBURG
SECUNDA- SPRINGS
SECUNDA- METHANE RICH EAST
SPRINGS (SASOLBURG - ISCOR (VDBIJLP)
SECUNDA- SASOLBURG- GNP
SASOLBURG PLANT - FUEL GAS
Middelburg
Witbank
Kendal
Komati
Coalville
Secunda
Chart Cillers
Balfour
Delmas
Davyton
Johannesburg
Soweto
Westonaria
Boksburg
Nigel
Kinross
N

Appendix D:
Historical Data
World LNG Estimated Landed Prices


Canaport
1. US$ 2.71/MMBtu
2. US$ 1.69/MMBtu
3. US$ 2.57/MMBtu
Cove Point
1. US$ 2.77/MMBtu
2. US$ 1.77/MMBtu
3. US$ 2.84/MMBtu
NORTH AMERICA
Belgium
1. US$ 6.27/MMBtu
2. US$ 3.16/MMBtu
3. US$ 4.25/MMBtu
THE CIS
Korea
1. US$ 6.35/MMBtu
2. US$ 3.28/MMBtu
3. US$ 4.25/MMBtu
UK
1. US$ 5.85/MMBtu
2. US$ 2.41/MMBtu
3. US$ 4.45/MMBtu
EUROPE
China
1. US$ 6.35/MMBtu
2. US$ 3.26/MMBtu
3. US$ 4.25/MMBtu
Lake Charles
1. US$ 2.51/MMBtu
2. US$ 1.67/MMBtu
3. US$ 2.55/MMBtu
Spain
1. US$ 6.00/MMBtu
2. US$ 2.42/MMBtu
3. US$ 4.40/MMBtu
ASIA PACIFIC
India
1. US$ 6.24/MMBtu
2. US$ 3.10/MMBtu
3. US$ 4.25/MMBtu
Altamira
1. US$ 5.86/MMBtu
2. US$ 2.56/MMBtu
3. US$ 4.34/MMBtu
AFRICA
MIDDLE EAST
CENTRAL & SOUTH AMERICA
Bahia Blanca
1. US$ 6.27/MMBtu
2. US$ 2.82/MMBtu
3. US$ 4.40/MMBtu
1. March 2021
2. March 2020
3. March 2019