Specialist Climate Change Assessment

Gas Distribution Infrastructure

For the
Coega Special Economic Zone

Prepared by Promethium Carbon for:

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Executive Summary

Promethium Carbon has conducted a climate change impact assessment (CCIA) for the proposed Gas Distribution Infrastructure to form part of the Coega Development Corporation's (CDC) greater energy project. This CCIA was conducted as requested by SRK Consulting (Pty) Ltd.

This CCIA is intended to contribute to the Environmental Impact Assessment (EIA) process, adding to the environmental studies required for the environmental authorisation for the Gas Distribution Infrastructure. This report considers the contribution the Gas Distribution Infrastructures to climate change, as well as the resilience of the Gas Distribution Infrastructure to climate change impacts.

The proposed Gas Distribution Infrastructure is to be developed as part of the Coega 3,000 MW Integrated Gas-to-Power Project which is the overarching CDC energy project. The Coega SEZ is located within the Nelson Mandela Bay Metropolitan Municipality in the Eastern Cape province of South Africa. The Nelson Mandela Bay Metropolitan Municipality acknowledges the pending risks associated with climate change impacts on their local community, natural environment, as well as the Coega SEZ in the *Climate Change and Green Economy Action Plan*[1].

In South Africa, the regulatory framework and the legal provisions related to climate change are still in the process of being developed and interpreted, as can be seen in the recent development surrounding the Thabametsi case[2]. As the development of South African climate change laws and policies are still underway, there is minimal available guidance in the field of CCIAs.

This CCIA, in the context of the guidance provided by the Thabametsi Case, considers both the impacts of the proposed Gas Distribution Infrastructure *on* climate change (through a greenhouse gas (GHG) inventory calculation and assessment), as well as the impacts *of* climate change on the project (through a vulnerability assessment).

This assessment report was further informed by Section 24 of *National Environmental Management Act,* the *Impact Assessment Regulations*[3]. The *National Environmental Management Act* regulations are designed to assess the impact of local pollutants, and do not sufficiently provide for the assessment of GHG emissions which have long-term,[4] global impacts. Due to the global nature of climate change, GHG emissions from any specific project cannot be directly linked to global climate change. In a similar way, GHG emissions from a specific project cannot be directly linked to the climate change impacts on that project, or the climate change impacts on the local area in which

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1 Nelson Mandela Bay Metropolitan Municipality, 2015, *Climate Change and Green Economy Action Plan*, [Online] Available at: https://www.nelsonmandelabay.gov.za/datarepository/documents/nmbm-climate-change-and-green-economy-action-plan-final.pdf [Accessed on 30/03/2020].

2 *Earthlife Africa Johannesburg v Minister of Environmental Affairs and others* [2017] 2 All SA 519 (GP)

3 As published in the Government Gazette of 20 October 2014.

4 Greenhouse gas emissions can remain in the atmosphere for hundreds of years.

the project is implemented. In this regard, the work done in this CCIA was based on South African legislation, but was augmented by international best practice in the field of climate change risk and vulnerability assessments. A high-level GHG inventory was developed for the proposed Gas Distribution Infrastructure, to quantify its impacts on climate change. This GHG inventory estimated the emissions associated with the operation and value chain (both upstream and downstream) of the proposed Gas Distribution Infrastructure.

Potential avoided emissions (GHG emissions from current baseline scenarios that can be avoided due to the presence of the Gas Distribution Infrastructure) were also calculated. The assumed baseline scenario is the use of coal as a primary fuel source. The possible new scenario is an uptake of natural gas as a primary fuel source, rather than new coal, as it would be more readily available. The calculation is presented as a possible scenario to illustrate the potential impact that the project could have if there is a shift from coal-as-fuel to gas-as-fuel in industry, due to the lower emission factor associated with the combustion of natural gas when compared to the combustion of coal. This is regardless of what the energy gained from the combustion of the fuel is used for and can include processes such as boilers, heaters, electricity generation and furnaces.

The GHG inventory was assessed in comparison to a calculated South African carbon budget, which, in turn, informed the impact assessment conducted in this CCIA.

The outcomes of the GHG inventory are shown in Table 1. The project, with its direct and indirect emissions, will emit in the order of 28 million tons of CO_2e per year. Overall, 855 million tonnes CO_2e of emissions are emitted across the lifetime of the project. This is equivalent to around 19% of the South African carbon budget, or 8.1% of South Africa's low PPD scenario and 5.0% of its high PPD scenario.

The possible reduction in emissions from the coal-as-fuel baseline could be achieved because fuel brought in by the project could replace heat energy generated from the combustion of coal with heat energy generated from the combustion of natural gas.

In the scenario where avoided emissions is considered, the possible emission avoidance could be in the order of 10 million tons of CO_2e per annum for the case where a predominantly gas-as-fuel scenario, rather than coal-as-fuel scenario, is considered.

Table 1: Summary of GHG Emissions and potential avoided emissions.

Emission Source	Annual GHG emissions	Total project lifecycle GHG emissions
Scope 1 & 2 (Direct and energy indirect emissions)	865 000 tCO_2e/a	26 000 000 tCO_2e
Scope 3 (Other indirect emissions)	27 600 000 tCO_2e/a	829 000 000 tCO_2e
Total emission associated with the project	**28 500 000 tCO_2e/a**	**855 000 000 tCO_2e**
Baseline emissions that could be avoided	38 300 000 tCO_2e/a	1 150 000 000 tCO_2e
Potential avoided emission impact of the project	**-9 840 000 tCO_2e/a**	**-295 000 000 tCO_2e**

An assessment of the climate change risk and vulnerability of the Gas Distribution Infrastructure, considering the core operations, value chain, and social and natural environments, was conducted to inform the resilience of the project to climate change. This assessment identified the key vulnerabilities to climate change impacts which will affect the operations of the proposed Gas Distribution Infrastructure.

The main outcomes of the risk and vulnerability assessment indicate that the Gas Distribution Infrastructure is resilient to future climate change impacts. The Port of Ngqura has already taken impacts such as sea level rise and increased storm surge into account during its design, whilst the insulation of pipelines and storage units of the Gas Distribution Infrastructure reduces the evaporative losses of liquefied natural gas caused by an increase in average temperature. The climate change impacts that are likely to have severe impacts are associated with the increased frequency and severity of severe weather events, such as severe storms and severe rainfall events.

It is our opinion that Gas Distribution Infrastructure should receive authorisation based on the outcomes of this CCIA, if the following conditions with respect to the climate change impact and resilience of the project are met:

1. The design of infrastructure and processes should consider the potential impact of extreme weather events such as severe storms/storm surge.
2. The designs for the piping should account for increasing ambient temperatures as well as an increased frequency of very hot days and the associated material fatigue.
3. The disaster response procedures of the Gas Distribution Infrastructure must make provision for severe weather events.

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Declaration of Independence

The authors of this report do hereby declare their independence as consultants appointed by SRK Consulting to undertake a climate change assessment for the proposed Gas Distribution Infrastructure. Other than fair remuneration for the work performed, the specialists have no personal, financial business or other interests in the project activity. The objectivity of the specialists is not compromised by any circumstances and the views expressed within the report are their own.

Robbie Louw

Karien Erasmus

Johara Naidoo

Matthias Rommelspacher

List of Acronyms and Terms

Abbreviation	Definition
CCIA	Climate Change Impact Assessment
CDC	Coega Development Council
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalents
CH_4	Methane
DEA	Department of Environmental Affairs
DEFF	Department of Environment, Forestry and Fisheries
FSRU	Floating Storage and Regasification Unit
GHG	Greenhouse Gas
GWP	Global Warming Potential
ICMM	International Council on Mining and Minerals
IPCC	Intergovernmental Panel on Climate Change
IRP	Integrated Resource Plan
LNG	Liquid Natural Gas
LNGC	Liquid Natural Gas Carrier
LTAS	Long Term Adaptation Scenarios
Mt	Million tonnes (megatonnes)
$MtCO_2e$	Million tonnes of carbon dioxide equivalent
N_2O	Nitrous Oxide
NCV	Net Calorific Value
NDC	Nationally Determined Contribution
NEMA	National Environmental Management Act
NMBMM	Neslon Mandela Bay Metropolitan Municipality
RCP	Representative Concentration Pathway
SANS	South African National Standards
SEZ	Special Economic Zone
tCO_2e	Tonnes of carbon dioxide equivalent
WRI	World Resources Institute

Term	Definition
Short-term	For the purposes of this report short-term is defined as within the next 10-12 years or the operational phase of the mine.
Long-term	For the purposes of this report long-term is defined as the timeframe from 2030 onwards or the post-closure phase of the mine.

Additional timeframes which relate specifically to the environment impact assessment criteria used in this study are defined in **Error! Reference source not found.** of this report.

1 Introduction

SRK Consulting has appointed Promethium Carbon to conduct the Climate Change Impact Assessments (CCIAs) for the Coega Integrated Gas-to-Power Project proposed by the Coega Development Corporation (CDC). The Coega Integrated Gas-to-Power Project intends to construct three new gas-to-power plants, as well as the associated marine and land infrastructure required for the storage, movement, and processing of liquid natural gas (LNG) and natural gas.

There are four key studies to be developed under the umbrella of the CDC gas-to-power programme, namely:

- Gas Distribution Infrastructure;
- Gas to Power Plant in Zone 13;
- Gas to Power Plant in Zone 10 North; and
- Gas to Power Plant in Zone 10 South;

This gas-to-power programme will be located within the Coega Special Economic Zone (SEZ). The SEZ is located in Algoa Bay in South Africa, approximately 19 km north of Port Elizabeth, in the Eastern Cape Province.

This specialist CCIA will assess the ***Gas Distribution Infrastructure***. This CCIA forms part of the Environmental Impact Assessment (EIA) for this Project, which forms part of the overall Coega Integrated Gas-to-Power Project. The assessment of the 3 gas to power plants will be covered in independent assessments.

The Gas Distribution Infrastructure will involve the storage of up to 170 000 m^3 of LNG and natural gas and the processing of up to 46 700 m^3 of LNG per day, as well as the distribution of LNG and natural gas to and from the respective storage and regasification facility.

There are three key aspects which make up this CCIA, namely:

- An assessment of the Gas Distribution Infrastructure's prospective contribution to climate change through the emission of greenhouse gases, like carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) – collectively referred to throughout this report as CO_2e (carbon dioxide equivalent);
- An assessment of the impacts of climate change on the Gas Distribution Infrastructure during its lifetime and resilience of the Gas Distribution Infrastructure to climate change; and
- An indication of the possible mitigation or adaptation measures that can be adopted by CDC to ensure minimised impact on/by climate change.

1.1 Climate change impact assessments: Legal precedent

The *Thabametsi case judgement* is South Africa's **legal precedent** pertaining to climate change assessments in South Africa. Thabametsi's environmental authorisation was appealed by Earthlife on the basis that the Chief Director had failed to consider the climate change impacts of the power station. Earthlife (Applicant) maintained that the Department was obliged to consider the climate change impacts **before** granting an Environmental Authorisation and that it failed to do so.

Considering this judgement, CCIAs must follow a three-pronged approach, in line with emerging international best-practice, assessing (a) the impact of the Gas Distribution Infrastructure on climate change, (b) the impact of climate change on the Gas Distribution Infrastructure, and (c) make recommendations of mitigation and adaptation strategies to reduce the impacts highlighted in (a) and (b).

1.2 Details of the specialist

Promethium Carbon is a South African climate change and carbon advisory company based in Johannesburg.

The company has been active in the climate change and carbon management space since 2004.

Promethium Carbon's climate change impact studies include an estimation of the carbon footprint of the activity or group of activities, as well as the vulnerability of the activity/ies to climate change. Promethium Carbon has calculated greenhouse gas inventories for over 60 entities and is proficient in applying the requirements of ISO/SANS 14064-1 and the Greenhouse Gas Protocol's accounting standards, as well as South Africa's Greenhouse Gas Reporting Guidelines. Promethium Carbon has also assisted around 40 clients develop climate change risk assessments, which includes the compilation of climate change specialist reports. Promethium Carbon's assessments include thorough analysis of historical and projected weather data specific to the region in which the client operates. Promethium Carbon's assessment of vulnerability goes beyond core operations to include impacts within the supply chain and broader network of the Gas Distribution Infrastructure.

Robbie Louw is the founder and director of Promethium Carbon. He has over 15 years of experience in the climate change industry. His experience (35 years) includes research and development activities as well as project, operational and management responsibilities in the chemical, mining, minerals process and energy fields. Robbie's experience in climate change includes (but is not limited) to:

- Climate change risk and vulnerability assessments for large mining houses.
- Extensive experience in carbon foot printing. The team under his leadership has performed carbon footprint calculations for major international corporations operating complex businesses in multiple jurisdictions and continents.
- Carbon and climate strategy development for major international corporations.
- Climate change impact assessments for various companies and projects.
- Climate change scenario planning and analysis, particularly in terms of the recommendations of the Taskforce on Climate-related Financial Disclosure.

- In depth understanding of South Africa's climate change regulations and carbon tax requirements.

Karien Erasmus is a principal climate change advisor at Promethium Carbon and holds a Master's Degree (MPhil) in Development Practice, focussing on Sustainable Development and Responsible Leadership. The programme is affiliated with the Global Association of Master's in Development Practice, co-ordinated by Columbia University in New York. Her postgraduate qualifications include diplomas in: Project management, community development and mine closure and ecological rehabilitation. She has been involved in the sustainability and climate change industry for the past 13 years, working extensively in Africa and on strategic projects such as the Port Harcourt City Master Plan in Nigeria and locally on the Gautrain and the Bus Rapid Transit system in Johannesburg. Karien joined Promethium Carbon in 2015 and utilises her developmental background to inform the social context of various climate change and low carbon development projects. Over the past three years Karien has worked extensively within the mining sector. Karien's experience in climate change includes:

- Climate change risk and vulnerability assessments in South Africa, Ghana, the Democratic Republic of Congo, and Peru;
- Climate change impact assessments as part of the Environmental Authorisation process for several projects including coal and gold mines, strategic industrial developments and the establishment of new Special Economic Zones;
- Drafting Carbon Disclosure Project Climate Change and Water responses for numerous mining and industrial companies;
- Assessment of climate change and energy related regulations including the National Climate Change Adaptation Strategy and the Green Fund;
- Developing the land, community, and energy nexus concept which links land rehabilitation to community upliftment through sustainable energy projects.

Johara Naidoo is a Climate Change Advisor at Promethium Carbon since 2018 and has an Honour degree in Chemical Engineering. Prior to her placement at Promethium, Johara was appointed as an Engineer in Training at Eskom Holdings SOC Ltd. She was placed in the Process Engineering Department, where she worked on plant optimisation projects, including coal quality combustion modelling, primary air flow lowering, condition-based soot blowing initiatives, and condenser backpressure impact models. Her keen interest in climate change and sustainable development resulted in her appointment as the SAWEF Youth Ambassador of 2013/14 and thereafter, was the recipient of the Green Globe Youth-for-Youth Award in 2014 for her term of service. Over the past several months at Promethium Carbon, Johara has gained valuable experience. Some of the projects she has been active in include:

- Climate Change Impact Assessment for a proposed mine in South Africa;
- Climate Change Risk and Vulnerability Assessments for multiple sites of a mining company in both South Africa and other African countries;
- An energy security strategy implementation plan to be rolled out at provincial level;

- The development of a land, community, energy, ecology, and economy nexus concept linking community upliftment with sustainable tourism, based in the Eastern Cape;
- The drafting of CDP Climate Change and Water responses in both gold mining and platinum mining industries; as well as
- Calculations of various first principle concepts for modelling purposes, including:
    - Carbon tax models,
    - Carbon footprints, and
    - Science-Based Target models

Matthias Rommelspacher is a Climate Change Advisor appointed at Promethium Carbon who holds a Master's in Environmental Engineering. His postgraduate studies focused on urban water management, air quality control, waste management and ecological systems design. Part of his studies included field work on Mahé in Seychelles, where he was part of a transdisciplinary team that assessed the waste management system of Mahé Island. The research for his thesis combined his background as a Chemical Engineer with his studies and focused on the processing of urban wastewater for nutrient recovery. Over the past year at Promethium Carbon, Matthias has gained valuable experience. Some of the projects he has been active in include:

- GHG Reporting;
- Climate change risk and vulnerability assessments; and
- Calculations of various first principle concepts for modelling purposes, including:
    - Carbon tax models,
    - Carbon footprints, and
    - Science-Based Target models.

2 Report overview

The following section will provide an overview of the objective and boundaries of this report.

2.1 Climate change impact assessment objective

This CCIA is intended to form part of the specialist assessments conducted for the EIA of the Gas Distribution Infrastructure.

The analysis presented in this report is aligned with the principles of the National Environmental Management Act, 1998 (Act No 107 of 1998). It seeks to provide the environmental authorisation process with the best possible information to evaluate the Gas Distribution Infrastructure's impact.

To consider all facets of the environmental sustainability, the impacts of climate change must be considered in the development of this Project. This was made provision for in the EIA conducted for the Thabametsi Mine which resulted in the now legal precedent for South African CCIAs, the

Thabametsi case judgment. This is explained in more detail in Section **Error! Reference source not found.**.

Considering the terms of reference stipulated by SRK Consulting (Pty) Ltd, alongside the learnings from the *Thabametsi case judgement*, the study aims to achieve the following objectives:

- Determine the impact of the Gas Distribution Infrastructure on climate change.
  - Conduct a GHG inventory for the construction and operation phases of the Gas Distribution Infrastructure;
  - Conduct an analysis of the GHG inventory regarding the impact of the Gas Distribution Infrastructure on climate change;
  - Describe the existing climate conditions of the local area to inform the EIA;
  - Conduct an impact assessment of the Gas Distribution Infrastructure which includes the cumulative impacts of climate change in relation to the Gas Distribution Infrastructure; and
  - Propose mitigation and adaptation measures to minimise the impacts of the proposed Gas Distribution Infrastructure on climate change.
- Determine the impact of climate change on the Gas Distribution Infrastructure.
  - Conduct an analysis of the climate change impacts for the region in which the Gas Distribution Infrastructure will be located;
  - Determine the processes and associated infrastructure of the proposed Gas Distribution Infrastructure that will be affected by climate change, and the potential magnitude of the impacts;
  - Propose mitigation and adaptation measures to minimise the impacts of climate change on the proposed Gas Distribution Infrastructure.
- Determine possible mitigation and adaptation measures to reduce the projects impact on climate change and improve its resilience to climate change.

2.2 CCIA boundary

The boundaries of this CCIA include all infrastructure and process that occur between receiving of the LNG in the harbour and the delivery of the LNG and natural gas to the consumer.

The LNG is delivered via a Liquid Natural Gas Carrier (LNGC) to the Gas Distribution Infrastructure in the harbour. Emissions generated after the custody point where LNG is unloaded from the LNGCs, as shown in Figure 1, are within the boundary of the direct emissions of the project.

The natural gas is delivered to consumers via pipelines. The emissions generated before the custody point where LNG or natural gas is delivered to users such as power stations (as shown in Figure 1) are within the boundary of the direct emissions of the project.

Emissions that occur before the custody point, where LNG is unloaded from the LNGCs, and emissions that occur after the custody point where LNG or natural gas is delivered to users (as shown in Figure 1) are accounted for as indirect emissions of the project

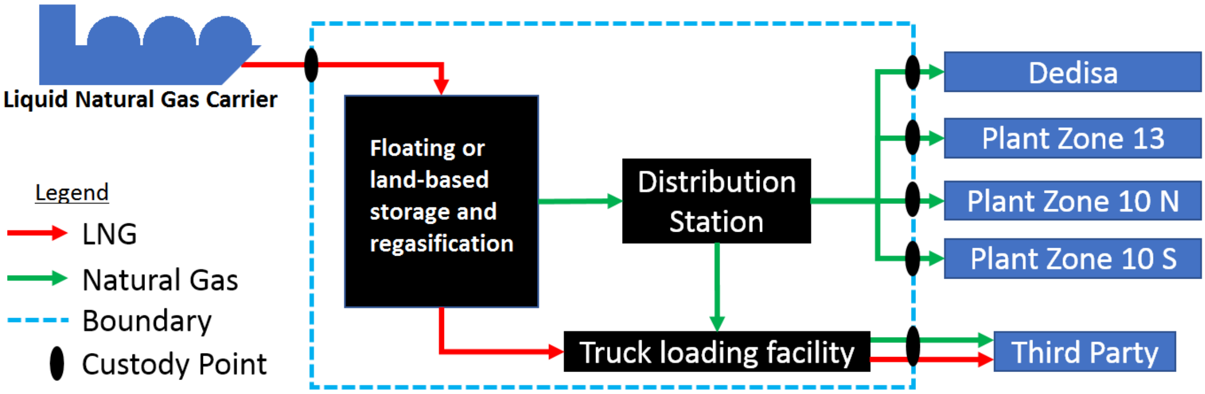

Figure 1: Simplified assessment boundary.

2.3 Description of project activities

The Gas Distribution Infrastructure will provide for the offloading, storage, regasification, and distribution of natural gas, in liquefied and gaseous form, within and around the Coega SEZ.

The infrastructure associated with the project will include:

- A berth will be constructed along the inside of the eastern breakwater of the Port of Ngqura specifically for the import of LNG by sea.
- A Floating Storage and Regasification Unit (FSRU) will be permanently moored at the berth to receive LNG from the LNGCs. The FSRU will be used to store the LNG and regasify a portion of it.
- A truck loading facility will receive LNG from the FSRU for the distribution of LNG to third parties via trucks.
- A gas distribution station will enable the distribution of piped natural gas to third parties as well as to the truck loading facility, where the natural gas can also be moved further by truck to third parties.

The following third parties will be supplied with piped natural gas:

- Three proposed gas to power plants, which will supply up to 3 000 MW of mid-merit energy to the national grid; and
- The existing Dedisa Peaking Power Plant (if it is converted to gas fuelled).

It has been indicated by the project developer, that the FSRU could be replaced by land-based facilities, if financially feasible. These facilities will retain the same functionality as the FSRU.

There will potentially be several sources of GHG emission in the Gas Distribution Infrastructure. As per the Terms of Reference, the following aspects will be covered by the assessment of the gas distribution infrastructure:

- An LNG offloading facility, consisting of a new jetty to connect the ships (both FSRU and LNGC) to the berth;
- Delivery of LNG every 3 days from LNGCs with an assumed 140 000 m^3 capacity;
- Up to two FSRUs of 170 000 m^3 each;
- Possible land-based storage & regasification consisting of two LNG storage tanks with 160 000 m^3 capacity per tank;
- Cryogenic pipeline(s) from the LNG offloading facility in the port to the land-based storage area;
- Gas pipelines to the power plants and the truck loading facility:
- Truck loading facility with an estimated third-party offtake 40 LNG trucks per day with a capacity of 20 tonnes each.

3 Receiving environment

This study considers the receiving environment of the greenhouse gasses emitted by the Gas Distribution Infrastructure as the global atmosphere. In this context, the impacts of the emissions from the project will be felt on both global and local levels. This section identifies key vulnerabilities that already exist in the local context.

Climate change is a phenomenon whose impacts cannot be geographically or politically contained, nor can any impact be attributed to any single contributor. It is therefore necessary to consider the impacts across all contexts; from the global context right down to the local context.

3.1 Global context

GHG emissions from all global sources accumulate and contribute to climate change. One of the main GHGs is CO_2. It, like all GHGs, contributes to climate change through the warming effect it has on the earth's atmosphere by trapping heat in the atmosphere. The greater the concentration of GHGs, the greater the warming effect. Thus, atmospheric CO_2 level is used as an indicator of this effect. The global CO_2 level measured in 2019 surpassed 410 parts per million for the first time in recorded history[5].

The Paris Agreement calls for a global increase in ambition and to aim to limit global average temperatures to a target of well below 2°C above pre-industrial temperatures.

5 NASA, 2019, *Graphic: The relentless rise of carbon dioxide*, [Online] Available at: https://climate.nasa.gov/ [Accessed on 13 December].

In 2018, the IPCC Special Report estimated the amount of GHGs that can still be emitted before the levels in the atmosphere are reached that will cause a warming of more than 1.5°C. This is generally referred to as a Carbon Budget.

The analysis in this CCIA makes use of the 580 gigaton CO_2e[6] carbon budget estimated by the IPCC. This is used for impact calculations as stipulate in Section **Error! Reference source not found.** of this CCIA.

The GHG emissions from the proposed Gas Distribution Infrastructure cannot be directly linked to any particular climate change effects. However, the Gas Distribution Infrastructure's emissions will contribute to global climate change, which will impact South Africa. South Africa is already experiencing the detrimental impacts of climate change. It is noted that each role player has a collective responsibility to address this global challenge.

3.2 National context

South Africa forms part of Sub-Saharan Africa, which is earmarked as an area of concern regarding climate change impacts. South Africa already experiences high levels of poverty and insecure service delivery. This leaves South Africa particularly vulnerable to the adverse effects of global climate change. The predicted trends regarding climate change impacts in South Africa are discussed in this section of this study.

3.2.1 The South African energy context

The single largest source of GHG emissions in South Africa are coal fired power stations where almost 90% of the country's electricity comes from. This coal intensive energy system has resulted in the country being the 12th largest GHG emitter in the world and thus a significant contributor to global GHG emissions[7]. In addition to the high emissions associated with the predominantly coal-fired South African energy grid, energy provision in South Africa is constrained.

The promulgation of the Integrated Resource Plan (IRP) 2019[8], published by the Department of Mineral Resources and Energy, and associated ministerial determinations guide the roll out of the Independent Power Producers Procurement Programme (IPPPP). The IRP 2019 plans for a total of 3 000 MW of new gas-fired power stations to be active by 2030. 1 000 MW of this will come online in 2024 and the remaining 2 000 MW in 2027. This represent s a low gas utilization under certain constraints. However, if no constraints are imposed, the power system does call for increased gas to be installed on the grid.

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[6] IPCC, 2018, *IPCC, 2018: Summary for Policymakers. In: Global warming of 1.5°C. An IPCC Special Report on the impacts*

[7] Global Carbon Atlas, 2019. http://www.globalcarbonatlas.org/en/CO2-emissions

[8] Department of Energy, 2019, Integrated Resources Plan (IRP2019), Government Gazette, [Online] Available at: http://www.energy.gov.za/IRP/2019/IRP-2019.pdf [Accessed on 10/05/2020].

3.2.2 South Africa's response to climate change

South Africa is particularly vulnerable to the effects of climate change with regards to the environment as well and the socio-economic context. The variable nature of climate change in terms of increase frequency and intensity of extreme weather events will be consequential for the South African society. Furthermore, South Africa is a water stressed country with predictions indicating future drying, increased droughts and variable and rainfall.

South Africa's National Development Plan 2030 (NDP) is centred on reducing inequality and eliminating poverty by 2030. Climate change impacts and climate change mitigation are highlighted as critical issues in Chapter 5 the NDP. This forms the basis of the following set of goals and action to meet the country's environmental sustainability and resilience needs have been mentioned:

- Achieving the peak, plateau and decline trajectory (PPD) for GHG emissions;
- Entrenching an economy-wide carbon price by 2030;
- Implementing zero emission building standards by 2030; and
- Achieving absolute reductions in the total volume of waste disposed to landfill each year.

South Africa's climate change response is also set out in the National Climate Change Response White Paper, which proposed that climate change be addressed through various interventions that build and sustain social, economic and environment resilience by retaining a fair contribution to the global efforts to stabilise GHG concentrations in the atmosphere. South Africa's Nationally Determined Contribution (NDC) submitted in Paris in 2015 sets out the nation's emissions trajectory up to 2050. South Africa's emissions are expected to peak between 2020 and 2025, plateau for approximately a decade and decline in absolute terms thereafter (the 'peak, plateau and decline trajectory').

As a developing nation, South Africa requires some additional allowance, to increase its emissions in the short-term, to foster economic growth in the transition towards a low carbon economy.

Thus, South Africa has not limited itself to specific emissions targets, but rather the South African NDC provides a peak, plateau and decline trajectory range from the year 2016 (reference point) to 2050. The country's pledge for the peak, plateau and decline trajectory is set to emit between 398 million tCO_2e and 614 million tCO_2e between 2025 and 2030.

The NDC is taken into consideration through the IRP. This document represents the long-term planning strategy of South Africa and closely considers South Africa's commitments to the Paris Agreement, linking the anticipated climate change impacts to the future energy mix of the country. The IRP makes provision for gas-to-power technologies to be added to the national energy mix.

Gas power acts as a transition fuel, which enables increased flexibility of the national grid in a cost-effective manner. Increased grid flexibility will complement the increased uptake of varying renewable energy technologies, specifically solar and wind power.

In addition to the NDC and the IRP, various environmental policies and laws have been put in place to ensure that South Africa collectively contributes to the overall reduction in emissions released into the atmosphere. Laws in this regard include the *National Greenhouse Gas Reporting Regulations* and the *Carbon Tax Act*. Government's laws and policies might change further in the future, as per the developments of the Department of Environment, Forestry and Fisheries (DEFF) mitigation system and proposed *Climate Change Bill*.

The *Climate Change Bill* will also aid in achieving the climate change goals encapsulated in the NDP stated above. Of note to the energy sector within which the proposed project falls, is the introduction of carbon budgets. The latest draft of the *Bill* requires a list of greenhouse gas emitting activities to be published which will be subject to carbon budgets. Where the carbon budget is allocated to a person for any period under review is exceeded, that person will be subject to an administrative penalty as provided for in the *Carbon Tax Act*, 2019. A person to whom a carbon budget has been allocated must also prepare and submit to the Minister for approval a greenhouse gas mitigation plan. Although the provisions of the *Act* are still being finalised, failure to prepare or comply with such a mitigation plan will constitute an offence. Should the Gas Distribution Infrastructure be granted environmental approval, it may be subject to the provisions of the *Climate Change Bill* and be required to prepare a GHG mitigation plan.

In terms of climate change adaptation, South Africa's National Climate Change Adaptation Strategy (NCCAS) was approved by Cabinet in 2020. The NCCAS will be used as the basis for meeting South Africa's obligations in terms of the adaptation commitments outlined in the NDC. The NCCAS has four key objectives[9]:

- Objective 1: Build climate resilience and adaptive capacity to respond to climate change risk and vulnerability.
- Objective 2: Promote the integration of climate change adaptation response into development objectives, policy, planning and implementation.
- Objective 3: Improve understanding of climate change impacts and capacity to respond to these impacts.
- Objective 4: Ensure resources and systems are in place to enable implementation of climate change responses.

The NCCAS recognises that the energy sector is one of the emerging sectors that will be affected by climate change. Energy provision and associated infrastructure are discussed specifically in terms of Intervention 1 of the NCCAS which relates to increasing resilience and adaptive capacity achieved in human, economic, environment, physical and ecological infrastructure. Key aspects discussed, and relevant to the context of this project as well as the project's resilience to climate

9 Department of Environment, Forestry and Fisheries, 2020, National Climate Change Adaptation Strategy: Republic of South Africa, [Online] Available at: https://www.environment.gov.za/sites/default/files/docs/nationalclimatechange_adaptationstrategy_ue10november2019.pdf [Accessed on 25/01/2021]

change, include climate resilience infrastructure and materials and creating a more adaptive energy system.

In addition, in terms of Intervention 4 of the NCCAS -*facilitate mainstreaming of adaptation responses into sectoral planning and implementation* - specific economic sectors, including the energy sector, must develop infrastructure cognisant of current and predicted climate change impacts.

3.2.3 South African Carbon Budget

South Africa has disclosed its NDC in the form of a Peak-Plateau-Decline (PPD) scenario[10,11,12]. This is a form of a self-determined carbon budget for South Africa. According to the PPD scenario, South Africa plans to emit between 10 550 $MtCO_2e$ and 16 928 $MtCO_2e$ from 2020 to 2050, for the low and high emission scenarios, respectively.

Several nations have also submitted NDC's according to the Paris Agreement. Despite the global and national commitment to limit global temperature increase to 2°C, the NDCs of all countries combined are insufficient to achieve this goal (at this point in time). According to Climate Action Tracker, current global policies and communicated pledges/targets are insufficient to meet the 2°C target, let alone the 1.5°C target[13]. South Africa's NDC is considered to be highly insufficient in this regard[14]. These pledges are due to be updated at the 26th Congress of the Parties in 2021. In light of this, an alternative carbon budget is proposed for assessing the impact on climate change.

South Africa's emissions and emission trajectory must be seen in the context of the global carbon budget of 580 gigatons of CO_2e[15]. This is the carbon budget to maintain global temperature change to 1.5°C of warming. This would be in line with the Paris agreement, to aim for well below 2°C of warming. To make a reasonable allocation of the country's fair share to this budget[16], the global budget was calculated using a per capita basis, as indicated below. This indiscriminate allocation is due to the inherent indiscriminate nature of climate change. Given that:

1. Population of South Africa = $59.18\ million\ people$[17]

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[10] South Africa's submission to the UNFCCC. Available at https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/South%20Africa%20First/South%20Africa.pdf [Accessed on 04/01/2021].

[11] August 2015. Discussion Document: South Africa's Intended Nationally Determined Contribution.

[12] ERC, CSIR and IFPRI. 2017. *The developing energy landscape in South Africa: Technical Report.* Energy Research Centre, University of Cape Town October 2017.

[13] Climate Action Tracker. [Online] https://climateactiontracker.org/global/cat-emissions-gaps/ [Accessed on 18/01/20201].

[14] Climate Action Tracker. [Online] https://climateactiontracker.org/countries/south-africa/ [Accessed on 18/01/20201].

[15] IPCC, 2014, *IPCC 5th Assessment Report.*

[16] This method of carbon budget allocation is a conservative approach developed by Promethium Carbon.

[17] StatsSA, 2018, *Mid-year population estimates 2018*, [Online] Available at: http://www.statssa.gov.za/?p=11341 [Accessed 08/03/2019].

2. Global population $= 7.781\ billion\ people = 7\ 781\ million\ people$[18]
3. Global carbon budget $= 580\ GtCO_2e = 580\ 000\ MtCO_2e$

We take the global carbon budget as a percentage of the South African population, thus:

$$South\ African\ carbon\ budget = \frac{South\ African\ population}{Global\ population} \times Global\ carbon\ budget$$

$$= \frac{59.18\ million\ people}{7\ 781\ million\ people} \times 580\ 000\ MtCO_2e$$

$$= 4\ 411\ MtCO_2e$$

South Africa's carbon budget is approximately 4.4 billion tCO_2e when allocating equally globally per capita.

The impact of the Gas Distribution Infrastructure on this **limited resource** will thus be evaluated by considering its contribution to the South African carbon budget and South Africa's PPD scenarios.

3.2.4 Observed trends and projected climate change

The *Long Term Adaptation Scenarios* (LTAS) was a study done by the then Department of Environmental Affairs (DEA) in 2013, which summaries the impact of climate change on South Africa[19]. Significant progress has been made in South Africa since the LTAS was published in terms of the local generation of detailed regional climate models for the country.

The most recent modelling was conducted for South Africa's *Third National Communication*[20]. Some salient points from this national communication and the LTAS are summarised here:

- South Africa's net GHG emissions for 2012 amounted to 518 ktCO2e across all sectors.
- The climate in South Africa is changing notably, when observing the trends from 1931 to 2015. An average temperature increase of around 0.2°C per decade has been observed as the plausible trend, which is twice the global rate of temperature rise.
- There has been an increased number of hot days annually.

[18] Worldometers, 2019, *Current world population*, [Online] Available at: http://www.worldometers.info/world-population/ [Accessed on 08/10/2019].

[19] DEA, 2013, *Long-Term Adaptation Scenarios Flagship Research Programme for South Africa. Climate Trends and Scenarios for South Africa*, Pretoria.

[20] DEA, 2018, *South Africa's Third National Communication under the United Nations Framework Convention on Climate Change*, Pretoria, Republic of South Africa, [Online] Available at: https://unfccc.int/sites/default/files/resource/South%20African%20TNC%20Report%20%20to%20the%20UNFCCC_31%20Aug.pdf [Accessed on 29/04/2020].

- There have also been increased rainfall events in the region of the Eastern Cape near the Gas Distribution Infrastructure.
- Sustained warming and increasing variability in rainfall over the short term (the next decade) will have increasingly adverse effects on key sectors of South Africa's economy in the absence of effective adaptation responses.
- The poorer, more vulnerable groups of society will experience the largest impacts of climate change first. This will occur since these societal groups are both more exposed and sensitive to fluctuations in weather patterns and climatic events like droughts and floods. In addition, poverty and a lack of infrastructure or service provision erodes the adaptive capacity of these communities to climate change, rendering them increasingly vulnerable.

Under globally low mitigation scenarios, as is the case considering current global NDC's[21], South Africa's temperatures are expected to increase drastically[22]. Low mitigation scenarios predict that there will still be significant amounts of CO_2 emitted into the atmosphere prior to 2050, but that these will be closer to half of could be with no emission mitigation at all. Under such scenarios, global temperatures are expected to have increased by >2°C by 2100, and South Africa is expected to experience above average warming.

According to the 2017 LTAS, South Africa will already experience 1°C to 2°C warming by 2035. This is for both low mitigation scenarios and worst-case scenarios. The Eastern Cape is predicted to experience an increased frequency in temperature anomalies between 2015 and 2035 coupled with this rise in average temperature.

Figure 2 below indicates the rainfall pattern projected over the period of 2015 to 2035, 2040 to 2060 and 2080 to 2099. These illustrations show that the south-west regions of South Africa (including the Algoa Bay region) and parts of the eastern coastal areas will already experience a decrease in annual rainfall in the near-term (2015 – 2035). For the central part of the country, there will be increased rainfall until 2060. By the end of the century, the projections indicate a general drying over the whole of South Africa.

21 Climate Action Tracker. [Online] https://climateactiontracker.org/global/cat-emissions-gaps/ [Accessed on 18/01/2021]

22 DEA, 2017, *South Africa's Third National Communication under the United Nations Framework Convention on Climate Change*, Pretoria.

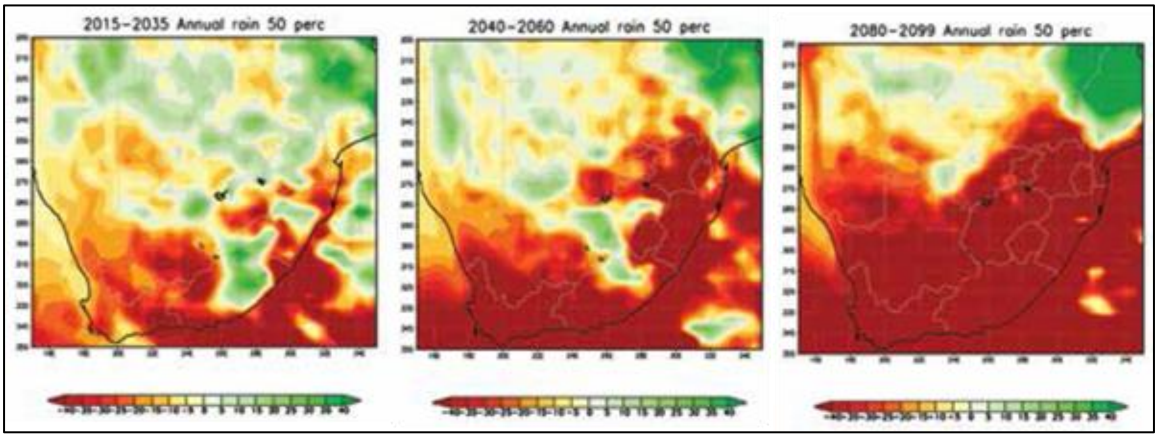

Figure 2: Projected change in the average annual rainfall (mm) over South Africa under low mitigation[23]

3.3 Local context

This section describes the context and key vulnerabilities of the localities surrounding the Gas Distribution Infrastructure, as well as the levels of acceptable change.

3.3.1 Location and population

The Gas Distribution Infrastructure is located in the Coega SEZ, 19 km north of Port Elizabeth. This is indicated in Figure 3 below.

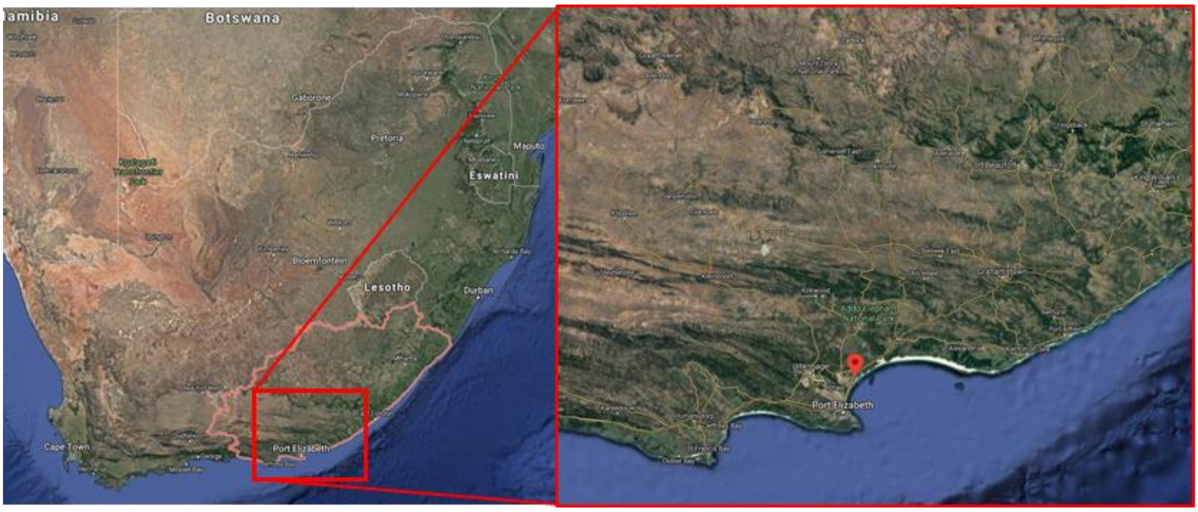

Figure 3: Location of the Coega SEZ near Port Elizabeth in the Eastern Cape of South Africa[24]**.**

The project is located within the Nelson Mandela Bay Metropolitan Municipality (NMBMM). At the last census, the population in the municipality was 1.3 million with a population growth of

[23] DEA, 2013, *Long-Term Adaptation Scenarios Flagship Research Programme for South Africa. Climate Trends and Scenarios for South Africa*, Pretoria.

[24] Google Earth Images. [Accessed on 28/04/2020]

2%[25] and an unemployment rate is 26.7%. The youth unemployment rate was even higher, at 38.2%. The average household size is 3.4 members, with a dependency ratio of 57.3.

The nearest community to the project is Motherwell. During the 2011 census, 140 000 people lived in the community. Most of the residents were connected to the local sewage network and electrical grid. The average household size was 3.6 and more than 60% of the households received an annual income of less than R38 200[26].

3.3.2 Historic local climate

The NMBMM has two predominant climatic regimes, namely temperate and sub-tropical. The temperature range of the region is not extreme, with monthly average maximum temperatures varying from 17-27 °C and the corresponding minimum temperatures varying from 12 – 21 °C. Figure 4 below shows the monthly average temperatures for the last decade in Coega.

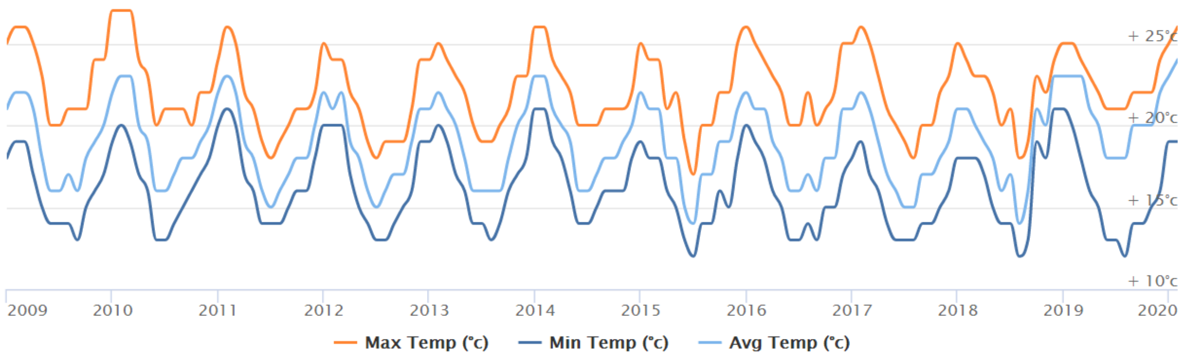

Figure 4: Monthly averaged maximum, minimum and average daily temperatures[27].

It also falls between the summer rainfall regions to the north-east and winter rainfall regions to the west. As a result, it rains year-round with an annual average of approximately 650 mm and a consistent monthly rainfall of 50 - 60 mm. Figure 5 shows the average monthly rainfall amount as well as the average number of rain events within a month.

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25 Municipalities of South Africa, 2020, *Nelson Mandela Bay Metropolitan Municipality (NMA): Demographic Information*, Available at: https://municipalities.co.za/demographic/1/nelson-mandela-bay-metropolitan-municipality [Accessed on 23/04/2020].

26 Stats SA, Motherwell. Available at: http://www.statssa.gov.za/?page_id=4286&id=6716 [Accessed on 23/04/2020].

27 https://www.worldweatheronline.com/coega-weather-averages/eastern-cape/za.aspx

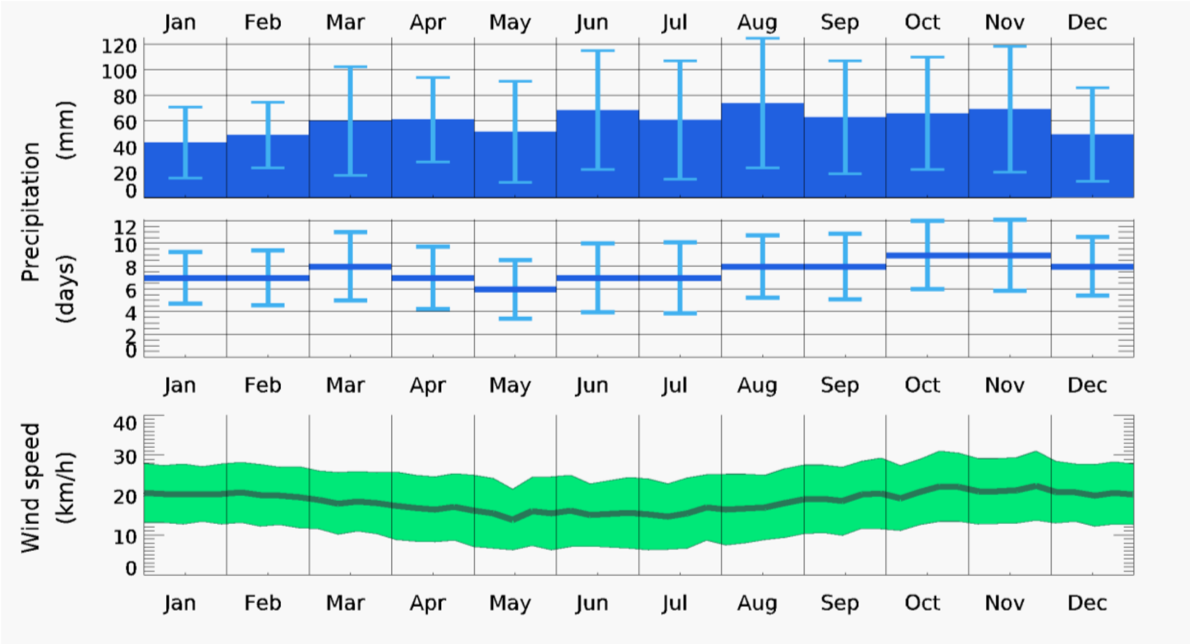

Figure 5: Average monthly rainfall, number of rain events and wind speed[28].

Figure 5 also shows that the area is very windy, with a daily average wind speed close to 20 km/hr.

3.3.3 Local climate change trends

Similarly, to the rest of South Africa, the average temperature in the Coega area of the NMBMM is expected to increase. Two Representative Concentration Pathway (RCP) scenarios, as adopted by the IPCC Fifth Assessment Report, are considered for this[29]. These are RCP 4.5 and RCP 8.5, where RCP 4.5 is a GHG concentration trajectory with emissions peaking at around the middle of the 21st century, whilst RCP 8.5 is the business as usual GHG concentration trajectory. By 2050, the GreenBook tool[30] indicates that the average temperature will increase by between 1.3°C and 1.5°C under the RCP 4.5 scenario and between 1.6°C and 1.9°C under the RCP 8.5 scenario. The number of very hot days is also predicted to increase by up to 7 days.

The area surrounding the project is already under significant water stress, according to the WRI Aqueduct tool. It is likely that total rainfall in the Coega area will increase in the future[31,32], however a significant portion of this increase will be due to an increased frequency of severe rainfall events

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[28] https://www.meteoblue.com/en/weather/historyclimate/climateobserved/coega_south-africa_1013168

[29] The Representative Concentration Pathway (RCP) scenarios (as adopted by the IPCC Fifth Assessment Report) are used in this assessment, which considers the risks associated with climate change impacts on temperature, water, biodiversity, transitional risks and the social context. We have used RCP 4.5 (emissions peaking around the middle of the 21st century) and RCP 8.5 (business as usual/ worst-case scenario).

[30] CSIR, 2019, *Nelson Mandela Bay: Climate (2050)*, [Website] GreenBook, Available at: https://riskprofiles.greenbook.co.za/ [Accessed on 15/04/2020].

[31] CSIR, 2019, *Nelson Mandela Bay: Climate (2050)*, [Website] GreenBook, Available at: https://riskprofiles.greenbook.co.za/ [Accessed on 15/04/2020].

[32] T.A. Ahmed (2018) *The Determination of Cope Levels in Modern Ports: A Case Study for the Port of Ngqura, Coega River Development.*

that could cause inland flooding. The level of water stress is predicted to significantly worsen by 2030, even in the optimistic scenario.

NMBMM is aware of the climate-related risks it faces. The Climate Change and Green Economy Action Plan was developed in 2015 to address these risks. The South African Weather Services assisted the NMBMM to develop a near term (from 2016 to 2055) climate impact scenario, relative to the weather patterns experienced between 1976 and 2005 in NMBMM. These anticipated climate change impacts are indicated in Table 2 below.

Table 2: Projected climate change related threats for Nelson Mandela Bay[33].

Nelson Mandela Bay's Climage Threats	
Change in temperature patterns	More hot days and heat waves; higher minimum temperatures and fewer cold spells; higher average temperature
Change in rainfall patterns	Decreases in average rainfall and number of rainfall events, BUT increase in rainfall intensity
Change in drought patterns	Increase in frequency (i.e. current 1:10 year drought occurs more often)
Change in flood patterns	Increase in intensity (i.e. 1:100 year flood will increase in magnitude)
Change in fire patterns	More frequent fires
Sea level rise	58cm-75cm rise in sea level
Change in storm surge patterns	Higher probablility of extreme storm surges
Change in wind patterns	Strengthening of easterly winds, weakening of westerly winds

3.3.4 Key vulnerability factors

The NMBMM categorizes the poor, the youth and the elderly as vulnerable groups. These more vulnerable groups of society will experience the impacts of climate change first. This will occur

[33] Nelson Mandela Bay Metropolitan Municipality, 2015, Climate Change and Green Economy Action Plan, [Online] Available at: https://www.nelsonmandelabay.gov.za/datarepository/documents/nmbm-climate-change-and-green-economy-action-plan-final.pdf [Accessed on 30/03/2020].

since these societal groups are both more exposed and/or more sensitive to fluctuations in weather patterns and climatic events such as droughts and floods. In addition, poverty and a lack of proper infrastructure or proper service delivery erodes the adaptive capacity of these communities to climate change, rendering them increasingly vulnerable.

The NMBMM has gone on further to categorize a community's climate change vulnerability, depending on the following key variables:

- Food Security;
- Ecosystem supply and buffering capability;
- Damage cost to economy;
- Income;
- Public Infrastructure;
- Impact on private property;
- Impact on employment; and
- Impact on welfare of people.

It is important to consider the effects of the project on these key variables as changes in these could significantly increase a community's vulnerability towards climate change and compromise their adaptability as well as any mitigation actions that might be taken.

Some of the surrounding environment is also highly vulnerable. One such area is Jahleel Island, just off the coast of the Port of Ngqura. It, as well as several other islands in the Algoa Bay, are used by several of South Africa's resident seabird species for breeding. These islands play a national and international role in the conservation of the Cape gannet, African penguin and Roseate tern. The Damara tern, a breeding endemic, also make use of the Algoa Bay area for roosting and occasionally for breeding.

The Eastern Cape Government has also published a Climate Change Response Strategy[34], which also highlighted some climate change vulnerabilities. However, this was not considered for two reason:

1. The document is significantly out of date, having been published in 2011. Since then several important national documents have been updated, such as the IRP, which are fundamental to how South Africa plans to tackle climate change on a national scale. Furthermore, there have been significant advances in climate science on the international level, which have led to the updates of the IPCC 2°C and 1.5°C scenarios, as well as developments in international commitments, culminating in the Paris Agreement of 2015. The Paris Agreement was ratified by South Africa in 2016. Also, the Carbon

[34] Department of Economic Development and Environmental Affairs, Eastern Cape (2011). *Eastern Cape Climate Change Response Strategy*.

footprint used to inform this document was based on emissions in 2008. Since then, the emissions profile of the province will have changed significantly.

2. The Gas-to-Power plants contribute to the national IRP published in 2019 and enable South Africa as a nation to move towards a lower carbon economy. Furthermore, the development of these projects reduces the stresses on the already ailing Eskom system, most of whose generating capacity is in the North-Eastern sections of South Africa. The decentralised nature of this project then also reduces national energy losses related to transmission and distribution. Thus, even though the Gas Infrastructure and the Gas-to-Power plants are situated in the Eastern Cape, they play an important role in South Africa's national electricity needs and national grid stability.

3.3.5 Existing impacts on the site

In 2011, the Coega River flooded after a severe storm, causing around R 2.6 million in damages. The severity of the storm was a 1-in-10-year storm event. Thus, similar flood events can be expected to occur every 10 years.

Another impact is that Coega has recently recorded a record breaking maximum daily temperature. The highest temperature recorded in Coega occurred in 2017, at 45°C, breaking the record that has only stood since 2012.

3.4 Levels of acceptable change

Climate change could cause significant changes to various facets of the biological, social, and economic environment in and around the Coega SEZ. It is important that the following studies take the climate change impacts into consideration, as they could be significantly impacted by climate change:

- It is important that the ecological study takes into consideration that climate change could impact various aspects of the local ecology. For the marine environment, aspects that could be affected include migratory habits, breeding success and feeding habits of various species. In general, the sensitivity of endemic species to climatic changes, such as increasing average temperatures, should also be considered. The changing climate could also cause a shift in biomes that needs to be considered.
- Studies focusing on the social impact of the project should also take into consideration changes of social norms that could be caused by climate change as well as other behavioural changes. These studies should also consider that climate change could change the attitude towards the SEZ and its projects as well as how people interact with them.

4 CCIA Methodology

The methodology used within this CCIA was informed by:

(i) The nature of climate change;

(ii) The project development timeframes; and

(iii) The long-term climate change impacts anticipated for the Coega SEZ and surrounding areas.

4.1 Project Impact

The proposed Gas Distribution Infrastructure project will result in GHG emissions. It is important to quantify the amount of GHG emissions and the possible impact that the GHG emissions could have. The methods of determining the impacts of the project on climate change are discussed below.

4.1.1 Greenhouse gas inventory development

The GHG inventory was developed assuming 121 deliveries per year of 140 000m^3 of LNG per delivery, or a total of 16.94 million m^3 of LNG being processed by the Gas Distribution Infrastructure per year.

4.1.1.1 Standards used

The quantification of the impacts of the proposed Gas Distribution Infrastructure on climate change have been guided by the following reference documents for this CCIA:

- *ISO/SANS 14064:2006 Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals* [35,36]
- The Greenhouse Gas Protocol's *A Corporate Accounting and Reporting Standard (Revised Edition)*[37];
- DEA's *Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry*[38]; and
- The 2006 IPCC *Guidelines for National Greenhouse Gas Inventories*[39].

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35 Standards South Africa, 2006, *SANS 14064-1:2006 Greenhouse Gases Part 1: Specification with guidance at the organisational level for the quantification and reporting of greenhouse gas emissions and removals*, Pretoria.

36 Note that the international standard ISO 14064 was updated in 2018, but that South Africa has not yet adopted the updated ISO14064:2018 as a South African standard.

37 Greenhouse Gas Protocol, 2015, *A Corporate Accounting and Reporting Standard: Revised Edition*.

38 DEA, 2016, *Technical Guidelines for Monitoring, Reporting and Verification of GHG Emissions by Industry*.

39 IPCC, 2006, *IPCC Guidelines for National Greenhouse Gas Inventories*, [Online] Available at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/ [Accessed on 05/04/2020].

The ISO14064-1 standard and the Greenhouse Gas Protocol's Corporate Accounting and Reporting Standard classify the GHG emissions into different scopes:

- **Scope 1** – direct emissions resulting from the operations of the activity;
- **Scope 2** – energy indirect emissions associated with the generation of the electricity consumed by the activity; and
- **Scope 3** – all other indirect emissions. This can be further divided into upstream emissions downstream emissions.

The carbon footprint for both the construction and operational phases of the proposed Gas Distribution Infrastructure is guided by the *ISO/SANS 14064-1 Standard*. The standard specifies principles and requirements used to quantify the GHG emissions and possible removals associated with the proposed project. The basic principles of the standard ensure that the GHG emissions inventory conducted for a project are true and fair. These principles are summarised in Table 3 below.

Table 3: ISO/SANS 14064-1 principles for carbon footprints

Relevance	Selecting all the greenhouse gas sources, sinks, reservoirs, data and methodologies that are appropriate.
Completeness	Including all the greenhouse gas emissions and removals relevant to the proposed project.
Consistency	Enable meaningful comparisons to be made with other greenhouse gas related information.
Accuracy	Reducing bias and uncertainties as far as is practical.
Transparency	Disclosing enough and appropriate greenhouse gas related information to allow intended users to make decisions with reasonable confidence.

The principles of this standard are applied in this CCIA to determine the approximate GHG emissions of the proposed Gas Distribution Infrastructure. The calculation of the GHG inventory for the proposed project follows the general steps stipulated here:

- Boundaries of the analysis are set;
- GHG sources inside the boundary are identified;
- Quantification method is established; and
- GHG emissions inventory is calculated.

The Greenhouse Gas Protocol's Corporate Accounting and Reporting Standard is also used in this analysis. This Standard classifies other indirect GHG emissions into two categories, namely:

- Upstream GHG emissions (related to purchased and/or acquired goods and services); and
- Downstream GHG emissions (related to sold goods and services).

4.1.1.2 Calculation Method

The direct and indirect emissions for both the construction and operational stages of the proposed Gas Distribution Infrastructure, as well as the upstream and downstream activities, are considered.

Limited data was available with regards to detailed designs of the Gas Distribution Infrastructure. Thus, some calculations were based on a case study published by the U.S. Department of Energy[40] (US Case Study).

The US Case Study considered various natural gas supply scenarios for a gas-to-power station based in the Netherlands. The calculations in this assessment were based on Scenario 1 of this case study.

In Scenario 1 of the US Case Study, the natural gas is extracted from Marcellus Shale and piped to an LNG facility for liquefaction and loading onto an LNG carrier. It is then shipped to the receiving port of Rotterdam. There it is regasified and transported to a gas-to-power station near the LNG import site.

The above described scenario is very similar to what will likely occur for the Gas Distribution Infrastructure in Coega. The natural gas will be extracted and liquified in the country of origin. Most of the big LNG exporters are not within piping distance, thus the LNG will be shipped over great distances via an LNGC to Coega. The regasification will occur in the Coega harbour and the natural gas will be utilised in the nearby gas-to-power stations in Zones 10 and 13 as well as other third-party consumers.

The relevant activities included in this case study were the following:

- Natural gas extraction;
- Natural gas processing;
- Domestic pipeline transport in the country of production;
- Liquefaction;
- Tanker transport to the destination country;
- Tanker berthing & deberthing;
- LNG storage;
- LNG regasification; and
- LNG dispatch via pipelines and loading facilities.

The data for these activities was given as emission intensities (kg CO_2e/MWh electricity output) and is shown in Table 5 in Section 4.1.3.1.

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[40] Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States. (2014) U.S. Department of Energy.

These intensities are given in CO_2 equivalents (CO_2e). A CO_2 equivalent is when the emissions of another gas are equated to an equivalent amount of CO_2 using the 100-year global warming potential (GWP) of that gas. The GWP of any GHG is the amount of heat absorbed per mass unit of a GHG divided by the amount of heat an equivalent amount of CO_2 would absorb over the specified period.

These intensities were converted to emissions per unit natural gas input (kg CO_2e/natural gas input) using the assumed efficiency of the closed-cycle gas turbines reported in the case study (see Table 6 in Section 4.1.3.2). This was calculated as follows:

$$EA_{Methane} = EA_{Elec} \times \varepsilon \times \frac{1\,MWh}{3.6\,GJ} \times \frac{1\,tCO_2}{1\,000\,kgCO_2}$$

- $EA_{Methane}$ represents the emission of an activity per unit of natural gas consumed, measured as tCO_2e/GJ;
- EA_{Elec} represents the emission of an activity per unit of electricity generated, measured as $kgCO_2e/MWh$;
- ε represents the conversion efficiency of natural gas consumed to electricity generated reported in the case study.

The total throughput of natural gas through the Gas Distribution Infrastructure was then calculated. The assumed total number of ships per year and assumed capacity of the ships, as stated in the *Scoping Report* (see Table 5), was used as well as the net calorific value[41] (NCV) and density of natural gas:

$$\begin{aligned} &Annual\ Natural\ Gas\ Throughput \\ &\quad = Ships\ per\ Annum \times Capacity\ of\ Ships \times Density\ of\ LNG \\ &\quad \times NCV\ of\ Natural\ Gas \times \frac{1\,GJ}{1\,000\,MJ} \end{aligned}$$

Where:

- the natural gas throughput is measured in GJ/a;
- the capacity of the ships is measured in m^3;
- the density is measured in kg/m^3; and
- the NCV is measured in MJ/kg.

The annual emissions per activity were then calculated according to this annual throughput of natural gas as follows:

$$Annual\ Emissions\ per\ Activity = Annual\ Natural\ Gas\ Throughput \times EA_{Methane}$$

[41] This is the amount of energy released by the burning of a substance.

The emissions associated with the use of the natural gas were calculated by determining the emissions resulting from the combustion of the natural gas that passes through the Gas Distribution Infrastructure. This was performed by using the relevant emissions factors and 100-year GWP, as indicated below:

$$Combustion\ Emissions = Annual\ Natural\ Gas\ Throughput \times \left[EF_{CO_2} + \left(EF_{CH_4} \times GWP_{CH_4}\right) + \left(EF_{N_2O} \times GWP_{N_2O}\right)\right] \times \frac{1\ TJ}{1\ 000\ GJ} \times \frac{1\ tCO_2e}{1\ 000\ kgCO_2e}$$

Where:

- EF_X is the Emission Factor of gas *X*, measured in kg*X*/TJ; and
- GWP_X is the 100-year Global Warming Potential of gas *X*, measured in $kgCO_2e$/kg*X*.

4.1.1.3 Environmental impact assessment criteria

According to the *Environmental Impact Assessment (EIA) criteria* (listed in Table 4 below), a criterion is provided to describe and assess *local* environmental impact. Since climate change is a global phenomenon, the criterion is not fully applicable to an assessment of the impacts of GHG emissions on climate change. However, the EIA criterion is currently the best tool for the development of CCIAs and is thus used for this assessment.

Promethium Carbon, as the climate change specialist, has amended the quantification of "Magnitude (M)" in the table below, to align the methodology with international best practice (as mentioned in Section 4.1.1.1), as supported during the peer review process of the *Thabametsi climate change impact assessment*[42].

The following criteria is used to assess the climate change impacts associated with the GHG emissions produced from the proposed Gas Distribution Infrastructure.

Table 4: Environmental impact assessment criteria

Nature	A description of what causes the effect, what will be affected and how it will be affected.
Extent (E)	An indication of whether the impact will be local (limited to the immediate area or site of development), regional, national, or international.
Duration (D)	An indication of the lifetime of the impact quantified. This includes durations that are; very short, short, medium-term, long term or permanent.

[42] EOH Coastal and Environmental Services, 2017, *Peer Review of the Climate Change Study for the Proposed Thabametsi Coal Fired Power Plant*, Berea, and East London.

Magnitude (M)	The magnitude of this proposed Gas Distribution Infrastructure will be determined considering the rating system described in Section 4.1.4.1 of this CCIA.
Probability (P)	An indication of the likelihood of the impact occurring. This includes very improbable, improbable, probable, highly probable, and definite with the impact occurring regardless of any prevention measures.
Significance (S)	The significance is based on the combination of the above categories and summarises the above into a single classification. This includes low, medium, and high.

The impact status can be described as one of three options: *positive*, *negative,* or *neutral*. Additional details are also provided regarding when the impact can be reversed, when the impact may cause irreplaceable loss of resources and the extent to which the impact can be mitigated.

4.1.2 Potential avoided emissions

The potential avoided emissions associated with the development of the Gas Distribution Infrastructure were calculated with reference to the Avoided Emissions Framework[43]. This framework follows a step-by-step approach which identifies all life cycle emissions for both the baseline scenarios as well as the life cycle emissions associated with the proposed operations scenario. This framework considers rebound emissions, conservative assumptions, and general sense checks, while always considering the most conservative approach.

Avoided emissions could be achieved by the Gas Distribution Infrastructure due to a switch in primary fuel source from coal to natural gas in downstream consumers.

The analysis presented in this report is offered as an indication of the potential impact that this project could have on the South Africa's emission profile. It is not offered as calculation of what emissions will be avoided by the implementation of the project, as there are too many unknowns regarding the possible replacement of coal with natural gas as a fuel. This analysis should therefore be seen as indicative of the contribution that the project can make.

The first step in calculating potential avoided emissions is determining the baseline. The product being supplied to the market through the Gas Distribution Infrastructure is natural gas as a fuel. It is assumed that this fuel replaces the use of coal as a fuel. Thus, the baseline scenario is the combustion of coal as a fuel source. This is independent of what process requires the coal/natural gas as a fuel source, whether it is for boilers, heaters, electricity generation or smelters.

[43] Stephens, A. & Thieme, V., 2019, *Towards >60Gigatonnes of Climate Innovations: Module 2. The Avoided Emissions Framework*, Missions Innovation.

The potential avoided emissions are the difference in emissions per unit of heat energy supplied from natural gas vs coal. These are only potential avoided emissions and are indicative of how the use of natural gas contributes to shifting South Africa towards a low-carbon economy.

The amount of energy that could be generated using these fuels is dependent on the respective NCVs. The energy that can be generated by natural gas is calculated as follows:

$$Annual\ Energy\ Generated = Annual\ Natural\ Gas\ Throughput \times NCV\ of\ Natural\ Gas$$

The emissions of the natural gas were calculated previously in Section 4.1.1.

The amount of emissions generated by the combustion of coal to achieve the same energy production can then be calculated using the emission factors and global warming potentials listed in Table 6. Thus, the amount of combustion emissions from coal is calculated as follows:

$$Coal\ Combustion\ Emissions = Annual\ Energy\ Generated \times \frac{1\ tCO_2}{1000\ kgCO_2} \times \frac{1\ TJ}{1000\ GJ} \times \left[EF_{CO_2} + \left(EF_{CH_4} \times GWP_{CH_4}\right) + \left(EF_{N_2O} \times GWP_{N_2O}\right)\right]$$

Where:

- EF_X is the Emission Factor of gas X for coal, measured in kg gas X/TJ; and
- GWP_X is the 100-year Global Warming Potential of gas X, measured in kg CO_2/kg gas X.

The extraction emissions from coal also need to be accounted for. No data is available for these emissions in South Africa's coal sector. The well-to-tank emission factor listed by the United Kingdom's Department for Environment, Food and Rural Affairs (DEFRA)[44] was used to calculate these emissions as follows:

$$Extraction\ Emissions = WTT_{Coal} \times Annual\ Energy\ Generated \times \frac{1\ tCO_2e}{1000\ kgCO_2e} \times \frac{1\ kWh}{0.0036\ GJ}$$

Where:

- WTT_{Coal} is the emission factor used to account for the upstream Scope 3 emissions associated with extraction, processing and transportation of the coal from the source to the point of use, measured in $kgCO_2e/kWh$.

[44] DEFRA, 2020, *UK Government GHG Conversion Factors for Company Reporting*.

The total emissions generated for the use of coal as a fuel source are the sum of the above calculations:

$$Total\ Coal\ Emissions = Coal\ Combustion\ Emissions + Extraction\ Emissions$$

The difference in the total annual emissions related to the use of coal as a fuel source and the total annual emissions related to natural gas is calculate as the potential avoided emissions, if any.

$$\begin{aligned} &Potential\ Avoided\ Emissions \\ &\qquad = Total\ Coal\ Emissions \\ &\qquad - Total\ Gas\ Distribution\ Infrastructure\ Emissions \end{aligned}$$

These avoided emissions are indicative of the emissions that could be saved if the fuel used in processes is switched from coal to natural gas. This is regardless of the actual process that the fuel is used for.

4.1.3 Data used

Multiple reference documents are used for the development of the GHG inventory of this CCIA. The two main data requirements are (i) Activity Data and (ii) Emission Factors. The combination of these two data sets result in the development of a GHG inventory. The sources of these data sets vary and are discussed in further detail in the sections below.

4.1.3.1 Activity data

The data used throughout this assessment was obtained from multiple sources. These include the Scoping Report of the proposed power generation project[45] and The US Case Study [46]. The key activity data used for this CCIA's GHG inventory development are indicated in Table 5.

Table 5: List of activities the produce GHG emissions.

Activity data	Value	Unit	Source
Number of LNGC	121	ships/a	Scoping Report
Volume of LNGC	140 000	m^3/ship	Scoping Report
Tanker Berthing & Deberthing	1.5	$kgCO_2e$/MWh output	US Case Study
LNG Regasification	17.7	$kgCO_2e$/MWh output	US Case Study
Natural Gas Extraction	29.0	$kgCO_2e$/MWh output	US Case Study
Natural Gas Processing	32.1	$kgCO_2e$/MWh output	US Case Study

[45] SRK Consulting, 2019, *Proposed Coega 3000MW Integrated Gas-to-Power Project Draft Scoping Report*, Report Number 494090/2, Coega Development Corporation.

[46] Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States. (2014) U.S. Department of Energy.

Domestic Pipeline Transport	27.8	$kgCO_2e$/MWh output	US Case Study
Liquefaction	63.6	$kgCO_2e$/MWh output	US Case Study
Tanker Transport	24.7	$kgCO_2e$/MWh output	US Case Study
Case study turbine efficiency	0.464	J electrical output/ J natural gas input	US Case Study

4.1.3.2 Emission factors

It is important that the emission factors used in GHG inventory calculations are appropriate for the local context and relevant to the technology being assessed. Where possible, emission factors have been sourced from South Africa's *Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emission by Industry*[47] (Technical Guidelines), which relies on the IPCC's *2006 Guidelines*[48].

The latest emission factors from the UK's Department of Environment, Food and Rural Affairs[49] (DEFRA) data sets were used where local or domestically approved emission factors were not available.

The emissions factors are presented in tonnes of CO_2e where possible. This takes into consideration the GWP of all emitted greenhouse gases over 100 years. The included gases are CO_2, CH_4 and N_2O. The emission factors and conversion factors used in this CCIA are presented in Table 6 below.

Table 6: Emission and conversion factors

Emissions	Value	Unit	Reference
CO_2 Emission Factor of Natural Gas	56 100	$kgCO_2$/TJ	Technical Guidelines Table A.1
CH_4 Emission Factor of Natural Gas	1	$kgCH_4$/TJ	Technical Guidelines Table A.1
N_2O Emission Factor of Natural Gas	0.1	kgN_2O/TJ	Technical Guidelines Table A.1
CO_2 Emission Factor of Coal	94 600	$kgCO_2$/TJ	Technical Guidelines Table A.1
CH_4 Emission Factor of Coal	1	$kgCH_4$/TJ	Technical Guidelines Table A.1

[47] DEA, 2017, *Technical Guidelines for Monitoring Reporting and Verification of Greenhouse Gas Emissions by Industry*, [Online] Available at: https://www.environment.gov.za/sites/default/files/legislations/technicalguidelinesformrvofemissionsbyindustry_0.pdf [Accessed on 09/10/2019].

[48] IPCC, 2006, *2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 Energy*, Intergovernmental Panel on Climate Change, [Online] Available at: https://www.ipcc-nggip.iges.or.jp/support/Primer_2006GLs.pdf [Accessed on 09/10/2019].

[49] DEFRA, 2020, *UK Government GHG Conversion Factors for Company Reporting*.

Emissions	Value	Unit	Reference
N_2O Emission Factor of Coal	1.5	kgN_2O/TJ	Technical Guidelines Table A.1
100-year GWP of CH_4	23	$kgCO_2e/kgCH_4$	Technical Guidelines Annex H
100-year GWP of N_2O	296	$kgCO_2e/kgN_2O$	Technical Guidelines Annex H
Density of LNG	430	kg/m3	International Group of Liquefied Natural Gas Importers
Net Calorific Value of natural gas	48	MJ/kg	Technical Guidelines Table A.1
Net Calorific Value of coal	19.2	MJ/kg	Technical Guidelines Table A.1
Well-to-Tank Coal (electricity generation)	0.05238	$kgCO_2e/kWh$	DEFRA, UK Government GHG Conversion Factors for Company Reporting

4.1.4 Determining project impact on climate change

The context within which the EIA reporting requirements were developed to describe and assess environmental impacts, have yet to be applied to GHG emissions, with a global impact. For this reason, a materiality threshold was defined based on international best practice (and in accordance with the peer review done for the Thabametsi CCIA).

The IPCC's Special Report (2018) indicates that the world can emit 580 gigatons of CO_2e if the effect of climate change is to be limited to a 1.5°C temperature increase by 2100. This figure is the global carbon budget.

A carbon budget is a baseline tool generally used to indicate the maximum amount of emissions that can be emitted within a specified timeframe.

Annex A of the Equator Principles[50] provides guidance on climate change risks assessments and the requirements. These state that a project must "*…also consider [the Project's] compatibility with the host country's national climate commitments, as appropriate.*"

[50] Equator Principles, 2020, The Equator Principles: July 2020, [Online] Available at: https://equator-principles.com/wp-content/uploads/2020/05/The-Equator-Principles-July-2020-v2.pdf

The IFC Performance Standards note the following in terms of Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts[51]:

- Paragraph 7: "*The type, scale, and location of the project guide the scope and level of effort devoted to the risks and impacts identification process. The scope of the risks and impacts identification process will be consistent with good international industry practice, and will determine the appropriate and relevant methods and assessment tools.*"
- Paragraph 7: "*The risks and impacts identification process will be based on recent environmental and social baseline data at an appropriate level of detail.*"
- Paragraph 7: "*The risks and impacts identification process will consider the emissions of greenhouse gases, the relevant risks associated with a changing climate and the adaptation opportunities…*"

The Equator Principles stipulates that climate change risk assessments must consider "national commitments". In this regard the South African budget (Section 3.2.3) is an appropriate local contextualisation of South Africa's climate commitments under the 2015 Paris Agreement. In addition, the IFC Performance Standards highlight the need for "*appropriate and relevant*" risk assessment methodologies, using "*recent environmental baseline data*". The South African carbon budget meets these requirements in terms of risk assessment, specifically considering the global nature of climate change and the need to assess localised greenhouse gas contributions thereto.

4.1.4.1 Outcomes of greenhouse gas inventory analysis

The South African carbon budget will be used to benchmark the emissions to be released by the proposed Gas Distribution Infrastructure. The following impact ratings (see Table 7) have been identified as a means of benchmarking GHG inventories, over the lifetime of any specific activity, related to emissions that occur within the boundaries of South Africa.

Table 7: The South African carbon budget associated rating scale for comparison analysis.

	GHG emissions generated (tCO_2e)		Percentage of South Africa's carbon budget over the life of the project	
GHG impact rating as a % of SA's carbon budget	Lower limit	Upper limit	Lower limit	Upper limit
Low	0 tCO_2e	10 000 tCO_2e	0%	0.000227%
Medium	10 001 tCO_2e	1 000 000 tCO_2e	0.000227%	0.0227%
High	1 000 001 tCO_2e	10 000 000 tCO_2e	0.0227%	0.227%
Very High	10 000 001 tCO_2e	+	> 0.227%	

[51] IFC, 2012, IFC Performance Standards on Environmental and Social Sustainability, International Finance Corporation, World Bank Group.

The categorisation indicated in Table 7**Error! Reference source not found.** will be used to indicate the intensity of the climate change impacts, as described in Section 4.1.1.3. The method indicated in Section 4.1.1.3 only had *Low*, *Medium* and *High* categories for the intensity of the impact. Therefore, the *Very High* category described in Table 7 will default to "*High*" to align with the method recommended by the Environmental Assessment Practitioner.

4.1.5 Limitations and assumptions

The Coega Gas-to-Power Project is still in the planning phase. Thus, there are numerous uncertainties regarding the final designs and ultimate GHG emissions contribution that will be made by the Gas Distribution Infrastructure to global anthropogenic climate change. Several assumptions are necessary for the evaluation of this CCIA, based on publicly available documentation used for the greenhouse gas quantification of this project. These are listed below:

- The project lifetime is assumed to be 30 years[52].
- The use of natural gas replaces the use of only coal as a fuel source as it would be more readily available to the market. The fuel could be used for various processes; such as boilers, heaters, electricity generation and furnaces.
- Based on past experiences of the Promethium Carbon team, the following were assumed to be immaterial towards the GHG footprint of the Gas Distribution Infrastructure during both construction and operation:
    - Mobile combustion associated with the use of vehicles on the project site;
    - Stationary combustion from backup generators;
    - Employee Commuting;
    - Quantity of construction and municipal waste generated, including the distance transported to landfill;
    - Emissions associated to nitrogen and LPG use as blending agents;
    - Purchase of capital goods, such as vehicles; and
    - Business travel.

The CCIA is also subject to certain limitations listed below:

- This assessment was limited to a desktop study;
- No modelling was done to determine LNG use patterns in South Africa;
- No modelling was done to determine changes in emissions intensity of LNG production;
- No climate change modelling was performed;
- The impact of changing legislation was not considered;
- The impact of a changing economy was not considered;

[52] Power Generation Technology Data for Integrated Resource Plan of South Africa. (2017) Department of Energy

- Detailed design document for the Gas Distribution Infrastructure were not available;

4.2 Project Resilience

Despite the global and national commitment to limiting global temperature increase to 2 °C, the NDCs of all countries combined cover only around one third of the emission reductions needed to achieve this goal. Thus, future climate change impacts are a reality and the resilience of the Gas Distribution Infrastructure to these impacts needs to be considered.

Significant climate change impacts are anticipated to affect South Africa, and in turn the proposed Gas Distribution Infrastructure, regardless of whether the global community implements their NDCs or not. Consequently, while the impact of the Gas Distribution Infrastructure on climate change may be small, the impact of climate change on the Gas Distribution Infrastructure could potentially be large.

The key risks resulting from climate change impacts include increased land-surface temperatures, increased rainfall variability, decreased overall rainfall, and increased frequency and intensity of extreme weather events. The impacts of these risks include decreased water availability, infrastructure damages, increased health problems and other such effects.

Climate change management should therefore not be limited to emissions reductions (mitigation) and should focus on adaptation measures as well. Identifying impacts of climate change on the proposed Gas Distribution Infrastructure will therefore be considered in this assessment.

4.2.1 International best practice

As previously mentioned in the introduction, South African laws (mostly considered under the umbrella of the National Environmental Management Act - or NEMA) do not provide adequate information and guidelines for the development of the required CCIAs, specifically with regards to unpacking and quantifying vulnerability and resilience to climate change. Thus, this report makes use of emerging and globally accepted international best practice, including:

- International Council on Mining and Minerals (ICMM): Adapting to climate change[53];
- GIZ Framework for Climate Change Vulnerability Assessments;
- International Finance Corporation Performance Standards[54];
- European Bank for Reconstruction and Development principles; and

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53 International Council on Mining and Minerals, 2013, *Adapting to a changing climate: implications for the mining and metals industry*. ICMM.

54 International Finance Corporation, 2012, *Performance Standards*, [Online] Available at: https://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/Sustainability-At-IFC/Policies-Standards/Performance-Standards [Accessed on 30/04/2020].

- The Equator Principles[55].

These enables us to adequately assess climate change impacts considering available baselines and relevant information. The abovementioned documents were also used to develop a rating system (indicated in **Error! Reference source not found.** in Section **Error! Reference source not found.** of this report) to which the current Gas Distribution Infrastructure is benchmarked.

4.2.1.1 Standards used

There is currently no guidance in South Africa for assessing the vulnerability and resilience of a project that considers the broad spectrum of the fields of influence that such a project has. Using the basis of the guidance from other sectors[56], Promethium Carbon has adapted the principles for resilience and vulnerability assessments. The resilience and vulnerability assessment conducted for this CCIA makes consideration for 4 key areas (listed in Table 8) that are impacted on/by the Gas Distribution Infrastructure.

Table 8: Key areas of impact.

Area of Impact	Relevance
The core operations;	These are operations that are performed by the Gas Distribution Infrastructure and that its management has complete control over.
The value chain (both upstream and downstream);	These are operations that are related to the Gas Distribution Infrastructure, but that its management does not have control over. These include activities of suppliers, customers, government, and the greater economic market.
The social environment (surrounding/ impacted communities); and	This includes the people that are both directly and indirectly affected by the Gas Distribution Infrastructure, such as employees, surrounding industry and local communities.
The natural environment.	This is related to the natural environment directly surrounding the operations of the Gas Distribution Infrastructure. These support said operations as well as those of surrounding industry and the livelihoods of the local communities.

For widescale considerations of the impacts of climate change, all four of the abovementioned aspects will be impacted by climate change and the proposed Gas Distribution Infrastructure.

55 The Equator Principles Association, 2020, *Equator Principles EP4*, [Online] Available at: https://equator-principles.com/about/ [Accessed on 30/04/2020].

56 International Council on Mining and Minerals, 2013, *Adapting to a changing climate: implications for the mining and metals industry*. ICMM

4.2.2 Data used

This vulnerability assessment refers to various data sources in the process of determining the key vulnerability factors faced by the proposed Gas Distribution Infrastructure. These sources include:

- The WRI Water Aqueduct Tool;
- The South African Risk and Vulnerability Atlas;
- The Green Book Tool;
- The NMBMM Integrated Development Plan; and
- Various other sources of local climate, vulnerability, and demographic factors.

4.2.3 Determining the vulnerability and resilience of the project

The overall vulnerability and resilience of the Gas Distribution Infrastructure and its surroundings to climate change impacts can be determined through identifying the exposure, sensitivity, and adaptive capacity of the surrounding region. The interrelation of these aspects impacting on vulnerability and resilience are summarised in Figure 6 below.

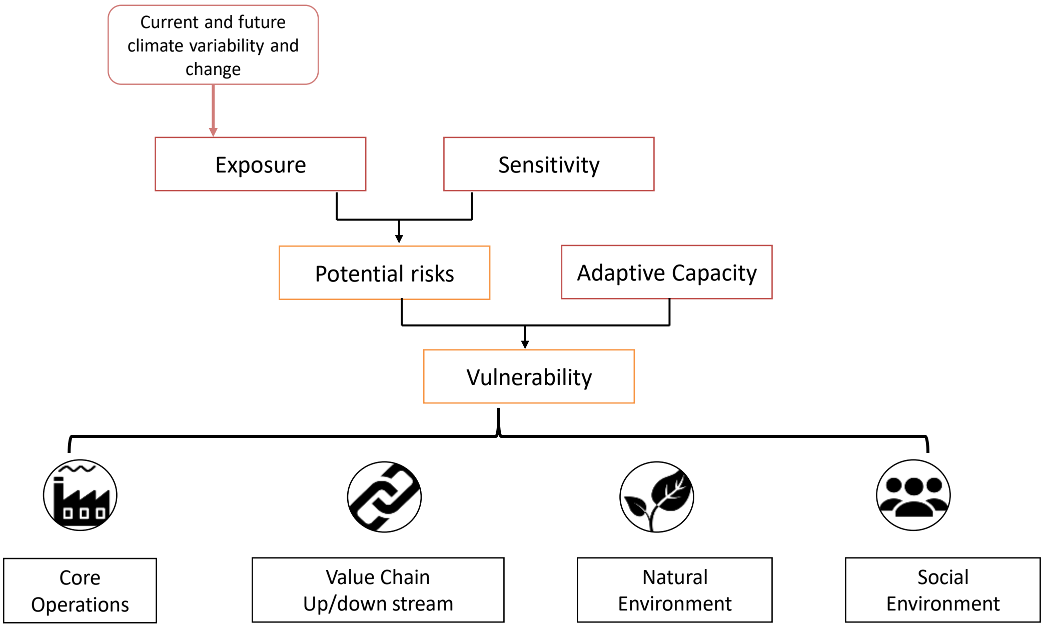

Figure 6: Interrelations of Exposure, Sensitivity and Adaptive Capacity which makes up the basis of the vulnerability and resilience assessment[57].

In accordance with the guidance used, Figure 6 indicates the vulnerability and resilience as a function of the exposure, sensitivity, and adaptive capacity. This is applicable for the core

[57] International Council on Mining and Minerals, 2013, *Adapting to a changing climate: implications for the mining and metals industry*. ICMM.

operations of the proposed Gas Distribution Infrastructure and its value chain. It also refers to the natural and social environments surrounding the Gas Distribution Infrastructure. The diagram illustrates that climate change impacts and variability could result in changes in the exposure levels experienced in this region.

The vulnerability and resilience assessment is conducted in light of the impact of climate change on the region's exposure. Thereafter, the overall vulnerability and resilience is determined using the project exposure, the sensitivity, and the present-day adaptive capacity.

4.2.4 Limitations and assumptions

The Gas Distribution Infrastructure's vulnerability and resilience to climate change is assessed within this CCIA through an analysis of available datasets. The limited availability of data results in increased uncertainties regarding the full extent and accuracy of the possible climate change impacts affecting the Gas Distribution Infrastructure's operations, its supply chain, the surrounding communities, and the surrounding environment.

The assessment of the vulnerability of the project to climate change is subject to further limitations, namely:

- The natural and social environments were limited to the area surrounding the Gas Distribution Infrastructure;
- Only impacts on the direct value chain was assessed;
- No modelling of climate change impacts was conducted; and
- Only impacts occurring during the lifetime of the project were considered.

4.3 Cumulative impacts of the proposed development

In terms of the NEMA Environmental Impact Assessment Regulations, 2014, cumulative impact is defined as follows:

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities.

This definition, whereas appropriate to the context of localised environmental impact, is not applicable to the global, variable nature of climate change. Greenhouse gas emissions associated with a project or an activity, whilst contributing to global climate change, cannot be directly linked to specific local impacts.

For the climate change impact assessment (in terms of the Thabametsi case judgement), greenhouse gas emissions are quantified to determine the impact of a project on climate change. Since the project impact on climate change (the project's greenhouse gas emissions) cannot be directly linked to local impacts, it is not possible to determine / quantify cumulative impacts associated with other gas to power projects within a 30 km radius of the site.

This climate change impact assessment does however consider the cumulative nature of climate change. This is achieved by contextualising impact in terms of the global carbon budget, and on a national level by using the South African carbon budget.

In terms of the project's vulnerability to climate change, this assessment considers climate change trends impacting both the project and its context. The granularity of this component of the climate change impact assessment relates to a broader area, indicating existing project or contextual risks which could be exacerbated.

5 Project impact on climate change

The Gas Distribution Infrastructure will result in GHG emissions to the global atmosphere. The impact of the proposed project is quantified by developing a GHG inventory. The GHG inventory quantifies the various emissions sources and is discussed below.

5.1 Project greenhouse gas inventory

The necessary facilities and infrastructure, as described in Section 2.3, will be built during the construction phase of the Gas Distribution Infrastructure.

No detailed designs were available from which to calculate the emissions originating from the construction of the Gas Distribution Infrastructure. After investigating available literature, it was determined that the contribution of the construction of the facility to the life-cycle greenhouse gas emissions of the Gas Distribution Infrastructure is negligible58.

The results of the operational phase of the GHG Inventory for the Gas Distribution Infrastructure are shown in and Table 9: Scope 1 and Scope 2 emissions of the Gas Distribution Infrastructure.

Activity	Annual GHG emission	Lifetime GHG emissions
Tanker Berthing & Deberthing	67 600 tCO2e/a	2 million tCO2e
LNG Regasification	798 000 tCO2e/a	24 million tCO2e
Total	**865 000 tCO2e/a**	**26 million tCO2e**

The Scope 1 and Scope 2 emissions were summarised into the following categories: Tanker Berthing & Deberthing and LNG Regasification. These categories are based on the US Case Study. The total Scope 1 and Scope 2 emissions for the Gas Distribution Infrastructure will be 865 000 tCO_2e per annum. With an assumed project life span of 30 years[59], this amounts to 26 million tCO_2e throughout the lifespan of the Gas Distribution Infrastructure project. These emissions are related to a total annual throughput of 16.9 million m^3 of LNG per year.

[58] Life Cycle Assessment of a Natural Gas Combined-Cycle Power Generation System. (2000) P. Spath & M. Mann.

[59] Power Generation Technology Data for Integrated Resource Plan of South Africa. (2017) Department of Energy

These Scope 1 and Scope 2 emissions equate to 0.56% of South Africa's carbon budget. These emissions are also equal to 0.25% of South Africa's low PPD scenario and 0.15% of South Africa's high PPD scenarios.

Table 9: Scope 1 and Scope 2 emissions of the Gas Distribution Infrastructure.

Activity	Annual GHG emission	Lifetime GHG emissions
Tanker Berthing & Deberthing	67 600 tCO_2e/a	2 million tCO_2e
LNG Regasification	798 000 tCO_2e/a	24 million tCO_2e
Total	**865 000 tCO_2e/a**	**26 million tCO_2e**

The upstream Scope 3 emissions amount to a total of 8.0 million tCO_2e per annum. The most significant portion of Scope 3 emissions, and of the entire project, is the downstream Scope 3 emissions which are 19.6 million tCO_2e per annum. Thus, the lifetime GHG inventory for Scope 3 emissions is 829 million tCO_2e. The downstream emissions are related to the combustion of the imported LNG for various processes. These processes include, but are not limited to, the combustion emissions arising from the three gas-to-power stations also being developed by the CDC in Zone 13 and Zone 10 of the SEZ.

The total annual emissions (Scope 1, 2 and 3) are 28.5 million tCO_2e per annum and the total GHG Inventory across the lifetime of the Gas Distribution Infrastructure is 855 million tCO_2e. These emissions equate to 19.4% of South Africa's carbon budget. These emissions are also equal to 8.1% of South Africa's low PPD scenario and 5.0% of South Africa's high PPD scenarios.

Table 10: Scope 3 emissions of the Gas Distribution Infrastructure.

Upstream Activity	Annual GHG Emissions	Lifetime GHG Emissions
Natural Gas Extraction	1.3 million tCO_2e/a	39 million tCO_2e
Natural Gas Processing	1.5 million tCO_2e/a	43 million tCO_2e
Domestic Pipeline Transport	1.3 million tCO_2e/a	38 million tCO_2e
Liquefaction	2.9 million tCO_2e/a	86 million tCO_2e
Tanker Transport	1.1 million tCO_2e/a	33 million tCO_2e
Downstream Activity	**Annual GHG Emissions**	**Lifetime GHG Emissions**
Combustion of Natural Gas for Electrical Power Generation	19.6 million tCO_2e/a	589 million tCO_2e
Total Scope 3 emissions	**27.6 million tCO_2e/a**	**829 million tCO_2e**

The emissions occurring within South Africa's borders are only Scope 1, Scope 2, and downstream Scope 3 emissions (shades of green in Figure 7**Error! Reference source not found.**). **Error! Reference source not found.** shows that 72% of the emissions across all scopes of the Gas Distribution Infrastructure occur within South Africa (20.5 million tCO2e emissions annually). This equates to 615 million tCO2e emissions in South Africa throughout the lifetime of the Gas Distribution Infrastructure.

Furthermore, the total emissions associated with the Gas Distribution Infrastructure cover all the emissions associated with the greater Coega Integrated Gas-to-Power Project proposed by the CDC. All direct emissions from the accompanying gas-to-power plants are covered by the downstream Scope 3 emissions. The upstream Scope 3 emissions of the gas-to-power plants are also covered by the Scope 1 and upstream Scope 3 emissions of the Gas Distribution Infrastructure.

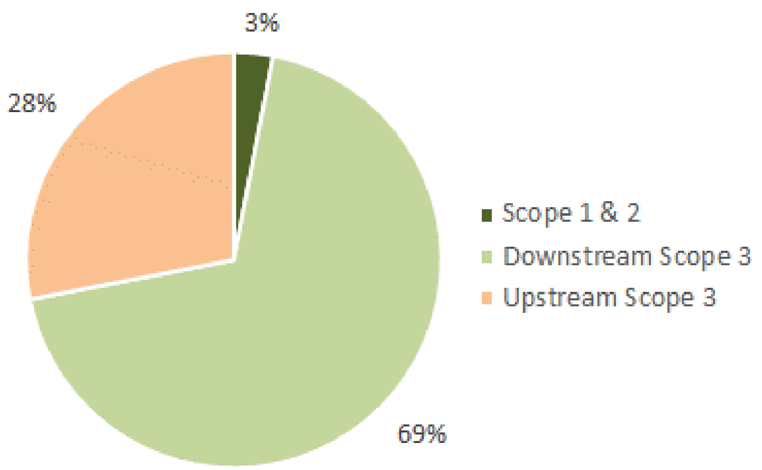

Figure 7: Breakdown of emission sources by Scope (including all upstream [extraction, processing, transport] and downstream [combustion] emissions).

5.2 Project contribution to climate change

All the various sources of GHG Emissions have an impact on global climate change. No impact can be linked to any specific source. Thus, the total GHG emissions are considered when determining the impact of the Gas Distribution Infrastructure on climate change. The impact assessment of the Gas Distribution Infrastructure is summarised in Table 11.

Table 11: Assessment of Impact of Gas Distribution Infrastructure.

Nature: The Gas Distribution Infrastructure emits GHGs into the atmosphere. These contribute to anthropogenic climate change.

The Scope 1 and Scope 2 emissions originate from tanker berthing and deberthing and from regasification processes. These amount to approximately 26 million tCO_2e during the 30-year lifetime of the project, or 0.59% of the carbon budget.

The Scope 3 emissions originate from upstream handling and downstream combustion of the natural gas. These amount to 829 million tCO_2e during the lifetime of the project. These are included in this assessment as they are a significant portion of the lifetime emissions.

Approximately 72% of all emissions occur within South Africa, namely 615 million tCO_2e.

The assessment in this table does not take avoided emissions into consideration.

	Without Mitigation	**With Mitigation**
Extent	International	International
Intensity	Very High	Very High
Duration	Permanent	Permanent

Consequence	Very High	Very High
Probability	Definite	Definite
Significance	Very High	Very High
Status of impact	Negative	Negative
Reversibility	None	None
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	No	No
Mitigation: There are some mitigation methods that could be applied. The LNG can be sourced from nearby suppliers, to reduce upstream transport emissions. The LNG could also be sourced from responsible suppliers, reducing emissions associated with extraction and upstream processing of the LNG. Good quality equipment can also reduce the amount of LNG that vaporizes and escapes as fugitive emissions. This would also require less flaring. However, the impact of these mitigation measures is insignificant relative to the overall impact of the project. There are no effective mitigation measures that will significantly reduce the overall GHG emissions of the project and resultant impact on climate change.		
Residual risks: The residual risk remains high due to the potential impact of climate change, despite mitigation efforts.		

5.2.1 Resource Efficiency and Pollution Prevention

The use of natural gas as a fuel source rather than coal can be significantly more efficient. The emission intensity of natural gas is close to half that for coal per unit of input energy. The burning of coal releases close to 95 tCO_2/TJ whilst the burning of natural gas only releases about 56 tCO_2/TJ.

Simultaneously, fewer GHG pollutants are released from the use of natural gas rather than the use of coal. Natural gas contains fewer impurities than coal. This leads to less emissions of other harmful gases such as metal oxides, SO_X and NO_X. The emissions from natural gas combustion are limited in variety, almost exclusively comprising of CO_2, with small quantities of CH_4.

Aside from the inherent benefits of using natural gas rather than coal, the Gas Distribution Infrastructure also has several measures in place to promote resource efficiency and pollution prevention. The Gas Distribution Infrastructure makes use of insulation for the storage tanks and cryogenic pipelines. This reduces the amount of energy required to maintain the temperature of the LNG below its boiling point. During the storage and pumping of LNG, some of the LNG does regasify by itself, also known as boil-off gas. The above-mentioned insulation also helps to minimise the amount of boil-off gas produced and thus the gas losses.

Furthermore, the Gas Distribution Infrastructure has systems in place to recover the boiloff gas rather than flaring it to atmosphere. This is achieved by re-liquefying the boil-off gas. This process does require some energy, but this is already minimised due to the incorporation of the insulation. This capturing of the boil-off gas also prevents wastage of LNG by excessive flaring and reduces the risk of CH_4 escaping the system.

5.2.2 South African Context

In South Africa, a large portion of the current electricity demand is being met by coal-fired power stations. This is a very carbon-intensive energy source. South Africa is a signatory member of the Paris Climate Agreement and has voluntarily committed to decarbonising its economy.

An important part of this is moving away from carbon-intensive power plants, such as coal-fired ones, and moving towards greener energy technologies. As mentioned in Section 3.2.2, South Africa's revised IRP of 2019 makes provision for 3,000 MW of natural gas based electricity to be supplied into the national grid by 2027[60].

The Gas Distribution Infrastructure will supply enough natural gas to cover the 3,000 MW stipulated in the IRP. In total, it will deliver 350 000 TJ of natural gas annually into South Africa, allowing for third party offtake as well. However, it will lead to annual emissions of 28.5 million tCO_2e.

A portion of the natural gas will be used to supply the gas-to-power plants that will be built in Zones 13 and 10 of the Coega SEZ. The existing Dedisa Peaking Power Plant can also be supplied with natural gas as it has been earmarked for conversion from diesel to natural gas. The uptake of natural gas as a power source, rather than new coal generation, will enable the national grid to become more flexible.

The flexibility of the national grid is especially important for the uptake of renewable energy sources, such as wind and solar. CSIR models[61] shows that the least cost scenario for South Africa's energy mix in 2050 has a significant decrease in coal and an increase in natural gas as fossil fuel sources, whilst the grid is dominated by renewables. Further studies have shown that the flexibility of natural gas is crucial for achieving a renewable dominated grid. A 60% renewables penetration could be achieved if natural gas makes up the remaining 40%[62].

5.3 Potential avoided emissions

The use of the natural gas imported via the Gas Distribution Infrastructure could replace the use of coal as a fuel source. It is also important to consider the impact this could have on future emissions. This can be achieved by calculating the avoided emissions. The possible avoided emissions are summarised in **Error! Reference source not found.**.The amount of emissions that could be avoided is considerable. The baseline scenario of burning coal as a fuel source would have resulted in 38.3 million tCO_2e per annum being emitted. Making use of natural gas would result in 28.5 million tCO_2e per annum being emitted, saving 9.84 million tCO_2e of emissions per annum. This equates to potential savings of 295 million tCO_2e for the entire life cycle of the Gas

60 Department of Energy, 2019, Integrated Resources Plan (IRP2019), Government Gazette, [Online] Available at: http://www.energy.gov.za/IRP/2019/IRP-2019.pdf [Accessed on 10/05/2020].

61 Council of Science and Innovation Research, 2017, *Formal comments on the South African Integrated Resource Plan (IRP) Update Assumptions, Base Case and Observations 2016*, Pretoria.

62 A. Townsend (2019) *Natural Gas and the Clean Energy Transition.*

Distribution Infrastructure. Considering that the use of natural gas in gas-to-power technologies further opens the national grid for renewable energies, even greater savings could be achieved.

Thus, the avoided emissions could save as much as 6.7% of South Africa's carbon budget, or 2.8% to 1.7% of South Africa's low and high PPD scenarios, respectively.

Table 12: Summary of potential avoided emissions for the Gas Distribution Infrastructure.

Activity	Value	% of SA Carbon Budget
Annual emissions from use of coal	38.3 million tCO2e/year	26.1%
Annual emissions from use of natural gas	28.5 million tCO2e/year	19.4%
Potential annual avoided emissions	**- 9.8 million tCO2e/year**	**-6.7%**

6 Project resilience to climate change

The climate change impacts that the Gas Distribution Infrastructure is likely to experience are summarised in Section 3 of this report. The assessment of the project resilience is a qualitative assessment. Thus, no ratings can be applied to the project's resilience.

6.1 Core operations

The core operations of the Gas Distribution Infrastructure that are affected by climate change can be categorised into two main section. These are the physical impacts on equipment, or tangible assets, of the Gas Distribution Infrastructure and the impacts on the labour force supporting the Gas Distribution Infrastructure.

6.1.1 Equipment

Due to the nature of the Gas Distribution Infrastructure, there is a significant amount of diverse equipment that can be impacted by climate change.

6.1.1.1 Temperature

The increase in average temperatures as well as the increase in the frequency of hot days can impact the evaporative losses of LNG. Any malfunction in the cooling systems or containment of the LNG could be exacerbated by the increased average temperature.

The heat also affects the piping systems. The excessive expansion and contraction of the pipelines under elevated temperature conditions can lead to warping and deformation of the pipelines. This can impact the structural integrity of the pipelines.

6.1.1.2 Storms/Winds

Another climate change impact is the potential increase in frequency and severity of storms and winds. High winds can damage equipment. Structures such as cranes are especially susceptible to being blown over by high winds or during severe storms.

The winds could also cause the ships to rock in the harbour, as the ships will be moored facing broadside into the direction of most of the severe winds recorded in the area. This could result in collisions between the ships or between the ships and their moorings/berth.

Debris can also be thrown by high winds and cause damage to equipment it collides with. Objects falling onto equipment can cause severe damage, especially to smaller, less sturdily built equipment.

Winds can also exacerbate other impacts. Natural gas is highly explosive. As the storage of LNG and the pipelines will be operated near atmospheric pressure, there is a low risk of explosive decompression. However, if natural gas is leaking from the system and there is a source of ignition nearby, then an explosion could occur. Wind plays a role in the dispersion and movement of any leaked natural gas. This also means that the explosion does not necessarily occur at the source of the leak, but could occur further away, increasing the area of potential explosive risk.

6.1.1.3 Storm surge/coastal flooding

Some of the climate change impacts that the Gas Distribution Infrastructure could face are related to increased storms surges and coastal flooding. These can have severe impacts considering the projected rise in sea level as this enables more severe storm surges.

Increased storm surge can lead to larger waves that could break over the breakwater. These and/or coastal flood water could damage equipment, especially electronics, on the berth and along the seawall.

Increased wave action could also lead to increased erosion of the foundations of the coastal equipment, such as pipelines, which could decrease the structural integrity of the installations.

Some of these climate change related risks have already been taken into consideration during the construction of the port. The breakwater was designed to withstand extreme wave conditions and already minimises the likelihood of damage to infrastructure within the harbour. However, this does not influence infrastructure beyond the protection of the harbour's breakwater, such as pipelines built on the outside of the breakwater and along the shoreline.

6.1.1.4 Rainfall

Rainfall related flooding would most likely occur along the Coega River watercourse. The Port of Ngqura is built in the Coega River mouth and is thus susceptible to flooding, as was seen during the flood in June 2011.

Such floods can cause significant damage to riverbanks and could result in the erosion of the foundations of equipment installed near a watercourse. Sediment can also be carried downstream into the harbour. Especially silty water could damage pumps operating in the harbour. Furthermore, pollutants could also be carried downstream and be washed into the ocean through the harbour.

6.1.2 Labour

Increased daytime temperatures could have an impact on health risks of employees. In very hot days the risk of suffering from heat stress related illnesses is significantly increased. Such symptoms include dehydration and heat stroke. This could even lead to employees taking more sick leave. It could also increase the cost of ensuring the health and safety of employees on the premises. If these illnesses are not taken into consideration, an employee's overall productivity at work could be significantly impacted.

Flood and storm damage could also hamper an employee's ability to perform their required tasks. Especially in cases where roads are washed away, this could hamper business operations for several days. Exposure to flood events also makes it easier for employees to contract water borne illnesses, especially due to the contamination of flood water.

6.2 Value chain

6.2.1 Up Stream value chain

The Gas Distribution Infrastructure is dependent on the regular external supply of LNG via LNGCs. Inclement weather could prevent the carriers from entering the harbour and offloading their cargo. If inclement weather persists for extended periods of time, the Gas Distribution Network might not have enough LNG storage to supply to the operations reliant on the gas without interruption.

More severe storms could also damage the LNGC itself. This could include the offloading mechanisms, such as piping or valves, or navigational equipment on the ship's superstructure. Such damage could also lead to delay's due to required repairs. In cases of severe damage, such as to the ship's hull, fuel/oil could leak into the ocean and impact/pollute the marine environment.

The increase in average atmospheric temperature is a climate change impact that is experienced globally, with some areas being affected more severely than others. This means that along the value chain of supplying natural gas elevated average temperatures can be expected. This could lead to increased evaporative losses of natural gas along the supply chain, further increasing the net GHG emissions along the supply chain.

6.2.2 Down Stream Value Chain

The three gas to power plants that are planned to be built consume roughly 45% - 70% of the LNG that passes through the Gas Distribution Infrastructure. Climate change impacts could result in these power plants, as well as the Dedisa Peaking Power Plant, being damaged and shut down for repairs. The impacts that could cause this are similar to those experienced by the core operations of the Gas Distribution Infrastructure, including damage from stronger storms/winds, flood damage, reduction in operation efficiency due to temperature rise. Climate change impacts could also result in a disruption of the transmission lines leaving the power plants, in which case the power plants would also not be in operation. This could lead to a reduction in natural gas offtake.

The remainder of the LNG passing through the Gas Distribution Infrastructure is for third party offtake via LNG trucks. Climate change related impacts further afield can cause significant variation in the third-party demand of LNG. The third-party's facilities could be damaged or the supply of LNG to third parties could also be interrupted. These facilities could then be temporarily shut down leading to a reduction in third-party offtake of natural gas.

Natural gas could play a significant role in enabling South Africa to move towards a greener economy. If the desire of society to become climate friendly becomes stronger, the drive towards a green economy could become even more significant. It is likely that this could increase the demand for LNG and gas-to-power plants due to their load-following capability. This could increase imports into the Algoa Bay area above what has been expected.

6.3 Social environment

6.3.1 Community Health, Safety, and Security

The proposed Gas Distribution Infrastructure is located within the Coega SEZ in the NMBMM. Motherwell is the residential settlement located closest to the Coega SEZ. It is noted as vulnerable community in accordance with the NMBMM Integrated Development Plan. As a vulnerable community, it will be inclined to require support from the Coega SEZ in times of uncertainty. As climate change impacts become more frequent and severe, the local community might turn towards the project owners, as members of the SEZ, for support and assistance in service delivery.

An increase in severe rainfall events could result in more frequent flood events. This could wash pollutants into the water system and lead to increased soil contamination. This could have a detrimental impact on the health of the local community, such as from water-borne illnesses. The residential area of the communities surrounding the SEZ are also very densely populated. This increases the number of people exposed to any local climate change impact.

Similarly, increased wind severity and heavier rains will result in more infrastructure damages in and around the communities near the Coega SEZ. Housing, vehicle, and land damages may lead to increased assistance required of the developers. Road networks may experience integrity damages due to increased flooding, causing potholes, collapsed bridges and other road damages.

Higher atmospheric temperatures and increased drought occurrences will result in increased water stress experienced within the area. Higher average temperatures could also lead to increased occurrences of vector-borne diseases. It could also significantly increase the risk of wildfires occurring, as well as their severity. Wildfires are difficult to predict and so is their impact on local communities. A wildfire could uproot an entire community in a matter of hours, as was experienced in Knysna in 2017, and burn for days across a wide area, as was more recently seen in the Australia's summer 2019/20.

Informal settlements in the vicinity are characterised by poor service delivery, making them especially susceptible to any outbreak of disease or water shortage. This is even more concerning, considering the recent COVID-19 pandemic and that the area around Coega is one of three national plague surveillance sites.

6.4 Natural environment

6.4.1 Biodiversity Conservation and Sustainable Management of Living Natural Resources

The Gas Distribution Infrastructure will cross/be in proximity to several ecosystems, such as rivers, dunes, and wetlands. Each ecosystem has its own unique characteristics and sensitivities to climate change.

Climate change could increase the severity of rainfall in the area which can increase the number of pollutants and contaminants entering the groundwater system. These pollutants and contaminants can also be washed into the marine ecosystem and impact the local sea life.

The environment within and near the SEZ is home to several endemic and near-endemic species as well as a few threatened and endangered species. These species are very sensitive to changes in their environment. Slight climatic shifts, such as increased temperature or shifting rainfall season can have significant impact on the vegetation and thus the animals it supports. There is also a significant protected area close to the SEZ, namely the Addo Elephant National Park, which plays a key role in South Africa's conservation and climate change adaptation plans.

Marine species could be similarly affected. As temperatures rise, the breeding success of several marine birds on the surrounding islands could be affected. The migratory patterns of marine species of interest and endangered species could also shift in response to changing climatic conditions, such as changes in water temperature. A significant event that could be affected is the annual sardine run up the east coast, as these fish follow pockets of colder ocean water.

Special considerations should be made to accurately reflect the impact of climate change on the local ecosystems.

6.5 Summary

Several climate change impacts could affect the core operations of the Gas Distribution Infrastructure. These impacts mostly affect the structural integrity of the equipment and installations.

The health and safety of employees as well as their performance could also be significantly impacted, mostly due to increasing average temperatures and reducing water security.

The Gas Distribution Infrastructure is very sensitive to upstream disturbances as a result of Climate Change impacting the reliability of supply of LNG.

The local community could experience worse water security, food security and living standards as there could be a change in rainfall patterns as well as droughts. They could also be susceptible to structural damage of their houses due to increased severity of storms and floods. This could impact the project's social license to operate.

The local ecosystems could suffer significantly from climate change impacts due to its high levels of endemism and presence of key migratory species.

7 Project impact mitigation measures

7.1 Measures to reduce the impact of the project on climate change

The CDC has already included some actions to reduce the impact of the Gas Distribution Infrastructure on climate change. Most notably, the use of insulation for the LNG storage and cryogenic pipelines to reduce electricity consumption of cooling systems and reduce evaporative losses of natural gas.

It is important that the CDC takes measures, where possible, to reduce the impact of the Gas Distribution Infrastructure on climate change. This includes measures that could reduce the Scope 1, Scope 2, and Scope 3 emissions of the Gas Distribution Infrastructure. Table 13 below shows further measures that should be considered to reduce the impact of the Gas Distribution Infrastructure.

Table 13: Measures to reduce impact of Gas Distribution Infrastructure on climate change.

Measure/Action	Benefit
Source the LNG from nearby suppliers, such as northern Mozambique	This will reduce transport related emissions and thus the Upstream Scope 3 emissions.
Source the LNG from climate responsible producers	This will reduce extraction and processing related emissions and thus the Upstream Scope 3 emissions.
Use good quality equipment	This will reduce the amount of natural gas that escapes the system as fugitive emissions, as well as reducing the amount of natural gas needing to be flared.

7.2 Measures to increase the resilience of the project to climate change

As described in Section 5.3 of this report, the Gas Distribution Infrastructure is susceptible to several climate change impacts. There are several actions that the CDC can take to improve the resilience of the Gas Distribution Infrastructure to climate change impacts. These are listed in Table 14.

Table 14: Actions to improve resilience of Gas Distribution Infrastructure.

Measure/Action	Benefit
Pipeline and building foundations should be designed to resist erosion from increased rainfall/flooding	This reduces the likelihood of infrastructure being damaged and releasing LNG/natural gas during severe rainfall events and flooding.
Educate staff/contractors on impacts of climate change and how to deal with it;	This will ensure that the Gas Distribution Infrastructure will remain operational, even after climate change related events, such as extreme weather events. It also better equips the staff/contractors to regain full operation of the Gas Distribution Infrastructure when it is damaged by such events.

8 Opinion of the Gas Distribution Infrastructure

The proposed Gas Distribution Infrastructure will have several positive and negative impacts. It is important to remain cognisant of some negative aspects of the Gas Distribution Infrastructure. These are that:

- The Gas Distribution Infrastructure does release GHG emissions that will need to be mitigated where possible.
- The project does contribute to climate change and can exacerbate the climate vulnerability of local communities.

There are several conditions that should be met prior to receiving authorisation by DEFF to go ahead with the Gas Distribution Infrastructure. These are that:

- The designs of infrastructure and processes should consider the potential impact of extreme weather events such as severe storms/storm surge;
- The designs for the piping should account for increasing ambient temperatures as well as an increased frequency of very hot days and the associated material fatigue; and
- Safety protocols should take into consideration the impacts of climate change on construction and operations. This includes the introduction of disaster management policies, as well as onsite employee training, specifically for risk management of extreme weather events.

However, it is also important to consider the benefits. Most notably among those are the following:

- The Gas Distribution Infrastructure acts as an enabler for a wider use of natural gas within South Africa's economy, especially for power generation. Natural gas is significantly less emission intensive than coal, which will reduce the emission intensity of the national grid, and other combustion related activities, such as for heaters, boilers, furnaces, and similar processes. Compared to coal, the emissions from natural gas also contain significantly less harmful products and a negligible amount of ash.

- The use of natural gas as a fuel source for electricity generation significantly improves the ability of South Africa's National Grid to incorporate more intermittent renewable energy sources, such as wind and solar. Currently, South Africa's national grid can realistically only draw a small portion of its power from these renewable energy sources, as it is mainly driven by coal-fired power stations. If natural gas were to underpin the national grid as the main fuel, then most of the national grid's power can be drawn from intermittent renewable energy sources.
- In future, the Gas Distribution Infrastructure could also be repurposed for the distribution of biogas or biomethane, further reducing the amount of emissions generated.
- On a national scale, the Gas Distribution Infrastructure could lead to a potential emission saving of 295 million tCO_2e across the lifetime of the project. This is relative to using coal as a fuel source as a baseline.

It is our opinion that the proposed Gas Distribution Infrastructure should be authorised.

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

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File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Coega Gas-to-Power Gas Distribution Infrastructure

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
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Environment House
473 Steve Biko Road
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Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	Promethium Carbon			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	
Specialist name:	Karien Erasmus			
Specialist Qualifications:	MPhil Development Practice; Hons Sustainable Development			
Professional affiliation/registration:	IAIA SA Land Rehabilitation Society of South Africa			
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Telephone:	(+27)11 706 8185	Fax:	NA	
E-mail:	karien@promethium.co.za			

2. DECLARATION BY THE SPECIALIST

I, Karien Erasmus, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Erasmus.

Signature of the Specialist

Promethium Carbon

Name of Company:

08/03/2021

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, Karien Erasmus, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

Promethium Carbon

Name of Company

08/03/2021

Date

Signature of the Commissioner of Oaths

2021/03/08

Date

COMMISSIONER OF OATHS (RSA)
Leande Viljoen
Ex-officio - Professional Accountant (S.A)
23 Eaton Avenue, eTravel House
North Block, 2nd Floor, Bryanston, 2021
+27 11 706 8185

I certify that this document is a true copy of the original which was examined by me and that, from my observations, the original has not been altered in any manner.

SIGNATURE
Commissioner of Oaths - Leande Viljoen
Designation: Ex-officio-professional Accountant (s.a)
Date: 2021/03/08
23 Eaton Avenue, eTravel House
North Block, 2nd Floor, Bryanston, 2021

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

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PROJECT TITLE

Coega Gas-to-Power Plant in Zone 13

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- all the particulars furnished by me in this form are true and correct; and
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Signature of the Specialist

Promethium Carbon

Name of Company:

08/03/2021

Date

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Name of Company

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PROJECT TITLE

Coega Gas-to-Power Plant in Zone 10 - North

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Signature of the Specialist

Promethium Carbon

Name of Company:

08/03/2021

Date

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Erasmus.

Signature of the Specialist

Promethium Carbon

Name of Company

08/03/2021

Date

Signature of the Commissioner of Oaths

2021/03/05

Date

COMMISSIONER OF OATHS (RSA)
Leande Viljoen
Ex-officio - Professional Accountant (S.A)
23 Eaton Avenue, eTravel House
North Block, 2nd Floor, Bryanston, 2021
+27 11 706 8185

I certify that this document is a true copy of the original which was examined by me and that, from my observations, the original has not been altered in any manner.

SIGNATURE
Commissioner of Oaths - Leande Viljoen
Designation: Ex-officio-professional Accountant (s.a)
Date: 2021/03/05
23 Eaton Avenue, eTravel House
North Block, 2nd Floor, Bryanston, 2021

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SIGNAT...
Commissioner of Oa... ...ande Viljoen
Designation: Ex-officio-p... ...nal Accounta... (s.a)
Date:
23 Eaton...
North Block, 2...

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Coega Gas-to-Power Plant in Zone 10 - South

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	Promethium Carbon			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	
Specialist name:	Karien Erasmus			
Specialist Qualifications:	MPhil Development Practice; Hons Sustainable Development			
Professional affiliation/registration:	IAIA SA Land Rehabilitation Society of South Africa			
Physical address:	23 Eaton Avenue, E-travel House, North Wing, Second Floor, Bryanston			
Postal address:	PO Box 131253, Bryanston			
Postal code:	2121	Cell:	(+27) 82 905 2383	
Telephone:	(+27)11 706 8185	Fax:	NA	
E-mail:	karien@promethium.co.za			

2. DECLARATION BY THE SPECIALIST

I, Karien Erasmus, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

KErasmus.

Signature of the Specialist

Promethium Carbon

Name of Company:

08/03/2021

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, Karien Erasmus, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

Promethium Carbon

Name of Company

08/03/2021

Date

Signature of the Commissioner of Oaths

2021/03/05

Date

COMMISSIONER OF OATHS (RSA)
Leande Viljoen
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SIGNATURE
Commissioner of Oaths - Leande Viljoen
Designation: Ex-officio-professional Accountant (s.a)
Date: 2021/03/08
23 Eaton Avenue, eTravel House
North Block, 2nd Floor, Bryanston, 2021

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

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Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Coega Gas-to-Power - Gas Distribution Infrastructure

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Email: EIAAdmin@environment.gov.za

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, Matthias Rommelspacher, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

Promethium Carbon

Name of Company

18/02/2021

Date

Signature of the Commissioner of Oaths

2021/03/08

Date

COMMISSIONER OF OATHS (RSA)
Leande Viljoen
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