TotalEnergies EP South Africa B.V.

OFFSHORE PRODUCTION RIGHT AND ENVIRONMENTAL AUTHORISATION APPLICATIONS FOR BLOCK 11B/12B

Climate Change Impact Assessment Report

REPORT NO: 41105306-358523-6
SEPTEMBER 2023

PUBLIC

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DATE: SEPTEMBER 2023

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ACRONYMS AND ABBREVIATIONS

Abbreviation	Explanation
AEL	Atmospheric Emission Licence
AFOLU	Agriculture, Forestry and Other Land Use
AR6	Sixth Assessment Report
BA	Basic Assessment
CA	Competent Authority
CC	Climate Change
C3S	Copernicus Climate Change Service
CDS	Climate Data Store
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
ERA5	Fifth Generation Atmospheric Reanalysis
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
GCMs	General Circulation Models
GHG	Greenhouse Gas
GN	Government Notice
GPG	Good Practice Guidance
GTL	Gas To Liquids
GTP	Gas to Power
GWP	Global Warming Potential
HFC	Hydrofluorocarbons
IEA	International Energy Agency
I&AP	Interested and Affected Parties
IFC	International Finance Corporation
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
JET IP	Just Energy Transition Investment Plan
LPG	Liquefied Petroleum Gas
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002)
NAEIS	National Atmospheric Emissions Inventory System

Abbreviation	Explanation
NCCAS	National Climate Change Adaptation Strategy
NCCRP	National Climate Change Response Policy
NDC	Nationally Determined Contribution
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998) (as amended)
NGO	Non-Governmental Organisation
PFCs	Perfluorocarbons
PR	Production Right
PWP	Production Work Programme
RCPs	Representative Concentration Pathways
RSA	Republic of South Africa
S&EIA	Scoping & Environmental Impact Assessment
SAGERS	South African Greenhouse Gas Emissions Reporting System
SELs	Sound Exposure levels
SSPs	Shared Socioeconomic Pathways
TBC	To Be Confirmed
TCFD	Taskforce for Climate-related Financial Disclosure
TEEPSA	TotalEnergies Exploration and Production South Africa B.V.
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Convention on Climate Change
VSP	Vertical Seismic Profiling
WMO	World Meteorological Organisation
WBCSD	World Business Council for Sustainable Development
WCG	Western Cape Government
WML	Waste Management Licence
WRI	World Resources Institute
WSP	WSP Group Africa (Pty) Ltd

UNITS OF MEASURE

Unit	Explanation
°C	Degree centigrade
Gg	Gigagrams
“	Inch = 2.54 cm
kg/h	Kilogram per hour
km	Kilometre
km^2	Square Kilometre
m	Metre
MMstb	Millions of standard tank barrels
$MMSm^3/yr$	Million Standard Cubic Meters per year
m/s	Meters per second
Mt	Million Tonnes
Tcf	Trillion Cubic Feet
T/day	Tonnes per day
%	Percentage
W/m^2	Watts per square metre

DETAILS OF THE SPECIALISTS

A comprehensive CV is included in Appendix A.

Details of Specialist	
Name:	Verushka Singh
Contact number:	+27(0) 11 254 4800
Email:	Verushka.singh@wsp.com
Company Name:	WSP Group Africa (Pty) Ltd

Qualifications

Specialist Qualifications	
Education:	BSc Eng (Hons) (Chemical Engineering), University of the Witwatersrand, South Africa, University of the Witwatersrand, Gauteng
Professional affiliations:	-
Summary of experience:	Verushka is a Principal Associate with a Chemical Engineering (BSc Hons) degree obtained from the University of the Witwatersrand. She is currently employed at the Johannesburg branch of WSP and has worked on various greenhouse gas assessments, climate change impact assessments, climate change disclosure and carbon credit projects for a variety of clients over the past twelve years. She has provided consulting support to various client industries including petrochemical, mining, metallurgical, manufacturing and government bodies among others. She is also certified as both an Energy Manager (CEM) and a Management & Verification Professional (CMVP).

Details of Specialist	
Name:	Novania Reddy
Contact number:	+27(0) 11 254 4800
Email:	Novania.reddy@wsp.com
Company Name:	WSP Group Africa (Pty) Ltd

Qualifications

Specialist Qualifications	
Education:	BSc Eng (Hons) (Chemical Engineering), University of Kwa Zulu Natal, Howard College, Durban South Africa
Professional affiliations:	-
Summary of experience:	Novania is a Principal Consultant with a Chemical Engineering Degree (BSc Hons) from the University of Kwa Zulu Natal, Howard College. She is

Specialist Qualifications	
	currently employed at the Johannesburg branch of WSP with over 9 years' experience in the environmental consulting industry. Her area of expertise lies within the air quality and climate change fields related to sectors ranging from mining to the oil and gas industry. Some of the countries of work experience include, but are not limited to, South Africa, Ghana, Mozambique, Botswana, Cameroon, Ethiopia, Democratic Republic of Congo, Australia and United Arab Emirates.

Details of Specialist	
Name:	Nomthandazo Mosia
Contact number:	+27(0) 11 254 4800
Email:	Nomthandazo.Mosia@wsp.com
Company Name:	WSP Group Africa (Pty) Ltd

Qualifications

Specialist Qualifications	
Education:	BSc Hons in Geography, North-West University, South Africa
Professional affiliations:	-
Summary of experience:	Thando is a Graduate Consultant with a BSc Hons in Geography from the North-West University. Her research interests are climate change and air quality. She currently assists with climate change assessments, this includes baseline trends, climate projections and climate hazards amongst others.

DECLARATION OF INDEPENDENCE BY SPECIALISTS

I, Verushka Singh, Novania Reddy and Nomthandazo Mosia declare that I –

- Act as the independent specialist for the undertaking of a specialist section for the TEEPSA Offshore Production Right and Environmental Authorisation Applications for Block 11B/12B;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed;
- Do not have nor will have a vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity; and
- Undertake to disclose, to the competent authority, any information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document.

SPECIALIST REPORT REQUIREMENTS IN TERMS OF NEMA

This report is compiled in such a manner that it adheres to the EIA Regulation requirements as detailed in Appendix 6 of the NEMA EIA Regulations of 2014, as amended. It is also a supporting document that will be appended to the ESIA and does not require all the following sections, as it is a technical report contributing to other specialist reports.

Section	Requirements	Section addressed in report
(a)	Details of	
	(i) the specialist who prepared the report; and	Details of the specialists
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Appendix A
(b)	A declaration that the specialist is independent in a form as may be specified by the competent authority;	Declaration of independence by specialists
(c)	An indication of the scope of, and the purpose for which, the report was prepared,	Section 1.3
	the quality and age of base data used for the specialist report and a description of existing impacts on the site,	Sections 5, 6
	cumulative impacts of the proposed development and levels of acceptable change;	Section 8
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	No site visit was undertaken as the climate assessment was a desktop study based on information received.
(e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 4
(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 7
(g)	An identification of any areas to be avoided, including buffers (if and where applicable);	This is not relevant in terms of a climate change impact assessment. This report however does contain information on impacts of climate change on the region surrounding the Project.
(h)	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers (if and where applicable);	Section 1.1
(i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4
(j)	A description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 6
(k)	Any mitigation measures for inclusion in the EMPr;	Section 6

Section	Requirements	Section addressed in report
(l)	Any conditions for inclusion in the environmental authorisation;	N/A
(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorization;	Section 6
(n)	A reasoned opinion—	
	(i) whether the proposed activity, activities or portions thereof should be authorized regarding the acceptability of the proposed activity or activities; and	Section 9
	(ii) if the opinion is that the proposed activity, activities, or portions thereof should be authorised, an avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 9
(o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	Included in ESIA report
(p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Included in ESIA report
(q)	Any other information requested by the competent authority.	Included in ESIA report

EXECUTIVE SUMMARY

This report presents the Climate Change Impact Assessment prepared as part of the Environmental and Social Impact Assessment (ESIA) for the Production Right and Environmental Authorisation applications for Block 11B/12B offshore of the Southern Cape Coast of South Africa (hereafter referred to as the “Project”).

The Climate Change Impact Assessment includes the contribution of the proposed Project on climate change and the Project’s resilience to climate change through its twenty-seven year (27)-year life.

The impact of the Project on climate change was assessed based on the greenhouse gas (GHG) emissions anticipated from the Project. In terms of direct Scope 1 emissions, the Project will emit 1.5 $MtCO_2e$ over its 27-year lifetime. South Africa’s climate change mitigation target as updated in the 2021 Nationally Determined Contribution (NDC) is in a range of 350 – 420 Mt CO_2e for the period of 2026 to 2030. In comparison to South Africa’s lower targeted total national inventory for 2030 of 350 $MtCO_2e$, the Project’s average annual emissions will increase the national inventory by 0.016%. The GHG emissions from the F-A platform, which is an associated facility to the Project is a Scope 3 emission, which amounts to approximately 4 $MtCO_2e$ over a 25-year production period. There are no Scope 2 emissions associated with the Project as the Project will not be importing electricity.

Climate projections for the offshore Project region indicate a 7.5% increase in air temperature and a 42.1% reduction in precipitation under SSP5 worst-case scenario by 2060. By 2050, there is a projected sea level rise of 0.28 m under the worst-case future scenario. No unacceptable risks were identified through the qualitative physical risk assessment.

It is noted that the end-use of products from the proposed Project can replace coal for numerous applications such as power generation, which is beneficial in the shift to a low-carbon economy.

1 INTRODUCTION AND SCOPE OF REPORT

1.1 PROJECT BACKGROUND AND LOCATION

TotalEnergies EP South Africa B.V. (TEEPSA), together with its joint venture partners, QatarEnergy, Canadian Natural Resources International South Africa Limited, and a South African consortium, MainStreet 1549, held an Exploration Right (Exploration Right Ref. No.: 12/3/067) over Block 11B/12B, located offshore from the Southern Cape coast, South Africa, which expired in September 2022. TEEPSA has now applied for a Production Right (PR) which was submitted in September 2022. If a PR is granted and if commercial agreements for the sale of the gas onto the domestic market can be achieved, TEEPSA is planning to develop Block 11B/12B.

The Block 11B/12B application area is located offshore the south coast of South Africa and covers approximately 12 000 km^2. The closest north-eastern point of the application area is about 75 km offshore from Cape St Francis, whereas the closest north-western point is about 120 km offshore from Mossel Bay (Figure 1-1). Development and production related activities are proposed for the western portion of Block 11B/12B, in the Project Development Area. TEEPSA proposes to conduct further investigations in the eastern portion of the block, referred to as the Exploration Priority Area, including exploration and appraisal drilling, to enable further refinement of the geological and reservoir understanding, as is typical of developments of this nature.

In accordance with the regulatory requirements, TEEPSA must conduct an Environmental and Social Impact Assessment (ESIA) process for undertaking the proposed development and production related activities in Block 11B/12B. WSP Group Africa (Pty) Ltd (WSP) has been appointed by TEEPSA to undertake the ESIA process in support of an environmental authorisation (EA) application. The Final Scoping Report was accepted by the Competent Authority (CA) on 18 May 2023, indicating that the Impact Assessment Phase could commence, and the specialist studies completed.

A Climate Change Impact Assessment has been undertaken in support of the ESIA process. The objective of this assessment was to determine the impact of the Project on climate change (in the form of a Greenhouse Gas (GHG) Assessment), and to determine the impact of climate change on the Project (in the form of a Climate Change Risk Assessment). This report presents the methods and results of the Climate Change Impact Assessment carried out in support of the ESIA.

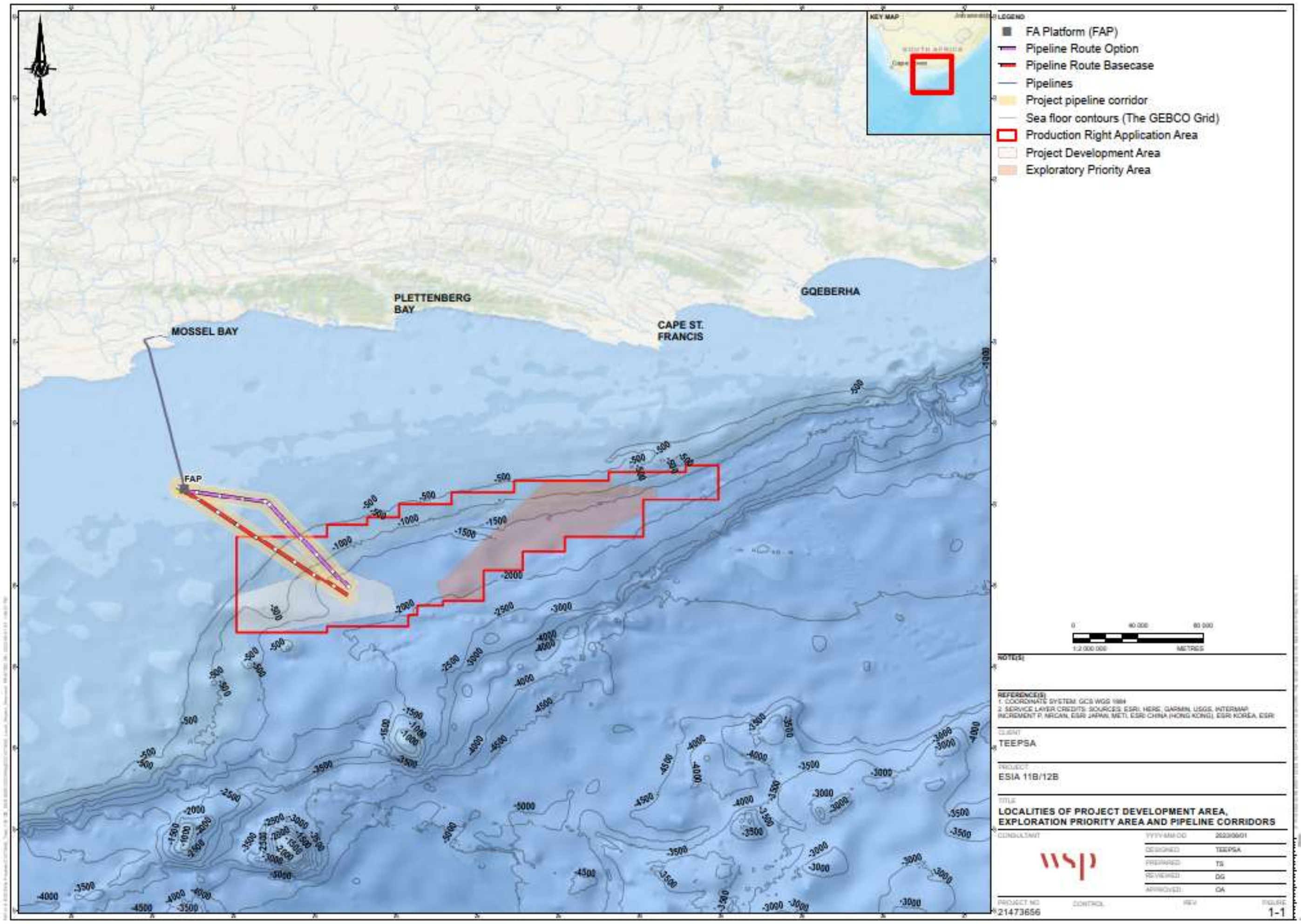


Figure 1-1 - Localities of Project Development Area, Exploration Priority Area and Pipeline Corridors

1.2 PROJECT COMPONENTS AND ACTIVITIES

The section below and Table 1-1 provides more information regarding these activities and summarises the Project activities and components together with the location and phasing. The following subsections are focused on the Project components considered in this assessment.

Table 1-1 – Details of Project Activities

Aspect	Details
Proposed exploration and appraisal drilling activities (Eastern Portions of Block)	▪ Mobilisation of drill rig to site ▪ Drilling of up to four (4) exploration and appraisal wells ▪ Possible flow testing, VSP, well logging for each well drilled ▪ Plugging and abandonment of each well ▪ Demobilisation of drill rig from site ▪ Onshore support
Proposed offshore surveys (Whole Block)	▪ Mobilisation of specialised vessels for survey work ▪ Bathymetry and sonar surveys ▪ Seafloor sampling surveys ▪ Metocean surveys ▪ Demobilisation of survey vessels ▪ Onshore support
Proposed production and development activities (Western Portion of Block)	
Construction Phase	Offshore
	▪ Mobilisation of drill rig, support and specialised vessels to site ▪ Drilling of up to six (6)[1] production and appraisal wells and testing ▪ Installation of Well-heads and Christmas-Trees (XMT) ▪ Laying of deep-water subsea production manifolds and jumpers connecting the wells ▪ Installation of subsea production pipeline ▪ Connection of manifolds to the F-A Platform via the production pipeline, riser and umbilical ▪ Demobilisation of drill rig from site ▪ Demobilisation of pipeline installation and support vessels
	Onshore
	▪ Establishment of logistics base within the Mossel Bay port. ▪ Support vessels transport of equipment, bulk materials and general supplies from shore to drill unit, survey and pipeline laying vessels. ▪ Helicopter flights for ship/shore personnel movement and in emergency events. ▪ Periodic bulk delivery (equipment) from Gqeberha and/or Cape Town port

[1] At this stage of the engineering design, five production wells will be drilled in the Production Development Area with the option for a sixth well should it be required. This GHG assessment assesses the five well option.

Aspect	Details
Production Operations Phase	Offshore ▪ Operation of gas field, including subsea infrastructure to supply F-A Platform ▪ Operation of F-A Platform and associated infrastructure[2] ▪ Vessel movements for maintenance and inspections of subsea infrastructure and flowlines pigging Onshore ▪ Movement of support vessels from shore for transportation of equipment, bulk materials and general supplies ▪ Helicopter flights for ship/shore personnel rotation and in emergency events ▪ Periodic bulk delivery (equipment) from Gqeberha and/or Cape Town port
Decommissioning Phase	Offshore ▪ Mobilisation of drill unit to site ▪ Mobilisation of specialised vessel for survey/ROV work ▪ Movement of support vessels from shore to drill unit for transportation of equipment, bulk materials and general supplies ▪ Helicopter flights for ship/shore personnel movement and in emergency events ▪ Decommissioning of production manifold, flowlines, umbilical and riser ▪ Decommissioning of subsea distribution units and power cable(s) ▪ Retrieval of shallow water infrastructure, such as production risers and umbilicals ▪ Pigging of production flowline incl. subsea tie-in ▪ Abandonment of wells ▪ Demobilisation of drill unit and support vessels from site Onshore ▪ Movement of support vessels from shore to drill unit for transportation of equipment, bulk materials and general supplies ▪ Helicopter flights for ship/shore transport ▪ Salvage of retrieved equipment and shipping to Gqeberha and/or Cape Town port

1.2.1 DEVELOPMENT AND PRODUCTION RELATED ACTIVITIES – OFFSHORE WESTERN AREA

The Project Development Area is located approximately 110 km southeast of the existing F-A Platform. The Project development concept comprises wells and a subsea production system (SPS) in the south-west corner of Block 11B/12B to produce gas and associated condensates. The

[2] The operation of the FA-Platform is not under TEEPA's operation and control.

development concept also includes a subsea pipeline to carry the gas and condensate to existing treatment and export facilities on the F-A platform where it will go to shore via the existing pipelines.

The proposed development concept will connect up to 6 wells in the Project Development Area via a multiphase pipeline carrying both gas and associated condensates from the wells up to the F-A Platform. From there, it will be carried for further treatment and exporting via the existing PetroSA-operated gas and condensate pipelines onshore.

Any construction, modification or upgrades at the F-A Platform or of any onshore facility, if required by the off-taker of gas or condensates, will be subjected to a separate EA application.

The production activities programme can be summarised as below;

- Drilling and flow test of up to 6 wells in the Project Development Area; and
- Installation of the subsea production system including pipeline and connection to the F-A Platform.

1.2.2 EXPLORATION AND APPRAISAL DRILLING RELATED ACTIVITIES – OFFSHORE EASTERN AREA

In addition to the development of the gas field in the western section of Block 11B/12B, TEEPSA intends undertaking exploration and appraisal drilling work to assess the potential for additional hydrocarbons resources. This programme may include:

- Drilling of up to 4 exploration and appraisal wells in the eastern section of Block 11B/12B. Final site selection of the wells will be based on further detailed analysis of the pre-drilling survey data and the geological target; and
- Well (flow) testing is undertaken to determine the economic potential of any discovery before the well is abandoned or suspended. One test would be undertaken per appraisal well if a resource is discovered. Testing may take 3 to 4 days of flow to complete and involves burning hydrocarbons at the well site. An estimated gas rate of 900 000 m^3/day could be flared per test. A high-efficiency flare is used to maximise combustion of the hydrocarbons over a wide range of weather conditions, to minimise emissions to air and unburnt droplets at sea.

1.2.3 MARINE SURVEYS

Various offshore surveys and data collection will be conducted in Block 11B/12B subject to identification of specific needs.

Sonar surveys will be used to investigate the structure of the seabed (bathymetry) in the vicinity of future wells, if needed. Sonar surveys will be conducted from a vessel and might use multi-beam echo-sounding, single beam echo-sounding and sub-bottom profiling. Such surveys entail transmitting frequency pulses down to the seafloor to produce a digital terrain model and identify any seafloor obstructions or hazards.

Seafloor sampling will possibly be undertaken to collect sea floor sediment samples for environmental baseline data collection and studies as well as for monitoring of the environment during / post operations. It can also be used to supplement geotechnical and geophysical studies.

TEEPSA is proposing to mobilise **metocean buoys** within the block in order to measure oceanographical, meteorological and possibly acoustic data, i.e., currents, waves, water temperature, ambient water noise levels, wind and air parameters. Metocean survey scope will be defined depending on the need for complementary parameters for this harsh weather conditions area. The wave buoy would require a temporary safety zone of between 500 m and 2 km radius on the sea surface (depending on the water depth). All vessels would be excluded from entering this safety zone.

1.2.4 ONSHORE SUPPORT ACTIVITIES AND COMPONENTS

The Project will include a shorebase/logistics base to support operations. It will also include a series of support and specialised vessels for specific activities. During drilling activities, support vessels will include supply vessels and tugboats.

Supporting activities will also include helicopter transportation from existing airport facilities to move personnel to and from the offshore facilities.

1.2.5 PROJECT PHASING AND TIMEFRAMES

The Project activities are associated with the timeframes as indicated in Table 1-2.

Table 1-2 - Development and production related timeframes

Project Component	Phase	Timeframe	Duration of Activities	No. of wells
Exploration	Mobilisation	To be determined	120 days per well	Not applicable
	Operations, including plugging and abandonment			Up to 4
	De-mobilisation			Not applicable
Offshore Surveys (for Development and Exploration areas)	Operations	To be determined	▪ Sonar: 15 – 30 days for 1 survey ▪ Seafloor sampling: 15 – 30 days for 1 survey ▪ Metocean Buoy: 7 – 15 days for deployment for 1 year monitoring	Not applicable
Development	Final well site selection, pipeline alignment selection	To be determined	To be determined	Not applicable
	Construction (including mobilisation)	Year 0	113 days per well	Two (2)
		Year 1	113 days per well	One (1)
		Year 10	125 days per well	Two (2)
	Production	Year 1 to Year 25	-	Year 1 to 10 – 3 wells Year 11 to 25 – 5 wells
	Decommissioning (including plugging and abandonment, and demobilisation)	Year 26	-	5

1.3 SPECIALIST STUDY SCOPE

The Climate Change Impact Assessment was prepared with guidance from:

The Draft National Guideline for Consideration of Climate Change in Applications for Environmental Assessment, Air Emissions License (AEL) and Waste Management License (WML).

As part of the Project scope, a Climate Change Impact Assessment was undertaken, in two parts:

- Impact of the Project on climate change (GHG Assessment): Calculation of the Project's GHG footprint (*It is important to note that this assessment reports on the GHG emissions for the Project, in terms of the control approach, where TEEPSA accounts for 100% of the estimated; and GHG emissions from the operations associated with the Project over which it has control*); and
- Impact of climate change on the Project (Climate Change Risk Assessment): Identification of key climate change-related vulnerabilities and risks to the Project.

2 CONSIDERATION OF ALTERNATIVES

Alternatives are defined in terms of the NEMA, as "different means of meeting the general purpose and requirements of the activity, which may include alternatives to –

(a) The property on which or location where it is proposed to undertake the activity;

(b) The type of activity to be undertaken;

(c) The design or layout of the activity;

(d) The technology to be used in the activity; and

(e) The operational aspects of the activity."

This section outlines the key alternatives to the proposed Project that are relevant to climate change.

2.1 TECHNOLOGY AND OPERATIONAL ASPECTS

The operational aspects involve the transportation of product through the production pipeline that connects the production wells to the F-A Platform. Processing of the gas and condensate and handling of waste streams will occur on the existing F-A Platform which is owned and operated by PetroSA.

The processed gas and condensate will be pumped to shore via existing infrastructure from the F-A Platform and PetroSA will be responsible for the operation of the field once commissioned.

No alternatives to operational aspects are considered as appropriate upgrades to existing equipment on the Platform will be done if the PR application is granted. PetroSA will be responsible for obtaining operational permits and licences for the upgrades to ensure compliance with safety and environmental standards.

2.2 END-USER OPTIONS

Negotiations are ongoing and the outcome will determine the preferred end-user option, which will impact downstream Scope 3 emissions associated with the intended use of the natural gas. Some possible use scenarios include GTL or GTP. A description of the resultant GHG's from the potential options are discussed in Section 6.

2.3 NO-GO OPTION

The No-Go alternative represents the option to not proceed with the development and exploration activities on Block 11B/12B.

The No-Go option precludes the opportunity of replacing the depleted supply of gas and condensate from the Block 9 field that provides feedstock for the F-A platform that, in turn, provides feedstock for the PetroSA GTL plant.

The shortage of feedstock has resulted in the GTL plant being put into care and maintenance in November 2020 with a loss in employment and local economic and social benefits for the Mossel Bay area. The No-Go option will result in this situation remaining unless gas is imported to provide feedstock for the GTL plant.

Thus, the No-Go option will most likely result in PetroSA having to import gas from further regions which will result in an increase in GHG's as opposed to using the local supply option. In the absence of domestic gas supply, South Africa will continue to rely on imports. LNG imports to South Africa are affected by exchange rate fluctuations (unpredictable) and global LNG prices, so there is no certainty regarding the affordability of the gas (IISD 2022).

3 APPLICABLE POLICIES, LEGISLATION, GUIDELINES AND STANDARDS

Table 3-1 and Table 3-2 outlines relevant policy, guidance and legislation (i.e includes both International and National policy, guidance and legislation) that provides the framework within which the GHG and climate change issues relevant to the Project have been considered. The references are directly applicable to the Project as the Project involves the exploration and extraction of hydrocarbons with implications to South Africa's global commitments to reducing GHGs.

Table 3-1 – Applicable policies, legislation, guidelines and standards - International

Policy, legislation, guideline or standard	Relevance to Project
International Policy	
The Intergovernmental Panel on Climate Change (IPCC) is a panel established in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) to provide independent scientific advice on climate change. This first assessment report of the IPCC served as the basis for negotiating the United Nations Framework Convention on Climate Change (UNFCCC - 1992).	The IPCC prepares comprehensive Assessment Reports (ARs) about the state of scientific, technical and socio-economic knowledge on climate change, its impacts and future risks, and options for reducing the rate at which climate change is taking place. The IPCC has finalised the Sixth Assessment Report (AR6) which consists of three Working Group contributions: ▪ The IPCC Working Group I (WGI) aims at assessing the physical scientific basis of the climate system and climate change. ▪ The IPCC Working Group II (WGII) assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive.

Policy, legislation, guideline or standard	Relevance to Project
The Intergovernmental Panel on Climate Change (IPCC) is a scientific body established by the United Nations in 1988. Its main role is to provide policymakers with regular assessments of the scientific basis of climate change, its impacts, and possible adaptation and mitigation strategies. While the IPCC does not have direct regulatory authority, its reports and findings play a crucial role in shaping global climate policies and informing decision-makers on how to address climate change.	▪ The IPCC Working Group III (WG III) assesses options for mitigating climate change through limiting or preventing GHG emissions. The IPCC is applicable to offshore oil and gas projects since: ▪ The IPCC regularly assesses the global GHG emissions and sources contributing to climate change. Offshore oil and gas activities are considered point sources of emissions. The IPCC helps in quantifying and understanding the extent of these emissions, providing a basis for policymakers to consider their impact on global climate goals. ▪ IPCC reports also analyse the impact of various GHGs on the Earth's climate system. This information helps in understanding the consequences of emitting these gases from offshore oil and gas operations and their implications for climate change.
The Paris Agreement, which was adopted in December 2015, is an international accord within the United Nations Framework Convention on Climate Change (UNFCCC). Its main objective is to limit global warming to well below 2 degrees Celsius above pre-industrial levels, with efforts to limit it to 1.5 degrees Celsius. To achieve this, the agreement aims to enhance the global response to climate change by strengthening countries' abilities to deal with the impacts of climate change and reducing greenhouse gas emissions	The Paris Agreement does not single out specific industries, rather it sets a framework for nations to develop and submit their own Nationally Determined Contributions (NDCs). These NDCs are country-specific climate action plans that outline the measures and targets each country will undertake to contribute to the global effort in combating climate change. These targets include reductions in emissions from various sectors, including the energy sector, where offshore oil and gas activities play a role. South Africa’s commitments are discussed in Table 3-2. The Paris Agreement also emphasises transparency and accountability. Countries are required to regularly report on their GHG emissions and progress towards their NDCs.
2023 IMO Strategy on Reduction of GHG Emissions from Ships	Member States of the International Maritime Organization (IMO), meeting at the Marine Environment Protection Committee (MEPC 80) 3-7 July, have adopted the 2023 IMO Strategy on Reduction of GHG Emissions from Ships, with enhanced targets to tackle harmful emissions. The revised IMO GHG Strategy includes an enhanced common ambition to reach net-zero GHG emissions from international shipping close to 2050, a commitment to ensure an uptake of alternative zero and near-zero GHG fuels by 2030, as well as indicative check-points for 2030 and 2040.

Table 3-2 – Applicable policies, legislation, guidelines and standards - National

Policy, legislation, guideline or standard	Relevance to Project
South Africa’s National Climate Change Response Policy White Paper (NCCRP) (2011)	The National Climate Change Response Policy is a comprehensive strategy to address both mitigation and adaptation in the short, medium and long term (up to 2050). Strategies are specified for the following areas:

Policy, legislation, guideline or standard	Relevance to Project
	▪ Carbon Pricing ▪ Water Agriculture and commercial forestry ▪ Health ▪ Biodiversity and ecosystems ▪ Human settlements ▪ Disaster risk reduction and management The policy has two main objectives: first, to manage inevitable climate change impacts through interventions that build and sustain social, economic and environmental resilience and emergency response capacity. Secondly, to make a fair contribution to the global effort to stabilise GHG concentrations in the atmosphere.
Western Cape Climate Change Response Strategy (2014)	The Western Cape Government (WCG) recognises we need to act locally to reduce our collective GHG emissions and adapt to global climate change. Building on the 2008 Western Cape Climate Change Response Strategy and Action Plan, the updated Strategy is newly aligned with the National Climate Change Response Policy and geared to strategically direct and mainstream climate change actions and related issues throughout relevant Provincial transversal agendas. In line with the National Climate Change Response Policy, the Strategy takes a two-pronged approach to addressing climate change: ▪ Mitigation: Contribute to national and global efforts to significantly reduce GHG emissions and build a sustainable low carbon economy, which addresses the need for economic growth, job creation and improving socio-economic conditions. ▪ Adaptation: Reduce climate vulnerability and develop the adaptive capacity of the Western Cape's economy, its people, its ecosystems and its critical infrastructure in a manner that simultaneously addresses the province's socio-economic and environmental goals. The Strategy is a coordinated climate change response for the Western Cape Province and will guide the collective implementation of innovative projects as well as the search for opportunities that combine a low carbon development trajectory with increased climate resilience, enhancement of ecosystems and the services they provide, as well as economic growth and job creation. A key component of the Strategy is to work better together by integrating climate action across all departments in the WCG and among other stakeholders, including all three spheres of government, civil society, business and industry, academia and research institutions. The focus of the Strategy is on pragmatic, locally implementable, programmatic approaches to address integrated climate change responses.
National Climate Change Adaptation Strategy (NCCAS) (2020)	The NCCAS provides a common vision of climate change adaptation and climate resilience for South Africa, and outlines priority areas for achieving this vision. It draws on South Africa's National Climate Change Response Policy (NCCRP) (DEA 2011), the National Development Plan (NDP) (NPC 2011), the adaptation

Policy, legislation, guideline or standard	Relevance to Project
	commitments included in its NDC, sector adaptation plans, provincial adaptation plans and local government adaptation plans. The main objective of the strategy is to provide guidance across all levels of government, sectors, and stakeholders affected by climate variability and change. It should also serve as the country's National Adaptation Plan and fulfils the commitment to its international obligations under the Paris Agreement.
South Africa's Nationally Determined Contributions (NDC) (2021)	South Africa updates and enhances its NDC under the Paris Agreement, meeting its obligation under Article 4.9 to communicate NDCs every five years, and responding to the requests in paragraphs 23 to 25 of decision 1/CP.21. The NDC was updated in 2021 to account for developments and increased ambitions since the first submission. Climate mitigation targets have been updated to: **Year** / **Target** / **Corresponding period of implementation** **2025** / South Africa's annual GHG emissions will be in a range from 398-510 Mt CO_2-eq. / 2021-2025 **2030** / South Africa's annual GHG emissions will be in a range from 350-420 Mt CO_2-eq. / 2026-2030 The NDC outlines adaptation goals and highlights planned mitigation and adaptation efforts and associated costs. The updated NDC highlights the importance of securing access to large-scale international climate finance.
National Legislation and Regulations	
South Africa's National Environmental Management: Air Quality Act (NEM-AQA - 2004)	The South African National Environmental Management: Air Quality Act aims to promote the protection of the environment and human health by regulating air quality and preventing air pollution in South Africa. The Act states that the contents of a provisional atmospheric emission licence and an atmospheric emission licence must specify greenhouse gas emission measurement and reporting requirements.
South African National Greenhouse Gas Emission Reporting (NGER) Regulations (2017)	The Reporting Regulations adheres to the National Environmental Management Air Quality Act. The purpose of the National Greenhouse Gas Emissions Reporting Regulations is to introduce a single national reporting system for the transparent reporting of greenhouse gas emissions, which will be used to maintain a National Greenhouse Gas Inventory, allow South Africa to meet its UNFCCC reporting obligations and to inform the formulation and implementation of legislation and policy. The emission sources and data providers who are covered by the Regulations are set out in Annexure 1 and Regulation 4. Energy is included as a sector. The Regulations also set out the reporting requirements, calculation methodology, verification procedure (to be carried out by the National Inventory Unit) and penalties (which include fines and imprisonment).

Policy, legislation, guideline or standard	Relevance to Project
	For this project, which falls under the Oil and Gas sector (code 1B2) under Annexure 1 of the Regulations (2017) and amended Regulations (2020), no thresholds have been set, which means that GHG emissions will still be required to be reported on an annual basis (using either the Tier 2 or Tier 3 method). This will need to be reported onto the South African Greenhouse Gas Emissions Reporting System (SAGERS). SAGERS is a Greenhouse Gas Reporting Module of the National Atmospheric Emissions Inventory System (NAEIS).
Declaration of Priority Pollutants and Pollution Prevention Plans (2018)	Under Section 29 of the NEM:AQA 39 of 2004, Government Notice 710 of 2017 (Government Gazette 40996), GHGs (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6)) have been declared as priority pollutants. Further, persons falling within the list of production processes, specified in Annexure A, which involves emission of GHGs in excess of 0.1 Mt annually are required to prepare and submit to the Minister pollution prevention plans for approval in line with NEM:AQA, Government Notice 712 of 2017 (Government gazette 40996). On 22 May 2018, in Government Notice 513 in Government Gazette 41642, the Minster of Environmental Affairs amended the National Pollution Prevention Plan Regulations (published in Notice 712 on 21 July 2017). In terms of this amendment, the first pollution prevention plan was due on or before 21 June 2018. A first pollution prevention plan must cover a period from the date of promulgation of these Regulations up to 31 December 2020 and the subsequent pollution prevention plans must cover periods of five calendar years each. It is understood that the proposed Project activities do not trigger any of the processes outlined in Annexure A. As such, a pollution prevention plan will not be required. However, such a plan may likely be required for the PetroSA F-A Platform as it is estimated the facility emits more the 0.1MtCO_2e annually.
South African Carbon Tax Act (2019)	The Act imposes a tax on carbon dioxide equivalent (CO_2e) GHG emissions. The tax follows the polluter pays principle to ensure that high emitting companies are accountable for their contribution to climate change. The legislation outlines that the carbon tax rate starts at R120 per tonne of CO_2 emitted within the 2019 reporting year and will increase by consumer price inflation (CPI) +2% until the end of 2022, after which it will only increase by consumer price inflation. A person is (a) a taxpayer for the purposes of this Act; and (b) liable to pay an amount of carbon tax calculated as contemplated in section 6 in respect of a tax period as specified in section 16, if that person conducts an activity in the Republic resulting in GHG emissions above the threshold determined by matching the activity listed in the column ''Activity/ Sector'' in Schedule 2 with the number in the corresponding line of the column ''Threshold'' of that table. This Project falls under the Oil and Natural Gas sector (code 1B2) which although has no threshold, is still liable to carbon tax.

Policy, legislation, guideline or standard	Relevance to Project
	Effective 1 January 2023, the carbon tax rate increased from R144 to R159 per tonne of carbon dioxide equivalent. To ensure transparency and provide certainty, future adjustments to the tax rate are provided in the Carbon Tax Act (2019), as outlined in the 2022 Taxation Laws Amendments Act. In line with the carbon tax rate increase, the carbon fuel levy for 2023/24 will increase by 1c to 10 cents a litre (c/l) for petrol and 11c/l for diesel from April 5, 2023. Carbon tax cost recovery quantum for the liquid fuels refinery sector increased from 0.63c/l to 0.66c/l, effective from January 1, 2023 The first phase of the carbon tax, with substantial allowances and electricity price neutrality, will be extended to December 31, 2025. However, in line with South Africa's commitments at COP26, the carbon tax rate will be progressively increased every year to reach $26 (R475) per tonne.
Draft National Guideline for the Consideration of Climate Change Implications in Applications for Environmental Authorisation, AEL and WML (2021)	On 25 June 2021, the Minister of Forestry, Fisheries and the Environment published a Notice under the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) seeking public comment on a draft National Guideline for the consideration of climate change implications in applications for environmental authorisation, atmospheric emission licences and waste management licences. The draft National Guideline aims to create a consistent approach for the incorporation of climate change considerations in EIAs, WMLs and AELs. It outlines a methodological approach for minimum requirements for consideration when conducting climate change assessments.
South African Climate Change Bill (2022)	The Climate Change Bill was introduced in Parliament in February 2022. It will be the first South African legal framework in response to climate change impacts. The Bill aims to enable effective development of climate change responses through a long-term transition to a climate-resilient and low-carbon society and economy, while considering sustainable development. The Bill aims to contribute fairly to global GHG stabilisation, conforms to South African international climate change obligations and commitments to protect and preserve our planet for current and future generations. The Bill provides two main mechanisms to reduce the country's greenhouse gas emissions: ▪ Section 21 of the Bill obliges the Minister to determine a national greenhouse gas emissions trajectory. This trajectory must be set in consultation with Cabinet. The trajectory must specify a national greenhouse gas emission reduction objective. This objective must be informed by South Africa's current and projected greenhouse gas emissions and be consistent with South Africa's international obligations. ▪ Section 22 of the Bill deals with sectoral emissions targets. According to section 22, the Minister must identify greenhouse gas emitting sectors and sub-sectors that should be subject to

Policy, legislation, guideline or standard	Relevance to Project
	sectoral emissions targets. The Minister must then set sectoral emissions targets for each sector, in consultation with the relevant Minister responsible for that sector. These targets must align with the national greenhouse gas emissions trajectory. The Minister responsible for each sector must then implement each sectoral target through a range of planning instruments, policies, measures, and programmes. In the case of this project, the "Energy" Sectoral Emissions Targets within Schedule 1 of the Bill is applicable.

4 METHOD OF STUDY

This section discusses the method used to determine the impact of the Project on climate change (GHG Assessment) as well as the impact of climate change on the project (Climate Change Risk Assessment).

4.1 GHG STUDY METHODOLOGY

This GHG Assessment has been undertaken in accordance with the NGER (Government Notice 710 of Government Gazette 40996) of 3 April 2017, to be read in conjunction with the amendments to the NGER (Government Notice 994 of Government Gazette 43712) of 11 September 2020. Additionally, the most recently published Methodological Guidelines for Quantification of GHG Emissions (Government Notice 2598 of Government Gazette 47257) of 7 October 2022 was read as a companion to the NGER (which is an updated version from the Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry (April, 2017)).

The structure of this Methodological Guideline for calculation of emission sources and sinks follows the structure suggested by the 2006 IPCC Guidelines. As such, the methodologies presented in this document have been mostly based on the 2006 IPCC Guidelines. The NGER requires all qualifying process activities in Annexure 1 to be quantified. Activities undertaken for the proposed activities fall within the Energy Sector under Annexure 1.

Additionally, the GHG Protocol's A Corporate Accounting and Reporting Standard (Revised Edition, 2004), and ISO 14064-1:2018 Part 1: Specification with guidance at the organisation level for quantification and reporting of GHG emissions and removals was sourced for added context.

This assessment is aligned with the above reference documents and follows the five GHG Accounting Principles: relevance, completeness, consistency, accuracy and transparency. These guiding principles ensure that all intended users can make decisions with reasonable confidence.

The methodology is as follows:

- Set the boundary – define the scope and complexity of the carbon footprint;
- Identify all GHG sources;
- Acquire all applicable activity data, using the correct tier approach, for all the sources identified;
- Identify the reporting period; and
- Identify the limitations and assumptions for the Project.

4.1.1 ORGANISATIONAL BOUNDARIES

Similar to financial accounting, reporting on the GHG emissions of operations is dependent on the structure of the organisation, and whether the operations are wholly owned, joint ventures or subsidiaries (WBCSD and WRI, 2004). It is expected that the organizations boundaries will state the makeup of the company, and the operations that it owns or controls.

In defining the organisational boundaries, there are generally two distinct approaches: equity share and control (WBCSD and WRI, 2004). With the equity share approach, the organisation accounts for GHG emissions from operations according to its equity share in the operation. Typically, the equity share is equivalent to the organisation's percentage ownership. With the control approach, an organisation accounts for 100% of the GHG emissions from the operations over which it has control. In terms of this approach, an organisation is not accountable for operations in which it owns a percentage but has no control. Control can be in the form of either financial control, in which the organisation directs the financial and operational policies of the operation, or operational control, where the organisation has the full authority to introduce and implement operational policies.

This assessment reports on the GHG emissions for the Project, in terms of the control approach, where TEEPSA accounts for 100% of the estimated GHG emissions from the operations associated with the Project over which it has control.

4.1.2 OPERATIONAL BOUNDARIES

The revised edition of the GHG Protocol Corporate Standard characterises GHG emissions as either direct or indirect (WBCSD and WRI, 2004) and, to improve transparency and consistency in reporting, three 'scopes' are used to ensure that emissions are not double counted. A brief description of the three scopes in the context of the Block 11B/12B Project is provided below:

Scope 1: Direct GHG emissions – occur from sources that are owned or controlled by the organisation, which includes the drill rig, support vessel engines and flaring during well flow testing (exploration appraisal wells test and production wells tests before connection to the subsea system) for the proposed Project;

Scope 2: Indirect GHG emissions – occur from the generation of purchased electricity or steam that is bought into the organisation's property. There are no Scope 2 GHG emissions for Block 11B/12B activities.; and

Scope 3: Other indirect GHG emissions – occur from sources that are not owned or controlled by the organisation. This includes the processing of hydrocarbons at the FA-Platform for the proposed Project and the end-use of the products, amongst others.

Figure 4-1 presents a schematic diagram of Scope 1, Scope 2, and Scope 3 emissions.

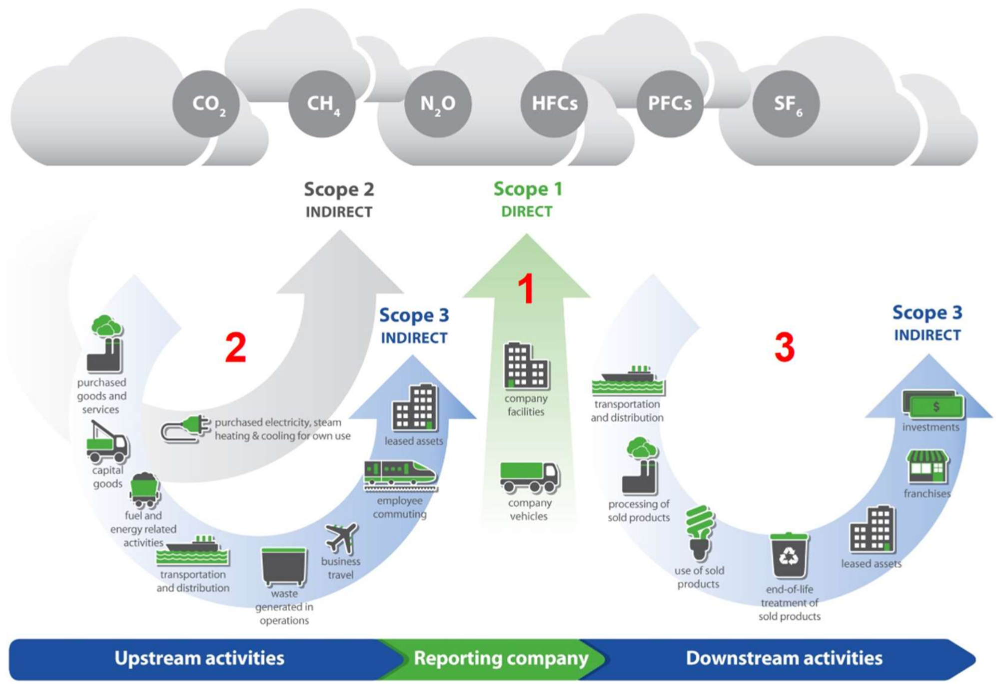


Figure 4-1 - Overview of Scope 1, Scope 2 and Scope 3 Emissions

4.1.3 GHG SOURCES FROM THE PROJECT

Table 4-1 presents a summary of the sources of GHG emissions for which TEEPSA provided estimates, and which were considered in this assessment.

Table 4-1 – Block 11B/12B and associated facility GHG Emission Sources

Scope	Source Type
Scope 1	Marine fuel oil combustion for vessels engine and power generation (drilling unit, tugboats, supply & support vessels, specialised vessels)
	Kerosene consumption in helicopters
	Flaring (well flow testing)
Scope 2	Not applicable to the Project as no electricity/ steam/ heat/ cooling is imported into the Project boundary
Scope 3	Qualitative assessment of processing and use of sold product
	FA-Platform use of hydrocarbon (process flaring and auto-consumption in turbines)

It should be noted that the **GHG emissions from the F-A Platform are reported as Scope 3 emissions** as the existing offshore installation F-A Platform will be owned and controlled by Petro SA. The F-A platform is considered **as an associated facility to the Project**, as it is necessary to the operation of the Project. Nevertheless, a quantitative assessment of this Scope 3 segment (where data was available) is provided in this study.

4.1.4 EMISSION TIER APPROACH

The methodology for the estimation of the GHG emissions from the operations is in line with the 2006 IPCC Guidelines and the prescribed tier method post the transitional period for each activity as defined in Annexure 1 of the NGER Regulations.

The Tiers are defined as follows:

- **Tier 1:** A bare minimum method using readily available statistical data on the intensity of processes (activity data) and default emission factors. This method is the simplest method and has the highest level of uncertainty;
- **Tier 2:** Similar to Tier 1 but uses technology or country specific emission factors. Tier 2 methods reduce the level of uncertainty. There are provisions within the NGERs for data providers to seek approval of country specific emission factor; and
- **Tier 3:** Tier 3 is defined as any methodology more detailed than Tier 2 and might include amongst others, process models and direct measurements. Tier 3 methods have the lowest level of uncertainty. Some of the requirements for a Tier 3 approach may include:
  - Chemical analysis;
  - Carbon content analysis;
  - Carbon balances;
  - Abatement equipment in use to determine any losses to the system;
  - Literary evidence to support assumptions; and
  - The measured values of flows and chemical composition of the fuels used.

The Tier methods used for this assessment is presented in Section 6.1.

4.1.5 REPORTING PERIOD

The reporting period for the proposed Project is for the 27-year life span.

It is recommended that this inventory be retrospectively recalculated should any new or additional information become available, or there are changes to the Project which would compromise the accuracy of the baseline. Further to this, it is recommended that the GHG inventory be reviewed, and updated if required, on an annual basis during the operational phase. Importantly, the inventory should be informed by credible data.

4.1.6 ASSUMPTIONS

The two main data requirements to calculate the GHG emissions for the proposed Project are (i) activity data and (ii) emission factors. The combination of these two data sets results in the development of a GHG inventory. The activity data was collected from the Project developer (TEEPSA). Where the project developer could not provide data, activity data was estimated using conservative assumptions, which are listed in Table 4-2.

Table 4-2 - GHG Assessment Assumptions

Project Phase	Assumption
GHG Methodology	This GHG Assessment has been undertaken in accordance with the NGER (Government Notice 710 of Government Gazette 40996) of 3 April 2017, to be read in conjunction with the amendments to the NGER (Government Notice 994 of Government Gazette 43712) of 11 September 2020. Additionally, the most recently published Methodological Guidelines for Quantification of GHG

Project Phase	Assumption
	Emissions (Government Notice 2598 of Government Gazette 47257) of 7 October 2022 was read as a companion to the NGER (which is an updated version from the Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry (April, 2017)).
Exploration	An estimated gas rate of 900 000 m^3/day could be flared per test per well and it was assumed that testing will take a maximum of 4 days to complete.
	Since the timeframe for this phase has not been yet established, the GHG emissions are not assigned to specific year on the Project timeline.
Development – Construction	The consumption of marine fuel oil from the drilling rig and support vessel is calculated for five wells as well as for the flow tests.
Development - Production	It is noted that the F-A Platform is not owned and operated by TEEPSA and thus the GHG emissions calculated from this facility is considered as a Scope 3 emission.
Development – Decommissioning	The consumption of marine fuel oil from the drilling rig, specialised and support vessel during year 26 is for the activity on subsea equipment (including the production wells).

4.2 CLIMATIC CONDITIONS METHODOLOGY

Current and future climate conditions for the Project were established for the offshore locations (the western and eastern areas of Block 11B/12B). The following sub-sections outline the data sources and methods used to represent this information for the Project.

4.2.1 CURRENT CLIMATE CONDITIONS

For the offshore locations, historic climate information was obtained from the Copernicus Climate Change Service (C3S) Climate Data Store (CDS) for the European Centre for Medium-Range Weather Forecasts (ECMWF) Re-Analysis (ERA5) dataset that is used to represent current climate conditions over the period of 1992-2022. ERA5 provides hourly estimates of a large number of atmospheric, land and oceanic climate variables by assimilating observations and climate modelling. This is a dataset that provides information about the Earth's atmosphere at a spatial resolution of approximately 31 km, across 137 vertical levels, and spanning pressure levels up to 1 pascal (Pa).

4.2.2 FUTURE CLIMATE PROJECTIONS

The IPCC is considered the definitive source of information related to past and future climate change as well as climate science. As an international body, the IPCC provides a common source of information relating to emission scenarios, provides third party reviews of models and recommends approaches to document future climate projections.

Periodically, the IPCC issues assessment reports summarizing the most current state of climate science. The Sixth Assessment Report (AR6) is the most recent synthesis of information regarding climate change projections.

Future climate is typically projected using general circulation models (GCMs) that involve the mathematical representation of global land, sea and atmosphere interactions over a long period of time. These GCMs have been developed by various government agencies, but they share several common elements described by the IPCC.

The IPCC acts as a clearinghouse for the distribution and sharing of the model forecasts. Future climate projection data are available from about 30 GCMs and five Shared Socioeconomic Pathways (SSPs) in AR6. The pathways include a suffix which specifies the radiative forcing projected to occur by 2100. For example, SSP2-4.5 denotes a pathway that includes climate change mitigation and adaptation options of SSP2, resulting in 4.5 W/m2 of radiative forcing by 2100. These SSPs are described more fully by O'Neil et al. (2014) and are summarised in Table 4-3.

Table 4-3 - Characteristics of Shared Socioeconomic Pathways in IPCC AR6

SSP	Radiative Forcing in 2100	Challenges	Global Temperature Change	Characterisation
SSP1	1.9 W/m^2 2.6 W/m^2	Sustainability – Low for mitigation and adaptation	1.0^{o}C – 2.4^{o}C	Sustainable development proceeds at a reasonably high pace. Analogous to SRES[3] B1 and A1T scenarios.
SSP2	4.5 W/m^2	Middle of the road – Medium for mitigation and adaptation	2.1^{o}C – 3.5^{o}C	An intermediate case between SSP1 and SSP3. Analogous to RCP[4] 4.5 scenario.
SSP3	7.0 W/m^2	Regional Rivalry – High for mitigation and adaptation	2.8^{o}C – 4.6^{o}C	Unmitigated emissions are high due to moderate economic growth. Analogous to SRES A2 scenario.
SSP4	3.4 W/m^2 6.0 W/m^2	Inequality – High for adaptation, low for mitigation	-	A mixed world, with relatively rapid technological development in low carbon energy sources in key emitting regions, leading to relatively large mitigative capacity in places where it mattered most to global emissions.
SSP5	8.5 W/m^2	Fossil-fuelled Development – Low for mitigation, high for adaptation	3.3^{o}C – 5.7^{o}C	In the absence of climate policies, energy demand is high and mostly met with carbon-based fuels. Analogous to SRES A1T scenario. Analogous to RCP8.5 scenario.

For the offshore locations, the Copernicus Climate Change Service (C3S) CDS was used to analyse two GHG mitigation scenarios (SSP2-4.5 and SSP5-8.5). The data source was based on the

[3] Special Report on Emissions Scenarios (SRES): This is a set of scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) to explore different potential future pathways of greenhouse gas emissions, based on varying assumptions about population growth, economic development, technology adoption, and policy decisions. These scenarios are used in climate modelling to assess potential climate change impacts and guide policy discussions.

[4] "RCP" stands for Representative Concentration Pathways. RCPs are a set of scenarios used in climate modelling to project future greenhouse gas concentrations in the atmosphere and their potential impacts on the Earth's climate system. These scenarios are similar to the SRES scenarios but are more focused on concentrations of greenhouse gases rather than emissions. RCPs describe different pathways of future emissions and concentrations of greenhouse gases, which in turn helps researchers and policymakers understand potential future climate changes. The RCPs are typically defined by the total radiative forcing (a measure of the imbalance between incoming solar radiation and outgoing infrared radiation) they would lead to by the year 2100.

Coupled Model Intercomparison Project 6 (CMIP6) data ensemble, based on AR6. The climate variables include mean air temperature, total precipitation, and wind speed. Additionally, CMIP5 data (in the absence of CIMP6 data) was accessed for sea-level rise projections.

4.3 CLIMATE CHANGE RISK ASSESSMENT APPROACH AND METHODOLOGY

The Project's vulnerability to climate change is qualitatively assessed within this assessment through an analysis of available datasets.

A review of the current and projected changes in climatic conditions was completed to identify potential climate hazards relevant to Project region. Based on the site infrastructure and potential identified hazards, a list of climate-infrastructure interactions was then developed for further consideration.

Likelihood and consequence rankings of climate-infrastructure interactions were then estimated to identify climate risks under current climate conditions and near-future conditions. Likelihood rankings were estimated for two future periods for the Project infrastructure to indicate how future climate risk may change for each. The likelihood for which the interaction may occur, and the consequence associated with this interaction, were assigned qualitatively using a ranking scale. The likelihood ranking scales are summarized Table 4-4, while the consequence ranking scales are summarized in Table 4-5. For likelihood, the scale with categories ranges from improbable/rare (1) to almost certain/ highly probable (5). For consequence, the categories range from insignificant (1) to catastrophic (5).

Table 4-4 – Likelihood Ranking Scales

Qualitative Descriptor	Description
Improbable/ Rare	Not likely to occur during the entire Project's operational life. Not likely to increase in intensity or duration during the Project life.
Could Happen/ Unlikely	Likely to occur once during the entire Project's operational life. Likely to increase in intensity or duration in 30-40 years of the Project life.
As Likely As Not/ Possible	Likely to occur more than once during the Project's operational life. Likely to increase in intensity or duration in the coming 20 to 30 years of the Project life
Probable/ Likely	Likely to occur at least once every decade throughout Project's operational life. Likely to increase in intensity or duration in the next 10 to 20 years of the Project life.
Almost Certain/ Highly Probable	Likely to occur at least once or even more in every year of Project's operation life. Will increase in intensity and duration annually since the start of the Project.

Table 4-5 – Consequence Ranking Scales

Qualitative Descriptor	Description
Insignificant	Minor loss/ damage to infrastructure. Plant/ equipment: no impact on availability.
Minor	Moderate loss / damage to infrastructure.

	Plant / equipment: offline for less than 1 month.
Moderate	Significant loss / damage to infrastructure Plant /equipment : offline for 1-3 months.
Major	Severe loss / damage / business impact. Plant / equipment : offline for 3-6 months.
Catastrophic	Major loss / damage /reportable event within local legislation. Plant /equipment : offline for >6 months.

The consequence and likelihood of climate interactions can be used to identify key climate risks levels for a project. If an interaction has a major consequence, but rare occurrence, the overall risk would be perceived as being medium risk. Evaluating both consequence and likelihood together allows for climate risks to be categorized (Figure 4-2). These risks are further defined in Table 4-6.

Consequence	Catastrophic	Medium Risk	Severe Risk	Severe Risk	Unacceptable Risk	Unacceptable Risk
	Major	Acceptable Risk	Medium Risk	Severe Risk	Severe Risk	Unacceptable Risk
	Moderate	Acceptable Risk	Acceptable Risk	Medium Risk	Severe Risk	Severe Risk
	Minor	Negligible Risk	Acceptable Risk	Acceptable Risk	Medium Risk	Medium Risk
	Insignificant	Negligible Risk	Negligible Risk	Acceptable Risk	Acceptable Risk	Acceptable Risk
		Improbable/ Rare	Could Happen/ Unlikely	As Likely As Not/ Possible	Probable/ Likely	Almost Certain/ Highly Probable
	Likelihood					

Figure 4-2 -Climate Risk Ranking

Table 4-6 – Risk Rating Definition

Risk Rating	Example
Negligible Risk	An identified interaction between the climate hazard and Project component has a negligible risk if the hazard has: ▪ An improbable/rare or could happen/unlikely likelihood of occurrence and an insignificant consequence; ▪ An improbable/rare likelihood of occurrence and a minor consequence; or **Expected no permanent damage to infrastructure/operations. Risks do not require further consideration.**
Acceptable Risk	An identified interaction between the climate hazard and Project component has an acceptable risk if the hazard has: ▪ An improbable/rare likelihood of occurrence and a moderate or major consequence; ▪ A could happen/unlikely likelihood of occurrence and a minor or moderate consequence; ▪ An As Likely As Not/ Possible likelihood of occurrence and an insignificant or minor consequence; or ▪ A Probable/ Likely or Almost Certain/ Highly Probable likelihood of occurrence and an insignificant consequence

Risk Rating	Example
	Expected minor damage to infrastructure/operations. Actions might not be required.
Medium Risk	An identified interaction between the climate hazard and Project component has a medium risk if the hazard has: ▪ An improbable/rare likelihood of occurrence and a catastrophic consequence; ▪ A could happen/unlikely likelihood of occurrence and a major consequence; ▪ An As Likely As Not/ Possible likelihood of occurrence and a moderate consequence; or ▪ A Probable/ Likely or Almost Certain/ Highly Probable likelihood of occurrence and a minor consequence. **Expected limited damage to infrastructure/operations. Some adaptation actions might be required.**
Severe Risk	An identified interaction between the climate hazard and Project component has a high risk if the hazard has: ▪ A could happen/unlikely likelihood of occurrence and a catastrophic consequence; ▪ An As Likely As Not/ Possible likelihood of occurrence and a major or catastrophic consequence; ▪ A Probable/ Likely of occurrence and a moderate or major consequence; or ▪ An Almost Certain/ Highly Probable likelihood of occurrence and a moderate consequence. **May result in permanent damage to infrastructure, assets, operations. High priority adaptation actions need to be implemented.**
Unacceptable Risk	An identified interaction between the climate hazard and Project component has an extreme risk if the hazard has: ▪ A probable/likely likelihood of occurrence and a catastrophic consequence; or ▪ An Almost Certain/ Highly Probable likelihood of occurrence and a major or catastrophic consequence. **May result in permanent damage or loss of asset and operations. Immediate adaptation actions need to be implemented or risks need to be monitored as part of continual improvement.**

5 BASELINE DESCRIPTION

This section describes the South Africa's GHG Inventory, and the baseline climate conditions for the Project area and surrounding region.

5.1 GHG BASELINE

5.1.1 NATIONAL GHG INVENTORY

In August 1997, the Republic of South Africa joined most countries in the international community in ratifying the UNFCCC. The first national GHG inventory in South Africa was prepared in 1998, using 1990 data (Van der Merwe & Scholes, 1998). It was updated to include 1994 data and published in 2004. It was developed using the 1996 IPCC Guidelines for National Greenhouse Gas Inventories.

For the 2000 national inventory (DEAT, 2009), a decision was made to use the published 2006 IPCC Guidelines (IPCC, 2006) to enhance accuracy and transparency, and to familiarise researchers with the latest inventory preparation guidelines. Following these guidelines, in 2014, the GHG inventory for the years 2000 to 2010 were compiled (DEA, 2014). An update was completed for 2011 and 2012 in 2016 (DEA, 2016), and for 2013 to 2015 in 2019 (DEA, 2019). The 2017 inventory (DFFE, 2020) was in accordance with the guidelines provided by the UNFCCC and follows the 2006 IPCC Guidelines (IPCC, 2006) and IPCC Good Practice Guidance (GPG) (IPCC, 2000; IPCC, 2003; IPCC, 2014).

The draft 8th National GHG Inventory was published in July 2022 and compiled for 2000 to 2020 was also in accordance with the UNFCCC and 2006 IPCC Guidelines (IPCC, 2006). The key trends from 2000 to 2020 are discussed below in Table 5-1 and emissions by sector can be seen in Figure 5-1.

Table 5-1 - Total National Emission Summary – 2000 to 2020

Sector	Emission Summary
Total National Emissions – Excluding Forestry and other Land Use (FOLU)	South Africa's GHG emissions were 473,832 Gg CO_2e in 2000 (excluding FOLU) and these increased by 4,802 Gg CO_2e (or 1%) by 2020 (478,634.1 Gg CO_2e). Emissions increased slowly over the 19-year period with a slight decline noted in 2020, most likely due to the COVID-19 lockdown restrictions.
Total National Emissions – Including Forestry and other Land Use	The Agriculture, Forestry and Other Land Use (AFOLU) sector is an overall source of emissions; however, this source has been reducing due to the increasing Land sink due to FOLU[5]. Emissions (incl. FOLU) were estimated at 446,275 Gg CO_2e in 2000 and slowly increased over the 19-year period up until 2010 where a slight decline to 445,566 Gg CO_2e (0.2%) was noted. It was noted that the Land sink increased from 2011 which caused an increase in the reduction of the emissions (incl. FOLU) between 2011 and 2019 and the further reduction in 2020 was potentially due to the COVID-19 lockdown restrictions.
Energy Sector	Energy sector emissions increased by 2.4% between 2000 and 2020. The emissions increased between 2000 and 2009, then declined to 2014 after which total emissions were stable until 2019. Emissions declined by 6.8% in 2020. The main contributor to the decline is a 19.7% reduction in emissions from "other" sectors and a 13.7% reduction in Transport emissions. Commercial/institutional emissions declined by 19.7% in 2020, along with a 13.7% reduction in road transport and 54.28% reduction in civil aviation emissions during this year. These reductions can be attributed to the reduced travel and trading during the COVID-19 lockdown restrictions. Total emissions from the Energy sector for 2020 were estimated to be 380,033 Gg CO_2e which is 79.4% of the total emissions (excl. FOLU) for South Africa. Energy industries were the main contributor, accounting for 62.3% of emissions from the Energy sector. This was followed by Transport (12.7%) and Manufacturing industries and construction (8.7%).

[5] Forests and natural lands play a crucial role in sequestering carbon dioxide (CO_2) from the atmosphere, acting as significant carbon sinks. A carbon sink is a natural or artificial reservoir that stores more carbon than it releases, helping to mitigate the impacts of climate change by reducing the concentration of greenhouse gases in the atmosphere.

Sector	Emission Summary
Industrial Processes and Product Use	Estimated emissions from the Industrial Processes and Product Use (IPPU) sector are 6,360 Gg CO_2e (-19.3%) lower than the emissions in 2000. This was mainly due to the decline in production in the iron and steel as well as carbide production categories in 2020. The overall decrease in the IPPU sector emissions is due to 24.9% decline in Mineral industry emissions and a 56.6% decline in metal industry emissions. The Cement industry and Iron and steel industries were the main contributors to these declines. IPPU emissions increased by 17.9% between 2000 and 2006, after which there was a - 0.2% decline to 2009. This decrease was mainly due to the global economic recession and the electricity crisis that occurred in South Africa during that period. In 2010 emissions decreased by -8.7% due to a decrease in the non-energy products from fuels and solvent use category. Emissions decreased by -9.0% between 2010 and 2017. Emissions within the sector decreased further from 2017 to 2020 by -17.6 % due to lower production demands in the mineral, chemical and metal industry. In 2020 the IPPU sector produced 26,595 Gg CO_2e, which is 5.6% of South Africa's emission (excluding FOLU). The largest source category is the metal industry category, which contributes 41.8% to the total IPPU sector emissions. Iron and steel production and Ferroalloy's production are the biggest CO_2 contributors to the metal industry subsector, producing 3,856 Gg CO_2e (34.7%) and 5,954 Gg CO_2e (53.6%) respectively to the total metal industry CO_2 emissions. The mineral industry and the chemical industry subsectors contribute 16.2% and 18.7%, respectively, to the IPPU sector emissions. Carbide production, carbon black production, iron and steel production, ferroalloy production and ammonia production produce 3,320 Gg CO_2e of CH_4, while chemical industries are estimated to produce 837Gg CO_2e of N_2O.
Agriculture, Forestry and Land Use Change	There was a 4.7% decline in emissions (excl. FOLU) and a 33.3% decline in emissions including FOLU between 2000 and 2020. Enteric fermentation emissions have been constant between 2000 and 2012, with a slight decline in 2006 and a slight increase in 2012. After 2012, emissions declined until 2020. This trend follows the livestock population trend. The 'other' cattle population has declined by 12.5% since 2014 which contributes to the decline in emissions. 'Other' cattle and sheep were the largest contributors to the Enteric fermentation emissions. Emissions from manure management increased by 11.8% between 2000 and 2020 and this is because most managed manure is on dairy, pig and poultry farms and these livestock have been increasing in numbers over this period. Emissions from aggregated and non-CO_2 emissions on land have remained constant except for a decline in 2003-2004 and 2015 and 2016, which are attributed to changes in biomass burning. The Land sector sink declined between 2000 and 2008, after which it increased to 2020. The sink was largest in 2016 due to increasing forest land and reduced losses through fuelwood collection and biomass burning. The sink declined in 2017 and 2018 but increased again thereafter. The overall AFOLU emissions totalled 15,892 Gg CO_2e (incl. FOLU) in 2020, and 48,961 Gg CO_2e excluding FOLU. Livestock contributed 31,372 Gg CO_2e (64.1% of total excl. FOLU). Aggregated and non-CO_2 emissions on land contributed 35.9% to the AFOLU (excl. FOLU) emissions in 2020, and the largest contributor to this category is direct N_2O from managed soils (72.9%). Nitrogen inputs from urine and dung contribute 49.4% to direct N_2O emissions, followed by 23.7% from crop residues and 15.6% from inorganic fertilisers. For the Land category the largest contributor to the sink is the Forest land, followed by Grasslands. Other land is the main contributor to the source in the Land category.

Sector	Emission Summary
Waste Sector	Solid waste disposal increased its contribution to the total Waste sector emissions by 4.6% since 2000. Incineration and open burning of waste increased its contribution since 2000 by 0.5%, while the contribution from Wastewater treatment and discharge remained stable throughout the time series. This is largely driven by increases of 0.4% in Domestic wastewater treatment, whilst there was a -0.5% decline in Industrial wastewater treatment and discharge. In South Africa the total Waste sector emissions for 2020 were 23,046 Gg CO_2e of total net national emissions. The majority of these emissions are from Solid waste disposal contributing 18,253 Gg CO_2e (79.2%) of the total Waste sector emissions. Wastewater treatment and discharge contributed a further 4,458 Gg CO_2e (19.3%) of waste emissions while open burning of waste contributed 335 Gg CO_2e (1.5%). Emissions from biological treatment of solid waste were estimated to be insignificant (0.0019) Gg CO_2e.

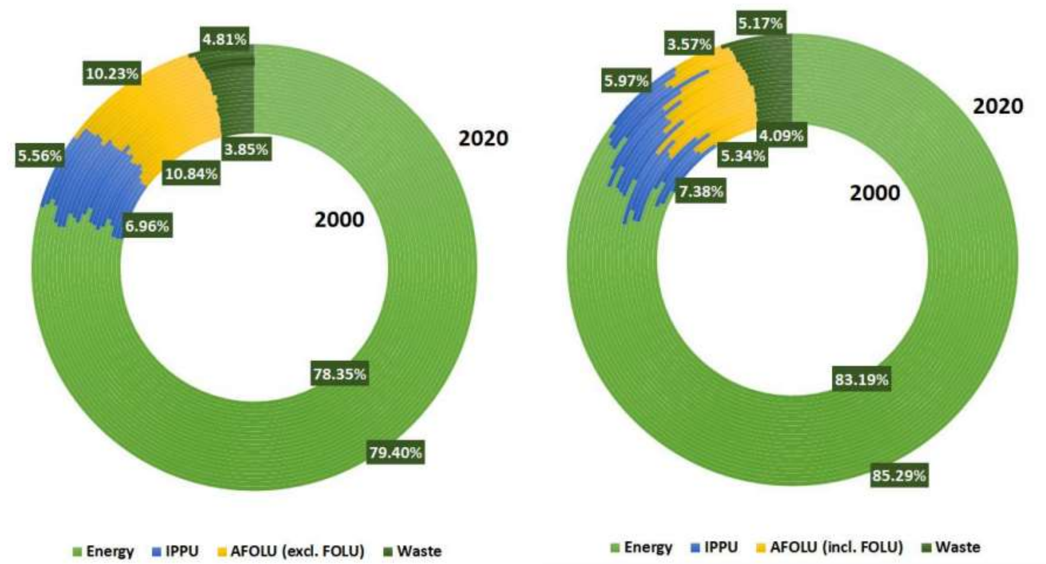


Figure 5-1 – South Africa Sector Contribution to Total Emissions (2000 and 2020)

5.1.2 NATIONAL GREENHOUSE GAS TARGET

South Africa's First Nationally Determined Contribution (NDC) under the Paris Agreement was updated in September 2021. The first NDC set out a "Peak, Plateau and Decline" trajectory range from 2016 to 2025. South Africa's lower boundary was set at 398 Mt CO_2e and the upper boundary was set at 614 Mt CO_2e, for all national GHG emissions, including those from land use. The updated NDC has revised the target to ranges of 398 to 510 Mt CO_2e for 2025, and 350 to 420 Mt CO_2e for 2030.

By comparison to the targets contained in South Africa's first NDC submitted in 2015, South Africa's updated mitigation targets represent a very significant progression. The upper end of the target range in 2025 has been reduced by 17%, and the upper end of the target range in 2030 has been reduced by 32%, and the lower range by 12%. Meeting these targets will require South Africa to implement a range of policies and measures, including a very ambitious power sector investment plan as set out in the 2019 Integrated Resource Plan, the Green Transport Strategy, enhanced energy efficiency programmes, and the carbon tax.

South Africa's updated NDC targets are aligned with planned policies and measures to provide opportunities for accessing large-scale international climate finance to fund low carbon infrastructure, and to fund a just transition to a low-carbon economy.

5.2 BASELINE AND FUTURE CLIMATIC CONDITIONS

The baseline and future climate conditions for the Project were analysed using the data sources described in Section 4.2. To define the baseline and future climate conditions for the Project area, climate variables were extracted for the Project area, Latitude (-34° to -36°) and Longitude (22° to 25°) coordinates. This area is shown by the black block in Figure 5-2.

Important to note is that the future projections are presented for two time periods i.e., 2020 – 2039 (short-term) and 2040 – 2060 (medium-term) using the NorESM2-LM CMIP6 data from the Copernicus CDS. According to Lim Kam Sian et al (2021) the three best performing global climate models (GCMs) over the South African Domain are FGOALS-g3, MPI-ESM1-2-HR and NorESM2-LM. Based on the available Copernicus dataset the NorESM2-LM was used to establish the future projections for this Project.

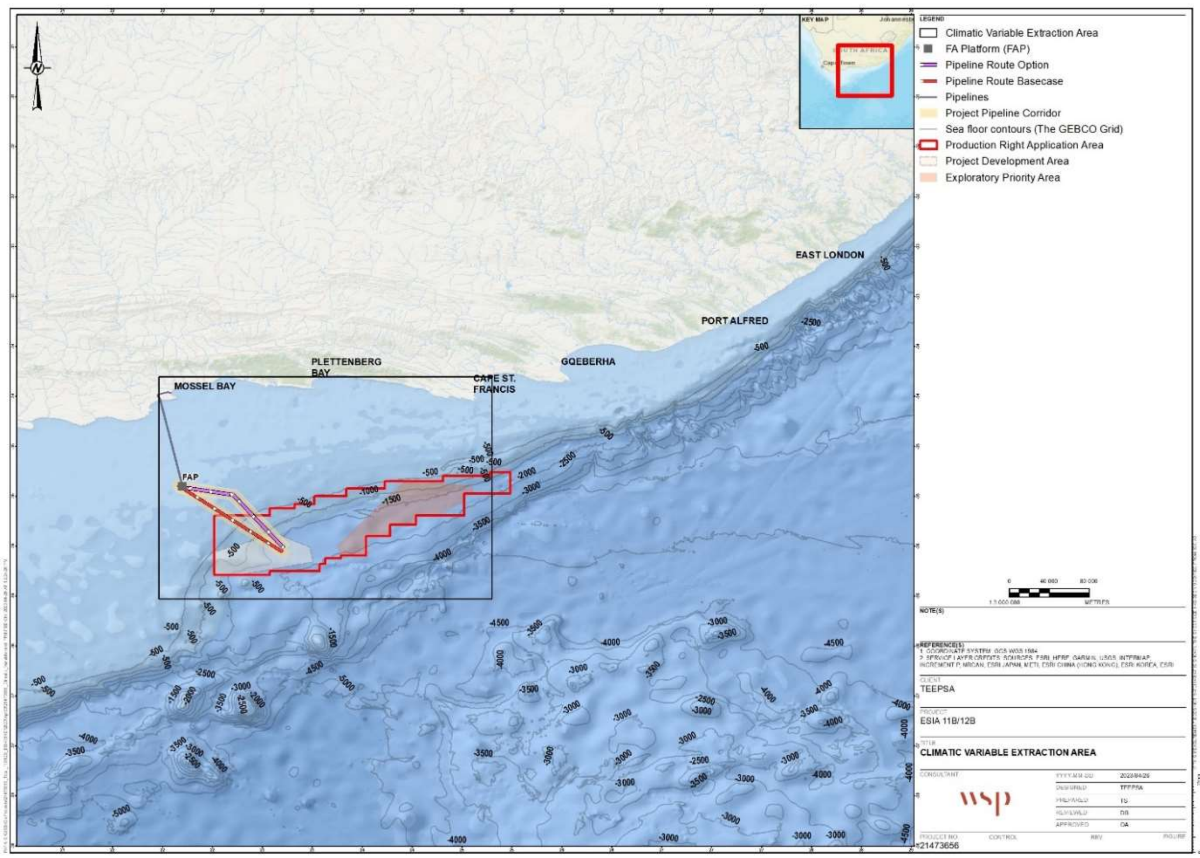


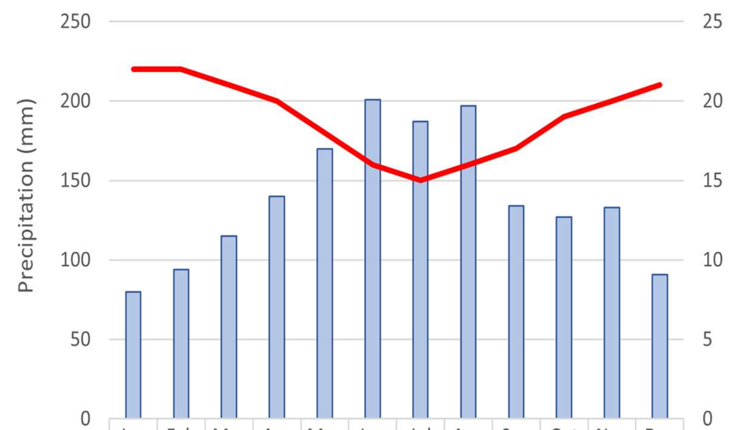
Figure 5-2 - Localities of Project Development Area, Exploration Priority Area, Pipeline Corridors and Climate Variable Extraction Area (Black block)

5.2.1 BASELINE CONDITIONS

5.2.1.1 Mean Temperature and Precipitation

ERA5 data by Hersbach et al. (2023) from the Copernicus Climate Change Service (C3S) CDS was used to present the mean temperature and precipitation baseline conditions for the southern offshore area for the period 1992 to 2022 (Figure 5-3).

The mean annual temperature is estimated to be 18.6 °C, with an average monthly temperature ranging between 20.0°C – 21.5°C during the summer months (December, January and February) and the lower temperatures ranging between 16.1°C to 17.0°C during the winter months (June, July and August). The annual precipitation is estimated to be 1667.6 mm with the highest precipitation amounts (between 169.7 mm to 200.7 mm) occurring during winter (between June, July and August) and the lower values (80.1 mm to 94.0 mm) occurring in the summer months (December, January and February). These results correlate with Jury (2020) which stated that the southwestern cape of South Africa is located between the sub-tropical easterly and mid-latitude westerly wind regimes and is mainly dominated by austral winter rainfall.

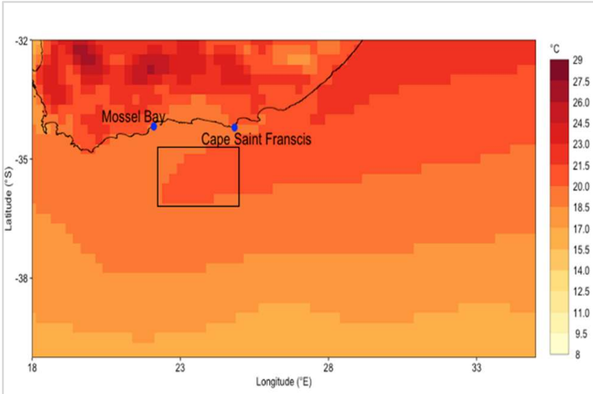


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precip	80	94	115	140	170	201	187	197	134	127	133	91
Temp	22	22	21	20	18	16	15	16	17	19	20	21

Figure 5-3 – Mean Temperature and Precipitation for the Southern Offshore Climate Variable Extraction Area
Source: Hersbach et al., 2023

5.2.1.2 Spatial Variability of Mean Temperature

Both the spatial variability temperature and precipitation maps are presented below (Figure 5-4). High temperatures are found on land and close to the coastal line while lower temperatures can be seen further offshore. Contrary to temperature, precipitation shows some spatial variability.



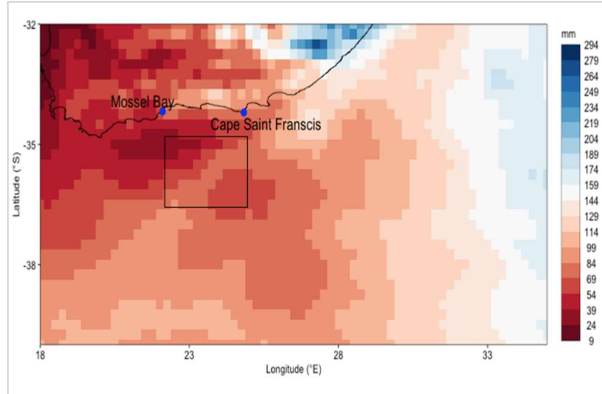


Figure 5-4 – Spatial variability of mean annual air temperatures (left) and precipitation (right) for 1992 to 2022. The black outlined box represents the location of the project area

Source: Hersbach et al., 2023

5.2.2 FUTURE CLIMATIC CONDITIONS

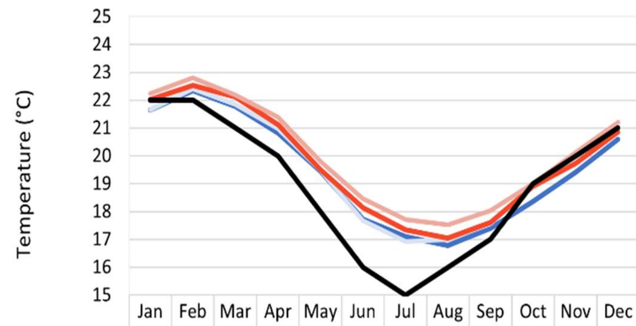
The following section provides an overview of future climate conditions for the southern offshore climate extraction area. The future climate projections are presented for two time periods i.e., 2020 – 2039 (short-term) and 2040 – 2060 (medium-term) using the NorESM2-LM CMIP6 data.

5.2.2.1 Project Mean Temperature

Figure 5-5 presents the projected mean annual temperature for the southern offshore climate extracted area.

Under the SSP2 scenario the mean annual near surface air temperature for the southern offshore is projected to increase to 19.5 °C from 2020 – 2039 and 19.7 °C from 2040 – 2060 compared to the 1992 to 2022 baseline.

Under the SSP5 scenario the mean annual near surface air temperature for the southern offshore is projected to increase to 19.6 °C from 2020 – 2039 and 20.0 °C from 2040 – 2060 compared to the 1992 to 2022 baseline.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020 - 2039 SSP2	22	22	22	21	19	18	17	17	17	18	19	21
2020 - 2039 SSP5	22	22	22	21	19	18	17	17	18	19	20	21
2040 - 2060 SSP2	22	23	22	21	19	18	17	17	18	19	20	21
2040 - 2060 SSP5	22	23	22	21	20	18	18	18	18	19	20	21
Baseline (1992-2022)	22	22	21	20	18	16	15	16	17	19	20	21

Figure 5-5 – Projected change in mean temperature under SSP 2 and SSP5 for 2020-2039 and 2040-2060

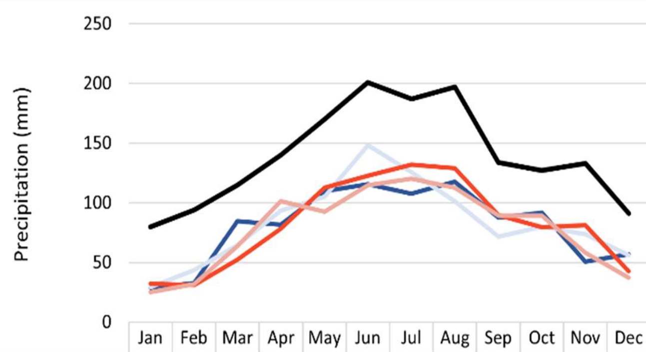
(Source: Copernicus Climate Change Service, Climate Data Store, 2021)

5.2.2.2 Projected Mean Precipitation

Figure 5-6 presents the projected mean annual precipitation for the Southern Offshore climate extracted area.

Under the SSP2 scenario the mean annual precipitation for the southern offshore is projected to decrease to 965.3 mm from 2020 – 2039 and 983.2 mm from 2040 – 2060 compared to the 1992 to 2022 baseline.

Under the SSP5 scenario the mean annual temperature for the southern offshore is projected to decrease to 993.2 mm from 2020 – 2039 and 936.9 mm from 2040 – 2060 compared to the 1992 to 2022 baseline.



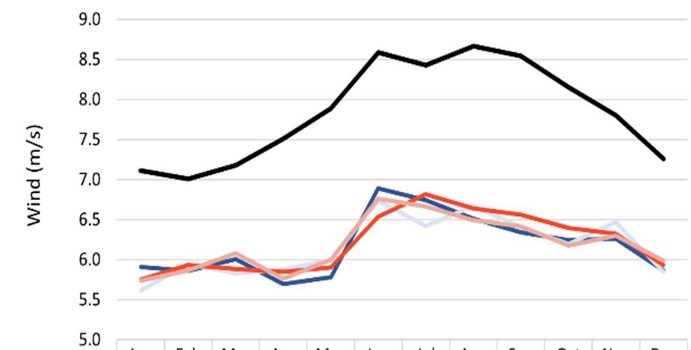
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020 - 2039 SSP2	29	33	85	82	110	116	108	118	88	92	51	57
2020 - 2039 SSP5	29	44	64	94	105	148	126	101	72	80	74	56
2040 - 2060 SSP2	32	31	52	78	113	123	132	129	90	80	81	43
2040 - 2060 SSP5	25	32	64	101	93	115	120	113	89	89	58	37
Baseline (1992 -2022)	80	94	115	140	170	201	187	197	134	127	133	91

Figure 5-6 – Projected change in mean precipitation under SSP 2 and SSP5 for 2020-2039 and 2040-2060

(Source: Copernicus Climate Change Service, Climate Data Store, 2021)

5.2.2.3 Projected Mean Near Sea Surface Wind Speed

Figure 5-7 presents the projected mean annual windspeed for the southern offshore climate extracted area. Under the SSP2 and SSP5 scenarios the mean annual near sea surface wind speed for the southern offshore is projected to be 6.2 m/s for both the 2020 – 2039 and 2040 – 2060 periods. As such, the near surface windspeed shows a decrease from the baseline however the wind pattern remains relatively constant over the southern offshore area.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020 - 2039 SSP2	5.9	5.9	6.0	5.7	5.8	6.9	6.7	6.5	6.3	6.2	6.3	5.9
2020 - 2039 SSP5	5.6	5.9	5.8	5.9	6.0	6.7	6.4	6.7	6.4	6.2	6.5	5.9
2040 - 2060 SSP2	5.8	5.9	5.9	5.9	5.9	6.5	6.8	6.6	6.6	6.4	6.3	5.9
2040 - 2060 SSP5	5.7	5.9	6.1	5.8	6.0	6.8	6.7	6.5	6.4	6.2	6.3	6.0
baseline (1992-2022)	7.1	7.0	7.2	7.5	7.9	8.6	8.4	8.7	8.5	8.2	7.8	7.3

Figure 5-7 – Projected change in mean near sea surface windspeed under SSP2 and SSP5 for 2020-2039 and 2040-2060

(Source: Copernicus Climate Change Service, Climate Data Store, 2021)

5.2.2.4 Ocean Currents, Waves and Storms

Currents

Ocean currents are responsible for reinforcing or opposing sea waves in their direction of travel. The reinforcing of the opposing force of the currents can affect the heights and other characteristics of sea waves. The main ocean currents around South Africa are the Agulhas Current, the South Atlantic Current and the Benguela Current (MacHutchon, 2006). According to Wepener & Degger (2019), the Agulhas Current is one of the largest western boundary currents in the world and is known to significantly influence weather and climate over the African continent.

The Agulhas current consists of two main parts: the Northern, which is stable with velocities that range from 1.4 to 1.6 m/s, and the Southern Agulhas comprising large meanders and mesoscale eddies with velocities that range from 1.5 to 2 m/s (Ponce de León & Guedes Soares, 2021). The Agulhas current moves warm water from the subtropic of the Indican Ocean (Mozambique Current) southwards down the east coast (Wepener & Degger, 2019). The Agulhas current then turns back on itself and retroflects to flow eastward Figure 5-8.

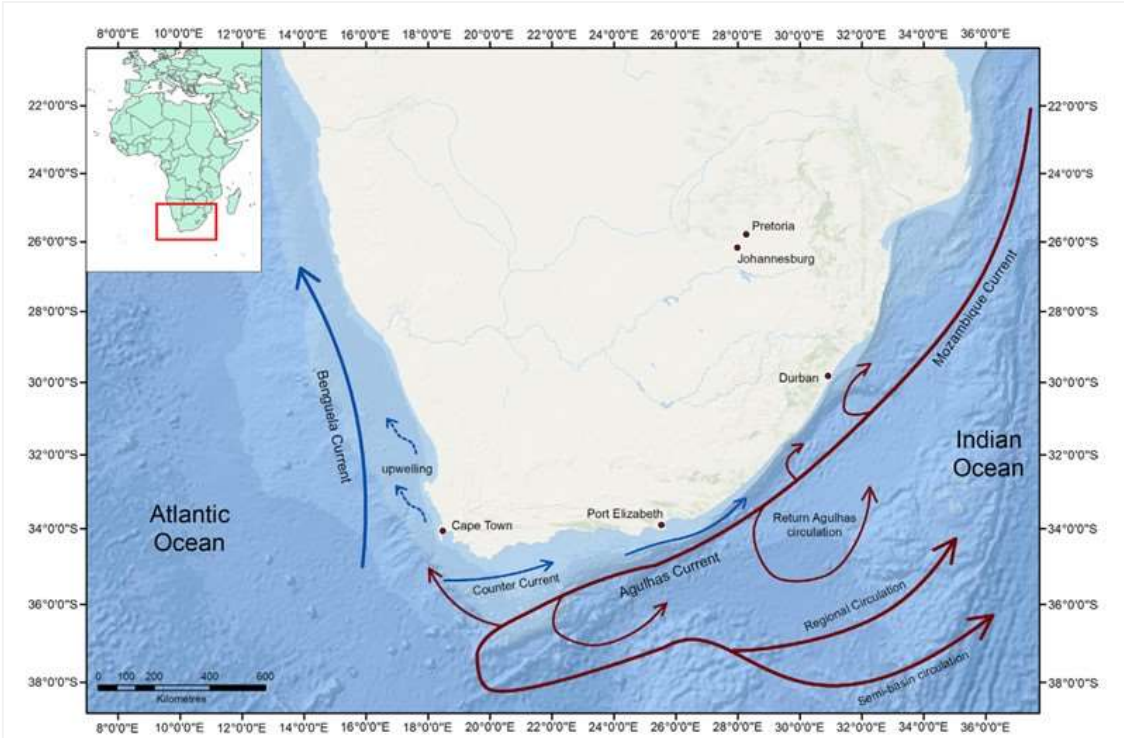


Figure 5-8 – Map showing the major ocean currents along the South African Coastline

Source : (Wepener & Degger, 2019)

Waves

Waves severely affecting maritime activities are generally caused by the passing frontal systems originating from the Southern Atlantic, cut-off low systems over South Africa's southern to eastern coast and occasionally by the tropical cyclones moving down the Mozambican channel (Theron et al., 2010). Wave condition is the main cause of extreme seawater levels and possible flooding/inundation, it is, therefore, important to quantify extreme wave conditions around the coast.

The Agulhas Current region is one of the places that shows a statistically substantial increase in mean significant wave height (Hs) (Ponce de León & Guedes Soares, 2021). Satellite altimetry data have shown that very large significant wave height gradients can be found in the Agulhas Current system (Ponce de León & Guedes Soares, 2021). Using the Simulating Waves Nearshore (SWAN) model Ponce de León & Guedes Soares (2021) found that the Agulhas Current region is exposed to severe storms that commonly occur during the winter months (May to October). The study of these authors aligns with authors such as Theron et al. (2010) who stated that wave climate over the South African coast has shown a clear seasonality and differs in intensity and direction of travel around the coast and, waves with high mean significant height are located in the winter months.

The South African coastline is highly exposed to the occurrence of waves and swells which can reach more than 5m. This provides a natural environment for storms from the sea (Wepener & Degger, 2019).

As can be seen in Figure 5-9, waves show a clear seasonality with high mean wave height found in the winter months (June-August). A study by Theron et al. (2010) found that for their long-term data

(1994-2010), the mean annual significant height collected offshore of Cape Town, showed no real progressive increase.

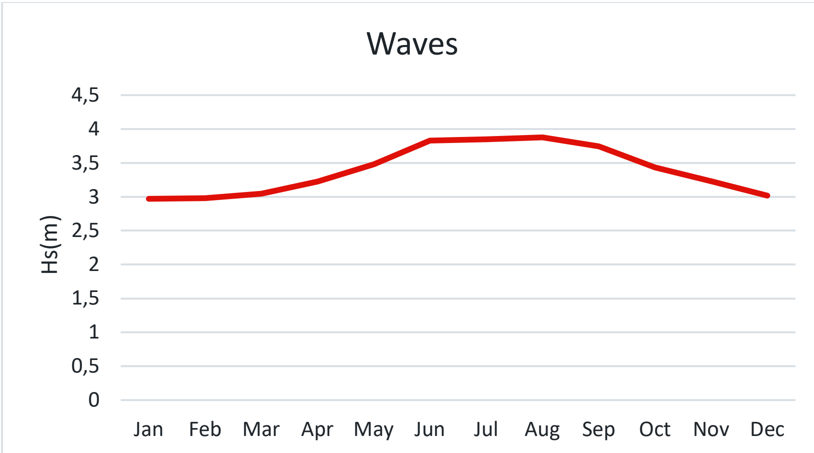


Figure 5-9 – ERA 5 mean significant height of wind waves and total swell over the Southern Offshore area for the period of 1992-2022

Source : (Wepener & Degger, 2019)

In addition to the significant height of waves, wave direction is important. The most severe wave conditions occur on South Africa's south-west and south coasts with decreasing magnitude along the west and east coasts (Theron et al., 2010). The distribution of wave period remains fairly constant as a result of swell moving northwards. The predominant wave direction is south-west but swings more toward a south-south-westerly direction on the east coast (Theron et al., 2010).

Storms

As mentioned, the South African coastline is highly exposed to the occurrence of waves and swells, and this provides a natural environment for storms from the sea (Wepener & Degger, 2019). According to MacHutchon (2006), sea storms affect ships at sea, offshore structures, and coastal engineering structures. In addition to this, climate change is anticipated to cause a rise in the intensity and frequency of storms along the coastline making it more susceptible to extreme weather events storm surges, coastal erosion, flooding and sea-level rise (Wepener & Degger, 2019). Although Theron et al (2010) found that the annual mean significant wave height remained constant for their selected period (1994 – 2010), the authors found some changes in individual storms. For instance, the individual storms during the more severe winter period (June to August), showed an upward trend of approximately 0.5 m over their study period. The trend might be indicative of a significant increase in storminess over the next decades. Important to note is that during the summer the authors found a downward trend in terms of individual storms over their selected 14-year period.

The comparisons of the baseline relative to the future climate conditions is summarised in Table 5-2. This summary was used to support the assessment of climate risk for the offshore Project infrastructure.

Table 5-2: Climate Trends for the Southern Offshore

Climate Hazard Description		Trend	Description of Current Climate	Comments on Future Trends
TEMPERATURE				
Near sea surface air temperature	Mean Annual Temperature	Increasing	Annual mean temperature is estimated to be 18.6°C for 1992-2022 period. Monthly mean temperatures greatest in February (21.5°C) and lowest in August (16.1°C). Over the 1992-2022 period an increasing annual mean temperature trend may be present over time. Higher temperatures are found on land and closer to the coast while lower temperatures can be seen further offshore.	Under the SSP2 scenario the mean annual near sea surface air temperature for the southern offshore is projected to increase to 19.5 °C from 2020 – 2039 and 19.7 °C from 2040 – 2060 compared to the 1992 to 2022 baseline. Under the SSP5 scenario the mean annual near sea surface air temperature for the southern offshore is projected to increase to 19.6 °C from 2020 – 2039 and 20.0 °C from 2040 – 2060 compared to the 1992 to 2022 baseline (+ 7.5% for the last period).
PRECIPITATION				
Precipitation	Mean Annual Precipitation	Decreasing	Annual mean precipitation is estimated to be 1667.6 mm for 1992-2022 period. Unlike the mean temperature, rainfall shows some spatial variability.	Under the SSP2 scenario the mean annual precipitation for the southern offshore is projected to decrease to 965.3 mm from 2020 – 2039 and 983.2 mm from 2040 – 2060 compared to the 1992 to 2022 baseline. Under the SSP5 scenario the mean annual precipitation for the southern offshore is projected to decrease 993.2 mm from 2020 – 2039 and 936.9 mm from 2040 – 2060 compared to the 1992 to 2022 baseline.
OTHER EVENTS				
Wind	Near Surface Wind	Relatively constant	Wind speed over the area remain relatively constant throughout the year with mean values ranging between 7.0 m/s and 8.7 m/s.	Under the SSP2 and SSP5 scenarios the mean annual near sea surface wind speed for the southern offshore is projected to be 6.2 m/s for both the 2020 – 2039 and 2040 – 2060 periods. From the results, near surface windspeed remains relatively constant over the southern offshore.
Sea Level Rise	Changing water levels	Increasing	There has been an observed average rate of increase in water level rise of between 2 and 4mm/year between 1993 to 2018 for the coast of South Africa.	In 2050, under RCP2.6, RCP4.5 and RCP8.5 scenarios the change in mean sea level rise is projected to increase to 0.24 m, 0.27 m and 0.28 m respectively, compared to the baseline.

6 GREENHOUSE GAS ASSESSMENT

There are six GHGs. These include CO_2, CH_4, N_2O, HFCS, PFCs and SF_6. The key GHGs for the proposed Project, and which has been assessed within this report, include CO_2, CH_4 and N_2O.

These GHGs are reported in terms of CO_2e, in which all of the GHGs are converted to an equivalent basis relative to their Global Warming Potential (GWP). The GWP is a measure of a compound's radiative efficiency, or the compound's ability to trap heat, over a certain lifetime in the atmosphere, relative to the effects of the same mass of CO_2. The CO_2e value also takes into account the likelihood of indirect effects from other GHG precursors or compounds formed. While relatively constant, occasionally GWPs are adjusted slightly as scientific understanding of radiative forcing, atmospheric lifetime, and indirect effects improves. Emissions expressed in equivalent terms highlight the contribution of the various gases to the overall inventory for the purposes of accounting emissions. Therefore, GWP is a useful statistical weighting tool for comparing the heat trapping potential of various gases (API, 2021).

The general methodology, which is relevant for all reporting subsectors mentioned above, combines activity data (the extent to which a human activity takes places) with the emission factor (coefficients which quantify the emissions or removals per unit of activity). The basic equation for both tier 1 and tier 2 approaches is therefore:

$$Emissions = Activity \times Emission\ Factor \times Global\ Warming\ Potential$$

Where:

$Emissions = estimate\ of\ CO_2e\ or\ GHG\ emissions\ in\ tonnes/year$

The IPCC Guidelines recommend that when calculating non-CO_2 GHG emissions, the most recent GWPs are used. However, under the NGERs, data providers are required to use GWP values provided by the IPCC 3rd Assessment Report (IPCC 2001), where required. The GHG Protocol however states that any of the IPCC Assessment Reports GWPs can be used, as long as they are referenced correctly and used consistently (Methodological Guidelines for Quantification of GHG Emissions, 2022).

In terms of the updated NDC in 2021, it is unclear which GWP values have been used to calculate the target range. The NDC states that its targets are based on the latest inventory report, and that the country will transition to using AR5 in 2024. In its first NDC of 2016, South Africa's target range was calculated using AR4 values. As the lower bound of the target range for 2025 is 398 $MtCO_2e$ (incl. Land Use, Land-Use Change and Forestry) in both the first NDC of 2016 and the updated NDC of 2021, it is assumed that South Africa has continued to use AR4 values for these figures, notwithstanding the values used in its inventory report. Furthermore, the comparison that "the upper end of the target range in 2025 has been reduced by 17%, and the upper end of the target range in 2030 has been reduced by 32%, and the lower range by 12%" points to comparing both target ranges in AR4 (Climate Action Tracker, 2021). For consistency in comparing the Project's GHG emissions to the National Inventory, AR4 values were thus considered in this assessment. .

Table 6-1 shows the heat trapping ability of the major GHGs after 100 years as compared to CO_2 as per the IPCC AR4 GWPs. Should the GWP from another version of the IPCC need to be adopted, the GHG inventory should be updated accordingly.

Table 6-1 – Global Warming Potential of GHGs

Greenhouse Gas	100-year Global Warming Potential
CO_2	1
CH_4	25
N_2O	298

6.1 GREENHOUSE GAS EMISSIONS FROM THE PROPOSED PROJECT

GHG emissions from the proposed Project will result from various stationary and mobile sources. The emission factors for these various fuel sources used during these activities for the proposed Project are provided below in Table 6-2 and Table 6-3.

Table 6-2 – GHG emission factors from the Methodical Guidelines for Quantification of GHGs (Tier 1 and Tier 2)

Fuel Source	CO_2		CH_4		N_2O		CO_2e
	Emission Factor (kg/TJ)	Tier Method	Emission Factor (kg/TJ)	Tier Method	Emission Factor (kg/TJ)	Tier Method	Emission Factor (kg/tonne)
Mobile Combustion -Kerosene	73 463[2]	2	0.5[4]	1	2[4]	1	3 209[6]
Mobile Combustion – Marine Fuel Oil[1]	73 090[2]	2	7[4]	1	2[4]	1	3 176[5]

Notes:

1) The Methodological Guidelines for Quantification of Greenhouse Gas Emissions do not have emission factors for marine fuel oil, as such the closest representation (i.e calorific values, specifications to this fuel) was used, which was heavy fuel oil, within the Guidelines.
2) A country specific emission factor was used (Methodological Guidelines for Quantification of Greenhouse Gas Emissions, page 208, Country specific CO_2 emission factors for stationary and mobile combustion: from the 2022 Liquid & Gas Fuel Study and 2022 Cement Study).
3) A default stationary fuel source emission factor was used (Methodological Guidelines for Quantification of Greenhouse Gas Emissions, page 206 and 207, default emission factors for stationary combustion).
4) A default mobile fuel source emission factor was used (Methodological Guidelines for Quantification of Greenhouse Gas Emissions, page 208, default emission factors for mobile combustion).
5) A country specific heavy fuel oil calorific value of 43 MJ/kg (Methodological Guidelines for Quantification of Greenhouse Gas Emissions, page 221, country specific net calorific values) was used as well as the GWP from AR4 to convert the various GHG emission factors into a CO_2e emission factor.
6) A country specific jet kerosene calorific value of 34.4 MJ/l and density of 0.794 kg/l (Methodological Guidelines for Quantification of Greenhouse Gas Emissions, page 221, country specific net calorific values) was used as well as the GWP from AR4 to convert the various GHG emission factors into a CO_2e emission factor.

Table 6-3 – GHG emission factors from Project specific data (Tier 3)

Fuel Source	CO_2 Emission Factor ($ktCO_2e/mmscm$)	Tier Method
Stationary Fuel Combustion – Gas Turbines (auto consumption) – FA Platform	2.30	3
Flaring[6]	3.17	3

6.1.1 DIRECT SCOPE 1 EMISSIONS

6.1.1.1 Exploration Drilling and Related Activities

The estimated GHG emissions from exploration activities will result from drilling of four successful wells with flow test (flaring) and the mobile GHG emissions associated with support activities. The calculated emissions are provided in Table 6-4 and Figure 6-1.

[6] The emission factor for process flaring on the FA-Platform was chosen to be used as the emission factor for well testing. It is anticipated that actual emission factor for well testing will be lower, however the higher emission factor was used to be environmentally conservative.

Table 6-4 – Exploration Drilling and Related Activities

No.	Emission Category	Emission Source	Quantity Wells	Source Data	Unit	No. Units (no. of days)	Fuel (T)	TCO_2e
1	**Stationary Combustion**	Flow testing (Flaring)	4	900 000	m^3/day	4		**47 534**[7]
2	**Mobile Combustion**	1 x Drilling unit	4	88.5	T MFO/day	120	42 480	**134 916**
3		Helicopter (2 trips/ day)	4	1.3	T Kerosene/ round trip	120	624	**2 002**
4		2 x Supply vessels	4	15.93	T MFO/day	120	7 646	**24 285**
5		1 x Tugboat	4	28.32	T MFO/day	120	13 594	**43 173**
Total GHG Emissions								**251 911**

[7] (1) 900 000 m³ per day. Source: Drilling data request sheet.
(2) 3 to 4 days of flow per well. Have used the maximum of 4 days. Source: Drilling data request sheet.
(3) Flared gas contains approximately 74.93% methane.
(4) GHG emissions from flaring during exploration was calculated using mass balance (Tier 3 approach), based on the volume flared of 900 000 m^3/day and the mol% composition as per Client data. It was assumed that the combustion efficiency is 98% based on best practice (USEPA AP42 Section 13.5.2, 2018), and the flaring will occur for four days for 4 wells as per Client data.

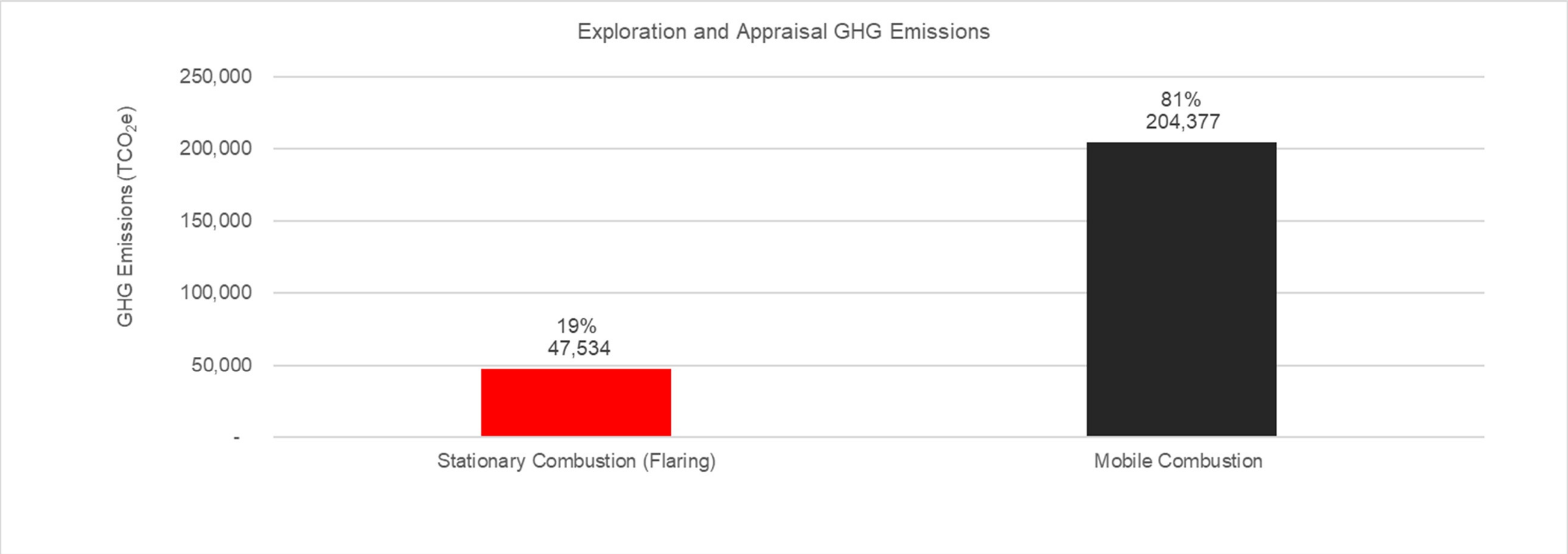


Figure 6-1 – Exploration Drilling and Related Activities

6.1.1.2 Construction Phase

GHG emissions from the activities associated with the construction phase of the Project, are from production well drilling, including well testing, construction of the subsea production system, subsea production pipeline and the riser to the F-A Platform. The direct emissions are from stationary combustion and mobile combustion emissions. The definition for the sources assessed are described below:

- Stationary combustion: flaring from well testing; and
- Mobile combustion: drilling unit, helicopter, support and supply vessels.

It is anticipated that the drilling of production wells will occur in Year 0, Year 1 and Year 10. In Year 0, 2 wells will be drilled, in Year 1, a single well will be drilled and in Year 10, 2 wells will be drilled[8]. The source data and emission factors are provided in Table 6-5 below, whilst a summary of the construction-related GHG emissions per year of construction is provided in Figure 6-2.

[8] At this stage of the engineering design, five production wells will be drilled in the Production Development Area with the option for a sixth well should it be required. As such, the greenhouse gas assessment was based on five wells.

Table 6-5 – Construction Phase GHG Emissions in Year 0, Year 1 and Year 10

Project Phase	Emission Category	Emission Source	Source Data	Unit	No. Units (no. of days)	Fuel (T)	Total TCO_2e (Life of Project)
Development Well Drilling	Mobile Combustion	1 x Drilling unit (Years 0/1/10)	88.5	T MFO/day	589 days	52 127	**165 554**
Development Well Testing	Stationary Combustion – well flow test (Flares)	Associated Gas Flaring (Year 0)	38.29	$MMSm^3/yr$			**121 335**
		Natural Gas Flaring (Year 0)	43.00	$MMSm^3/yr$			**136 251**
		Associated Gas Flaring (Year 1)	19.15	$MMSm^3/yr$			**60 668**
		Natural Gas Flaring (Year 1)	21.50	$MMSm^3/yr$			**68 126**
		Associated Gas Flaring (Year 10)	38.29	$MMSm^3/yr$			**121 335**
		Natural Gas Flaring (Year 10)	43.00	$MMSm^3/yr$			**136 251**
Development Well Support	Mobile Combustion - Drilling Support Vessels + Helicopter	Helicopter (2 trips/day)	1.3	T Kerosene / round trip	589	766	**2 457**
		2 x Supply vessels (Years 0/1)	15.93	T MFO/day	339	5 400	**31 205**
		2 x Supply vessels (Year 10)	17.7	T MFO/day	250	4 425	
		1 x Tugboat (Years 0/1)	28.32	T MFO/day	339	9 600	**58 599**
		1 x Tugboat (Year 10)	35.4	T MFO/day	250	8 850	
Construction	Mobile Combustion - Fast Supply Vessels	3 x Large Offshore Fast Supply Vessel (Year 0)	28.32	T MFO/day	221	6 259	**19 878**
		2 x Offshore Fast Supply Vessel (Year 0)	17.7	T MFO/day	307	5 434	**17 258**
		2 x Large Offshore Fªst Supply Vessel (Year 10)	28.32	T MFO/day	94	2 662	**8 455**
		1 x Offshore Fast Supply Vessel (Year 10)	17.7	T MFO/day	30	531	**1 686**
Total GHG Emissions							**949 057**

Table 6-6 – Construction Phase GHG Emissions in Year 0, Year 1 and Year 10

Emission Category	Year 0 (TCO_2e)	Year 1 (TCO_2e)	Year 10 (TCO_2e)	Total (TCO_2e)
Stationary Combustion (well test / Flaring)	257 586 (66%)	128 793 (73%)	257 586 (68%)	643 965
Mobile Combustion (Drill Unit)	63 523 (16%)	31 762 (18%)	70 269 (18%)	165 554
Mobile Combustion (Drilling Support Vessels incl. tug boat + helicopter for development wells)	32 704 (8%)	16 352 (9%)	43 204 (11%)	92 260
Mobile Combustion (Fast Supply Vessels for subsea construction)	37 136 (9%)	- (0%)	10 141 (3%)	47 277
Total GHG Emissions	390 949	176 907	381 201	**949 057**

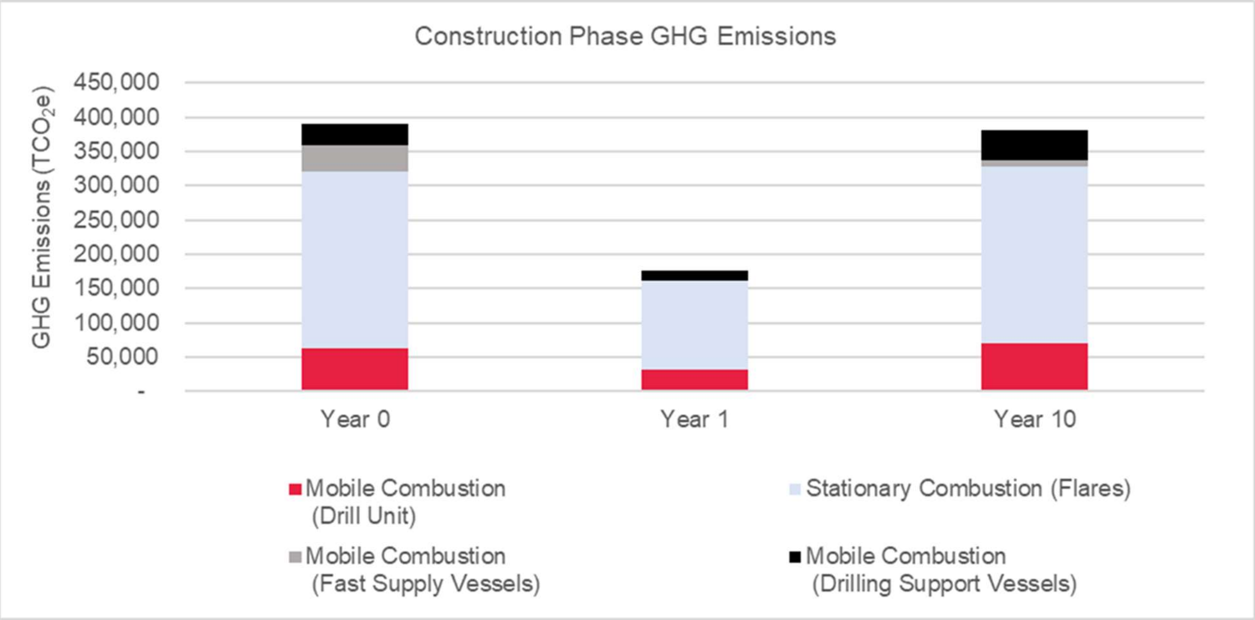


Figure 6-2 – Construction Phase GHG Emissions in Year 0, Year 1 and Year 10

6.1.1.3 Production Phase

GHG emissions from the production phase of the project are from the marine fuel oil consumed by the supply vessel (subsea maintenance and monitoring). The production phase is anticipated to occur from Year 1 to Year 25. The calculated emissions are provided in Table 6-7.

Table 6-7 – Production Phase Mobile GHG Emissions – Years 1 to 25

No.	Emission Category	Emission Source	Source Data	Unit	No. Units (no. of days)	Fuel (T)	Total TCO_2e over Project Life (25 years)
1	**Mobile Combustion**	1 x Supply vessel	8.85	T MFO/day	9 131	80 809	**256 650**
Total GHG Emissions							**256 650**

It is noted that the FA-Platform is an associated facility to the Project. The FA-Platform will emit GHG emissions during the Production phase of the project. These emissions have been quantified as a Scope 3 emission in Section 6.1.3, since the facility is not under TEEPSA's direct control.

6.1.1.4 Decommissioning Phase

The calculated emissions for decommissioning are provided in Table 6-8. These emission sources are associated with the plugging and abandonment of the production wells, and decommissioning of the subsea infrastructure excluding the rise to the F-A Platform that will be left in situ until the F-A Platform is decommissioned.

Table 6-8 – Decommissioning Phase GHG Emissions - Year 26

No.	Emission Category	Emission Source	Source Data	Unit	No. Units	Consumption of Fuel (Tons)	TCO_2e
1	**Mobile Combustion**	Drilling unit	88.5	T MFO/day	100	8 850	27 913
2		2 x Tugboat/Large FSV	56.64	T MFO/day	100	5 664	17 989
3		2 x Supply vessels	15.93	T MFO/day	100	1 593	5 059
4		Helicopter (1 trip/day)	0.65	T Kerosene/round trip	100	65,0	209
Total GHG Emissions							**51 170**

6.1.1.5 Methane Leakage from Offshore Facilities

Globally majority of offshore platforms conduct measurements and analysis of leakage for global emissions inventories and for mitigating climate change. Sources which may result in minimal leakage include but are not limited to:

Exploration:

- Seafloor sampling has the potential for fuel leaks from seafloor survey equipment.
- Leaks from drilling equipment.
- Leaks from survey equipment for drilling.
- Leaks during the sinking of wells.
- Leaks from pipelines.
- Leaks through faulty, damaged or corroded well casings (Böttner et al., 2020).

Construction:

- Leaks from drilling rigs.
- Leaks from survey equipment for drilling.
- Leaks during the sinking of wells.

Production:

- Leaks from faulty and/or damaged equipment, due to the disturbance of operations.
- Leaks as result of changes in the conditions of the water.

Decommissioning:

- Resource leaks during the removal of infrastructure.

Although such leaks are considered to be minimal, further research needs to be undertaken in order to develop emission factors for this quantification and to obtain cost effective methods to estimate emission measurements for such leaks.

6.1.2 SCOPE 2 INDIRECT EMISSIONS

Scope 2 emissions are indirect emissions associated with the consumption of purchased electricity, heat, steam, or cooling. This includes emissions from power plants and other facilities that externally generate the energy consumed by the reporting entity. The proposed Project does not have any energy demands that would be fulfilled through purchased electricity generated by sources that are not within the Project boundary. However, required electricity would be supplied by produced fuel combustion in the FA-Platform associated facility.

For this reason, Scope 2 emissions are not applicable to the proposed Project.

6.1.3 SCOPE 3 INDIRECT EMISSIONS

Scope 3 indirect emissions include those GHGs released outside of the Project boundary, and are not owned or controlled by TEEPSA, but are released because of the Project both upstream and downstream. The GHG Protocol identifies 15 categories of Scope 3 emissions, including the use of sold products, wastes generated, and purchased goods and services, as examples. The ISO 14064-1 standard has condensed these into four categories: transportation, products used, emissions associated with the use of the product, and emissions from other sources.

The F-A platform which will be owned and controlled by PetroSA is an associated facility to the Project and is thus considered to be part of the Scope 3 emissions. The GHG emissions from the production associated facility are from gas auto-consumption combustion in turbines and routine process flaring. The direct emissions are from stationary combustion.

- Stationary combustion: From fuel gas auto consumption for turbines + lost energy (Flaring).

The GHG emissions from the F-A platform are anticipated to be 4 049 699 TCO_2e over the 25 years of Project production life span with an average of 161 988 TCO_2e/annum.

The calculated emissions are provided in Table 6-9 below.

Table 6-9 – GHG Emissions from the F-A Platform associated facility

No.	Emission Category	Emission Source	Source Data	Unit	TCO_2e/annum	Total TCO_2e over Project Life
1	**Stationary Combustion**	Fuel gas auto consumption Combustion - Gas Turbines	62.39	$MMSm^3$ / annum	143 613	3 590 318
2		Flaring	0.0066	$MMSm^3$ / hr	18 375	459 381
Total GHG Emissions					**161 988**	**4 049 699**

Quantification and analysis of the Scope 3 emissions allows for a more holistic understanding of the Project effects by considering a lifecycle perspective. However, accurate quantification of Scope 3 emissions as part of an Impact Assessment is not feasible due to a lack of reliable and specific data of upstream and downstream activities flowing from the Project.

Given that one of the envisaged end uses of the gas is as a primary fuel for electricity generation (gas to Power (GTP)), a discussion of the resulting GHG emissions is relevant in the absence of a broader Scope 3 evaluation and quantification. The use of natural gas for electricity generation supplies lower carbon intensity power to the electrical grid and supports decarbonisation efforts by displacing higher carbon intense fuel such as coal and diesel. The relative GHG intensity of electricity production chains is illustrated in Figure 6-3.

Another option is to utilise the gas in an existing GTL plant in Mossel Bay. The lifecycle GHG emissions from using natural gas to produce liquid fuels can vary depending on several factors, including the specific conversion process, the energy efficiency of the process, and the source of the natural gas. The conversion of natural gas to liquid fuels involves various processes, such as steam methane reforming or GTL technology. These processes can consume additional energy and emit GHGs during the production phase. Once the liquid fuels are produced, they need to be transported to end-users, such as gasoline stations or industrial facilities. Transportation methods can involve emissions, depending on the distance and mode of transport (e.g., pipeline, truck, ship). When the liquid fuels are finally consumed by vehicles or industrial processes, GHGs are emitted through combustion. The efficiency of the combustion technology and any emission control systems in place can impact the emissions at this stage.

Natural gas also supports the adoption of renewable energy by ensuring a stable electricity supply to counter fluctuations or intermittency of renewable energy sources such as wind and solar.

For these reasons, the project aligns with the long-term GHG emissions reduction trajectory and reducing GHG emissions from the electricity generating sector.

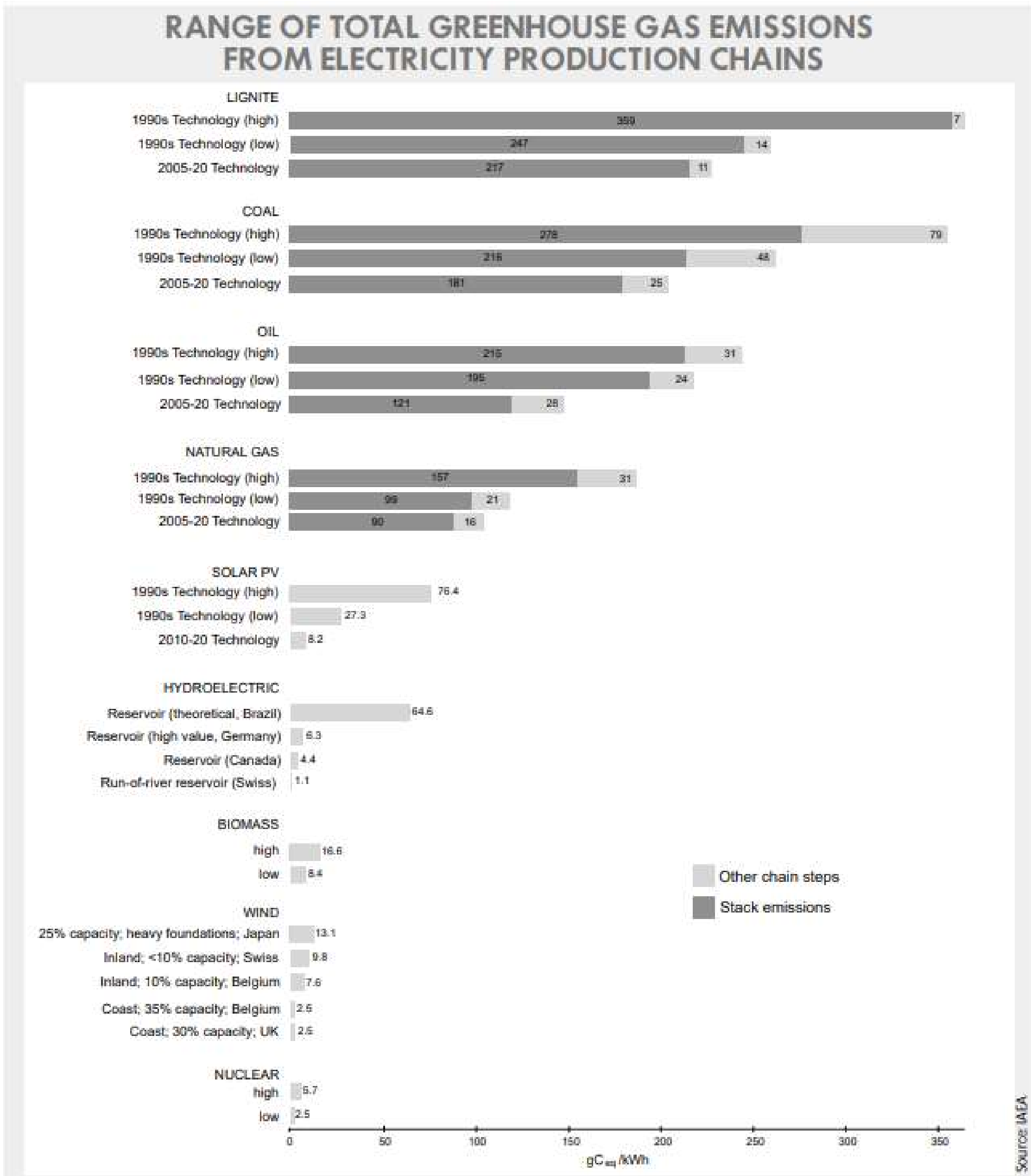


Figure 6-3 – Electricity Options Range of Total GHG Emissions

(Source: IAEA, 2000)

6.1.4 TOTAL PROJECT EMISSIONS

The total GHG emissions from the Project are provided in Table 6-10.

Table 6-10 – Project Total Direct GHG Emissions

Total Direct Project Emissions	Stationary Combustion	Mobile Combustion	Total TCO_2e
Exploration and Appraisal	182 450	69 461	251 911
Development - Drilling	643 965	257 814	901 779
Development - Construction	-	47 277	47 277
Development - Production	-	256 650	256 650
Decommissioning	-	51 170	51 170
Total GHG Emissions			**1 508 788**

6.1.5 GHG EMISSIONS CONTRIBUTION TO NATIONAL INVENTORY

Over the 27 years life of the Project, annual emissions will vary year to year with an average anticipated direct emissions of 56 $ktCO_2e$/annum.

South Africa's climate change mitigation target as updated in the 2021 Nationally Determined Contribution (NDC) is in a range of 350 – 420 Mt CO_2e for the period of 2026 to 2030. In comparison to South Africa's targeted total national inventory of 350 $MtCO_2e$, the Project's average annual emissions will increase the national inventory by 0,016%.

6.2 GHG IMPACT ASSESSMENT, PROJECT CONTROLS AND MITIGATION MEASURES

Project activities from all phases including exploration, construction, operation and decommissioning will result in the release of GHG's. When these gases are released into the atmosphere, they trap heat from the sun that would otherwise escape into space. This trapped heat warms the Earth's surface and leads to global warming, which is a major driver of climate change. The consequences of global warming and climate change are diverse and affect different regions in various ways, including rising sea levels, altered weather patterns, more frequent and severe extreme weather events, disruptions to ecosystems, and changes in agricultural productivity, among others.

Projects that contribute to GHG emissions can have far-reaching effects on the Earth's climate. While the emissions may originate from a specific geographical area, their impact is not confined to that area. Instead, the greenhouse gases disperse throughout the atmosphere and contribute to the overall concentration, affecting the global climate.

The impact of the Project on climate change is evaluated by assessing the impact of the total direct greenhouse gas emissions for all the phases of the Project over which TEEPSA has direct control. It is anticipated that the direct GHG emissions resulting from project activities that are operated and controlled by TEEPSA will amount to a total of 1.5 $MtCO_2e$ over the 27-year life of the Project. The GHG emissions from the F-A platform, which is an associated facility is also assessed. The F-A platform will contribute a total to 4 $MtCO_2e$ for a period of 25 years.

6.2.1 EXPLORATION PHASE

Source of Impact

The estimated GHG emissions from exploration activities, considering 4 successful wells tested, will result from possible well flow testing (non-routine flaring), and the mobile GHG emissions associated with the drill unit, helicopters, supply vessels and tugboat. The key GHGs for the Project include CO_2, CH_4 and N_2O.

Project controls

The following Project controls will be in place:

- TEEPSA will comply with the requirements set out in MARPOL Annex VI Regulation 18 - Fuel Quality. Project vessels will be supplied with marine gasoil (MGO) or heavy fuel oil (HFO) with less than 0.5% sulphur (mass).
- Project vessels will be operated and maintained to ensure the efficient consumption of fuel in completion of the required activities.
- Special attention to be placed on the drill unit, support vessels and survey vessel with a Ship Energy Efficiency Management Plan (SEEMP) that complies with the IMO 2022 guidelines.

Potential impact description

GHG emissions will contribute to global climate change (direct **negative impact**). The effect of climate change as a result of increased emissions of heat-trapping GHG's is related to increased temperatures, changing weather patterns and sea level rise.

Sensitivity of receptors

Due to the international scale and infrequent occurrence of the impact, receptors are considered to be of **low sensitivity**.

Impact magnitude (or consequence)

Total GHG emissions for the exploration phase are calculated as 251 911 TCO_2e. Within the context of the national GHG inventory and targets, this contribution of GHG emissions is considered to be **low intensity**. The impact will however have an **international** impact and will most likely be **permanent**. Based on the above, the magnitude of the negative impact is considered to be **high**.

Impact significance

Taking into account the **high** magnitude of the impact and the **low sensitivity** of receptors, the impact significance is considered to be **medium**, prior to mitigation.

Identification of mitigation measures

Over and above the Project controls listed above, in order to mitigate the negative impact on climate change during the exploration phase, the following mitigation measures are proposed:

- Maintain a record of fuel consumption for monthly submission to TEEPSA for reporting purposes.

- Optimise the exploration programme for the tracking of fuel consumption and other metrics relevant to the quantification of GHGs.
- Optimise helicopter flight paths.
- Optimise well test and monitor the efficiency of the flare programme to reduce burning as much as possible during the test.
- Use a high-efficiency burner for flaring to maximise combustion of the hydrocarbons in order to minimise emissions and hydrocarbon 'drop-out' during well testing.

Residual impact assessment

With the Project controls and mitigation measures mentioned above, the intensity of the impact could decrease to very low and the residual impact could be decreased to **negligible significance**.

Additional assessment criteria

The additional assessment criteria are summarised in Table 6-11. The negative impact on climate change during the exploration phase is **definite** and considered to be **irreversible.** Cumulative potential is **likely**.

Table 6-11 – Impacts on climate change during exploration

Project Phase:	Exploration	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Enhancement Impact	**Residual Impact**
Magnitude (Consequence)	**High**	**Very Low**
Intensity	Low	Very Low
Extent	International	International
Duration	Long-term to Permanent	Long-term to Permanent
Significance	**Medium**	**Negligible**
Probability	Definite	Definite
Confidence	Medium	Medium
Reversibility	Irreversible	Irreversible
Loss of Resources	Low	Low
Mitigation Potential	Low	Low
Cumulative potential	Likely	Likely

6.2.2 CONSTRUCTION PHASE

Source of Impact

The estimated GHG emissions from construction activities will result from possible well flow testing (non-routine flaring), and the mobile GHG emissions associated with the drill unit, helicopters, supply / fast supply vessels and tug boats. The key GHGs for the Project include CO_2, CH_4 and N_2O.

Project controls

- TEEPSA will comply with the requirements set out in MARPOL Annex VI Regulation 18 - Fuel Quality. Project vessels will be supplied with marine gasoil (MGO) or heavy fuel oil (HFO) with less than 0.5% sulphur (mass).
- Project vessels will be operated and maintained to ensure the efficient consumption of fuel in completion of the required activities.
- Special attention to be paid to the drill unit, pipelaying vessel, support vessels and survey vessel with a Ship Energy Efficiency Management Plan (SEEMP) that complies with the IMO 2022 guidelines.

Potential impact description

GHG emissions will contribute to global climate change (direct **negative impact**). The effect of climate change as a result of increased emissions of heat trapping GHG's is related to increased temperatures, changing weather patterns and sea level rise.

Sensitivity of receptors

Due to the international scale and infrequent occurrence of the impact, receptors are considered to be of **low sensitivity**.

Impact magnitude (or consequence)

Total GHG emissions for the construction phase are calculated as 949 057 TCO_2e, taking place at three points in time (Yr. 0, 1 and 10). Within the context of the national GHG inventory and targets, this contribution of GHG emissions is considered to be **low intensity**. The impact will however have an **international** impact and will most likely be **permanent**. Based on the above, the magnitude of the negative impact is considered to be **high**.

Impact significance

Taking into account the **high** magnitude of the impact and the **low sensitivity** of receptors, the impact significance is considered to be **medium**, prior to mitigation.

Identification of mitigation measures

Over and above the Project controls listed above, in order to mitigate the negative impact on climate change during the construction phase, the following mitigation measures are proposed:

- Maintain a record of fuel consumption for monthly submission to TEEPSA for reporting purposes.
- Optimize the operation programme for the tracking of fuel consumption and other metrics relevant to the quantification of GHGs.
- Optimise helicopter flight paths.
- Optimise well test and monitor the efficiency of the flare programme to reduce burning as much as possible during the test.
- Use a high-efficiency burner for flaring to maximise combustion of the hydrocarbons in order to minimise emissions and hydrocarbon 'drop-out' during well testing.

Residual impact assessment

With the Project controls and mitigation measures mentioned above, the intensity of the impact could decrease to very low and the residual impact could be decreased to **negligible significance**.

Additional assessment criteria

The additional assessment criteria are summarised in Table 6-12. The negative impact on climate change during the construction phase is **definite** and considered to be **irreversible**. Cumulative potential is **likely**.

Table 6-12 – Impacts on climate change during construction

Project Phase:	Construction	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Enhancement Impact	**Residual Impact**
Magnitude (Consequence)	**High**	**Very Low**
Intensity	Low	Very Low
Extent	International	International
Duration	Long-term to Permanent	Long-term to Permanent
Significance	**Medium**	**Negligible**
Probability	Definite	Definite
Confidence	Medium	Medium
Reversibility	Irreversible	Irreversible
Loss of Resources	Low	Low
Mitigation Potential	Low	Low
Cumulative potential	Likely	Likely

6.2.3 PRODUCTION PHASE

Source of Impact

The estimated Scope 1 GHG emissions from production activities will result from marine fuel oil consumed by the supply vessel used for subsea maintenance and monitoring. Scope 3 GHG emissions from the F-A Platform will result from gas auto-consumption combustion in turbines and process flaring. The key GHGs for the Project include CO_2, CH_4 and N_2O.

Project controls

- TEEPSA will comply with the requirements set out in MARPOL Annex VI Regulation 18 - Fuel Quality. Project vessels will be supplied with marine gasoil (MGO) or heavy fuel oil (HFO) with less than 0.5% sulphur (mass).
- Project vessels will be operated and maintained to ensure the efficient consumption of fuel in completion of the required activities.

- Special attention to be paid to the support vessels with a Ship Energy Efficiency Management Plan (SEEMP) that complies with the IMO 2022 guidelines.
- TEEPSA will continue to engage with PetroSA regarding the use of good international industry practice in the operation and maintenance of the F-A Platform.

Potential impact description

GHG emissions will contribute to global climate change (direct **negative impact**). The effect of climate change as a result of increased emissions of heat trapping GHG's is related to increased temperatures, changing weather patterns and sea level rise.

Sensitivity of receptors

Due to the international scale and infrequent occurrence of the impact, receptors are considered to be of **low sensitivity**.

Impact magnitude (or consequence)

The Scope 1 emissions resulting from maintenance of the well field and subsea infrastructure over the 25 years production lifespan of the Project is calculated to be 256 650 TCO_2e. Within the context of the national GHG inventory and targets, this contribution of GHG emissions is considered to be **low intensity**. Since the impact of medium intensity will have an **international**, and will most likely be **permanent**, the magnitude of the negative impact is considered to be **high**.

The GHG emissions from the F-A platform, which is a Scope 3 emission to the Project, are anticipated to be 4 049 699 TCO_2e over the Project life span with an average of 161 988 TCO_2e/annum. Within the context of the national GHG inventory and targets, this contribution of GHG emissions is considered to be **medium intensity**. Since the impact of medium intensity will have an **international**, and will most likely be **permanent**, the magnitude of the negative impact is considered to be **very high**.

Impact significance

For Scope 1 emissions, taking into account the **high** magnitude of the impact and the **low sensitivity** of receptors, the impact significance is considered to be **medium**, prior to mitigation.

For Scope 3 emissions, taking into account the very **high** magnitude of the impact and the **low sensitivity** of receptors, the impact significance is considered to be **very high**, prior to mitigation.

Identification of mitigation measures

Over and above the Project controls listed above, in order to mitigate the negative impact on climate change during the construction phase, the following mitigation measures are proposed:

- Maintain a record of fuel consumption for monthly submission to TEEPSA for reporting purposes.
- Optimise the operation programme (rotation of the support vessel for example) for the tracking of fuel consumption and other metrics relevant to the quantification of GHGs.

Residual impact assessment

For the Scope 1 emissions, with the Project controls and mitigation measures mentioned above, the intensity of the impact could decrease to very low and the residual impact could be decreased to **negligible significance**.

For the Scope 3 emissions, with the Project controls and mitigation measures mentioned above, the residual impact could be decreased to **medium significance**.

Additional assessment criteria

The additional assessment criteria are summarised in Table 6-14. The negative impact on climate change during the production phase is **definite** and considered to be **irreversible**. Cumulative potential is **likely**.

Table 6-13 – Impacts on climate change during production – Scope 1 emissions

Project Phase:	Production Scope 1 emissions (TEEPSA direct GHG emissions)	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Enhancement Impact	**Residual Impact**
Magnitude (Consequence)	**High**	**Very High**
Intensity	Low	Very Low
Extent	International	International
Duration	Long-term to Permanent	Long-term to Permanent
Significance	**Medium**	**Negligible**
Probability	Definite	Definite
Confidence	Medium	Medium
Reversibility	Irreversible	Irreversible
Loss of Resources	Low	Low
Mitigation Potential	Low	Low
Cumulative potential	Likely	Likely

Table 6-14 – Impacts on climate change during production – Scope 3 emissions

Project Phase:	Production Scope 3 emissions (F-A Platform only)	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Enhancement Impact	**Residual Impact**
Magnitude (Consequence)	**Very High**	**High**
Intensity	Medium	Low
Extent	International	International

Project Phase:	Production Scope 3 emissions (F-A Platform only)	
Duration	Long-term to Permanent	Long-term to Permanent
Significance	**High**	**Medium**
Probability	Definite	Definite
Confidence	Medium	Medium
Reversibility	Irreversible	Irreversible
Loss of Resources	Low	Low
Mitigation Potential	Low	Low
Cumulative potential	Likely	Likely

6.2.4 DECOMMISSIONING PHASE

Source of Impact

The emission sources associated with the decommissioning phase will result from mobile GHG emissions associated with the drill unit, helicopters, supply / fast supply vessels, and tugboats.

Project controls

- TEEPSA will comply with the requirements set out in MARPOL Annex VI Regulation 18 - Fuel Quality. Project vessels will be supplied with marine gasoil (MGO) or heavy fuel oil (HFO) with less than 0.5% sulphur (mass).
- Project vessels will be operated and maintained to ensure the efficient consumption of fuel in completion of the required activities.
- Special attention to be paid to the drill unit, pipelaying vessel, support vessels and survey vessel with a Ship Energy Efficiency Management Plan (SEEMP) that complies with the IMO 2022 guidelines.

Potential impact description

GHG emissions will contribute to global climate change (indirect **negative impact**). The effect of climate change as a result of increased emissions of heat trapping GHG's is related to increased temperatures, changing weather patterns and sea level rise.

Sensitivity of receptors

Due to the international scale and infrequent occurrence of the impact, receptors are considered to be of **low sensitivity**.

Impact magnitude (or consequence)

GHG emissions for the decommissioning phase are calculated as 51 170 TCO_2e. Within the context of the national GHG inventory and targets, this contribution of GHG emissions is considered to be **very low intensity**. Since the impact of medium intensity will have an **international**, and will most likely be **permanent**, the magnitude of the negative impact is considered to be **very low**.

Impact significance

Taking into account the very low magnitude of the impact on climate change and the **low sensitivity** of receptors, the impact significance is considered to be **negligible**.

Identification of enhancement measures

Over and above the Project controls listed above, in order to mitigate the negative impact on climate change during the decommissioning phase, the following mitigation measures are proposed:

- Maintain a record of fuel consumption for monthly submission to TEEPSA for reporting purposes.
- Optimize operation programmes for the tracking of fuel consumption and other metrics relevant to the quantification of GHGs.
- Optimise helicopter flight paths.

Residual impact assessment

With the Project controls and mitigation measures mentioned above, the residual impact significance will remain **negligible**.

Additional assessment criteria

The additional assessment criteria are summarised in Table 6-15. The negative impact on climate change during the production phase is **definite** and considered to be **irreversible**. Cumulative potential is **likely**.

Table 6-15 – Impacts on climate change during decommissioning

Project Phase:	Decommissioning	
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Sensitivity of Receptor	**LOW**	
	Pre-Enhancement Impact	**Residual Impact**
Magnitude (Consequence)	**Very Low**	**Very Low**
Intensity	Very Low	Very Low
Extent	International	International
Duration	Long-term to Permanent	Long-term to Permanent
Significance	**Negligible**	**Negligible**
Probability	Definite	Definite
Confidence	Medium	Medium
Reversibility	Irreversible	Irreversible
Loss of Resources	Low	Low
Mitigation Potential	Low	Low
Cumulative potential	Likely	Likely

6.3 RECOMMENDATIONS

Given the uncertainty associated with quantifying Project GHG emissions using operational forecasts, it is recommended that:

- The GHG inventory be reviewed, and updated if required, on an annual basis during the operational phase. The GHG inventory should also be updated once more accurate data on fuel consumption and activity rates are available. Any decision-making that considers the GHG emissions presented in this report must take into account the preliminary, and necessary conservativeness of the assessment.
- Given that GHG emissions from fuel combustion in the engines associated with the drill unit and support marine vessels amount to 47% of the total Project's direct GHG emissions over its lifetime, in going forward and as available, the use of energy efficient engines and use of low carbon or zero-carbon fuels, should be explored by TEEPSA's contractors. This is in line with the International Maritime Organization (IMO) Strategy of 2018 (MARPOL Annex VI: Ship Decarbonization – IMO Strategy of 2018).
- The IMO strategy calls for reduction in CO_2 emissions by at least 40% by 2030 compared to the 2008 levels and pursue reduction of 70% by 2050. The strategy also calls for reduction of total GHG emissions by 50% by 2050 compared to the 2008 levels. The reduction will be achieved by the use of more energy efficient engines and use of low carbon or zero-carbon fuels as they become available. For example, a significant number of new very large crude carriers (VLCCs) will be powered by liquified natural gas (LNG) as the primary fuel.

Reaching net-zero emissions for ship engines is difficult because distillate fuel oil (diesel or low-grade fuel oil) engines are preferred for marine vessels due to their superior thermal efficiency. Efforts are however underway to cut down the use of conventional fuel by developing new types of fuel and propulsion systems. TEEPSA will continue to engage with PetroSA regarding the use of good international industry practice in the operation and maintenance of the F-A Platform.

7 CLIMATE RISK ASSESSMENT

Assessing the impacts of climate change on the Project includes both mitigation and adaptation measures. The adverse impacts of climate change, including sea-level rise, increases in temperatures, more frequent extreme precipitation and heat events and more severe droughts, could have impacts on the Project (Table 5-2).

The Climate Change Risk Assessment is the process of managing climate adaptation issues for a project to improve its resilience to climate change. It involves identifying which climate hazards the Project is vulnerable to, assessing the level of risk, and considering adaptation measures to reduce that risk to an acceptable level.

7.1 CLIMATE INFRASTRUCTURE INTERACTIONS

Identifying potential interactions between site infrastructure and climate is an important step in assessing climate risk. The presence of a climate interaction for a given infrastructure category is denoted by a checkmark. This process helps demonstrate each infrastructure category that could be affected by various climate related events. The construction phase of the Project was not considered due to the short time frame, which has a smaller potential for meaningful interactions with the climate outside of the normal seasonal variation experienced in the region. There is a larger potential for changes in both the climate mean and extreme weather events during the operations phase. Lastly, after closure, many site operations and infrastructure will be discontinued and has therefore been excluded from the risk assessment.

Table 7-1: Production Infrastructure and Hazard Interactions

Production Infrastructure Components	Potential Hazards and Change Factors			
	Extreme Heat/Mean annual Temperature	Frequency / Amount of Heavy Rainfall Events/Total Annual Precipitation	Wind and Storm Events, Storm Surges	Sea-Level Change Waves and Sea-state
Subsea Infrastructure				
Well Head			✓	
Manifolds			✓	
Pipeline			✓	
Subsea Umbilical			✓	
FA Platforms and Onshore Infrastructure				
Offshore Platform	✓	✓	✓	✓
Onshore Logistics Centre (Including Coastal Support and Flood Protection System)	✓	✓	✓	✓
Onshore Transport and Delivery Infrastructure (support vessels, helicopters, and bulk delivery)		✓	✓	✓
Activities (Health and Safety of Workers)	✓	✓	✓	✓

7.2 PHYSICAL CLIMATE CHANGE RISK ASSESSMENT

The likelihood of climate-infrastructure interactions occurring has been evaluated qualitatively using the likelihood scales. The resulting likelihood rankings are provided for current climate and near future (2050s). The consequence rankings represent the severity of impacts if an interaction were to occur and is based on the defined consequence scale. Combining the rankings for both likelihood and consequence allows for risk rankings (as defined in Table 4-4 and Table 4-5) for each climate-interaction across infrastructure. These rankings consider the adaptation measures that would be in place to reduce the climate related risk and may lead to lower risk rankings. This section provides an overview of the risk rankings, which are summarized in Table 7-2.

Table 7-2 – Risk Ranking for Projected Climate

Infrastructure Component	Potential Interaction	Description	Relevant Adaptation Measures	Likelihood	Consequence	Risk
Well Heads	Extreme Events	Extreme weather such as wind/storm events may increase wave action that could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging.	The well heads will be located at a depth of between 500 m and 2 km and fixed in the seafloor. The engineering design specifications will take account of potential impacts of an increase in wave height or the maximum speed of the Agulhas current through the Project area.	Could Happen/ Unlikely	Moderate	Acceptable
Manifolds	Extreme Events	Extreme weather such as wind/storm events may increase wave action that could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging.	This subsea infrastructure will be located at a depth of between 300 m and 2 km and anchored to the seafloor. The engineering design specifications will take account of potential impacts of an increase in wave height or the maximum speed of the Agulhas current through the Project area.	Could Happen/ Unlikely	Moderate	Acceptable

Infrastructure Component	Potential Interaction	Description	Relevant Adaptation Measures	Likelihood	Consequence	Risk
Pipelines	Extreme Events	Extreme weather such as wind/storm events may increase wave action that could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging.	The pipeline will be located at a depth of between 100 m and 2 km and anchored to the seafloor. The engineering design specifications will take account of potential impacts of an increase in wave height or the maximum speed of the Agulhas current through the Project area.	Could Happen/ Unlikely	Moderate	Acceptable
Subsea Umbilical	Extreme Events	Extreme weather such as wind/storm events may increase wave action that could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging.	No mitigation measures identified	Could Happen/ Unlikely	Moderate	Acceptable
FA Platform[9]	Sea level rise	High sea levels expose oil and gas platforms (F-A platform) to damage and destruction. Severe wave heights may affect offshore operations and platforms.	The F-A Platform was installed in the late 1980's and will require regular maintenance and upgrading to structural elements and plant and equipment to extend the operational life of the installation for another 25 years.	Could Happen/ Unlikely	Major	Medium

[9] It is important to note that the FA Platform does not form part of TEEPSA's operational control.

A qualitative summary of the Project's direct risks and possible indirect risks are included below.

7.2.1 PROJECT INFRASTRUCTURE

All subsea infrastructure could be impacted by extreme weather such as increased wave height and/or increases in the maximum velocity of the Agulhas current that flows through the Project area, and this could result in damage to the installations especially if this occurs in conjunction with existing design defects, corrosion or damage to the infrastructure.

For all the subsea infrastructure, the likelihood of interactions for future climate is ranked as "Could Happen/Unlikely" as infrastructure is below the impact of wave action. The consequence of this is rated as "Moderate" as this could result in significant infrastructure damage. The risk is projected to remain "Acceptable" under current and future climate conditions.

The riser to the F-A Platform could be impacted by extreme weather such as extreme wave heights that could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging.

7.2.2 OTHER RISKS

7.2.2.1 Workers

- Severe weather such heavy rainfall may lead to movement restriction of key staff around the site and staff traveling to/from work via ship or helicopter to the George airport.
- Temperature is a climatic variable that can potentially affect occupational health through heat stress, dehydration, heat-stroke and death.
- Increasing mean temperatures and extreme events (heat waves) are expected to cause heat stress, and increased morbidity and in turn lead to respiratory and cardiovascular diseases which will most likely also affect workers.
- Storm surges and sea level rise will also affect the community and workers' safety and emergency response.
- Increased storms will increase the risk of drowning and injuries.
- Damage to infrastructure such as coastal roads and railways as well as harbours will affect the worker's ability to travel to and from work.
- High indoor temperatures may cause thermal discomfort.
- High winds/hurricanes may limit workplace safety as it might be too dangerous to work on heights.
- Sea level rise may lead to damage in drainage systems, buildings, control rooms and personnel.

7.2.2.2 Infrastructure

- Storm surges and sea level rise will affect offshore and coastal infrastructure.
- Increased damage to property (including coastal roads and railways as well as harbours) because of sea level rise and storm surge.
- Storm surges and sea level rise will also increase coastal erosion and loss of land.
- Winds will affect infrastructure damages.
- As sea level rises, it increases the occurrence of flooding and coastal erosion (Dye et al., 2017) and consequently oil and gas infrastructure on the coastal line as well as pipelines may be negatively affected (Dong et al., 2022).
- Onshore support vessels at Mossel Bay area may be affected by flooding.

- Increase in wave heights accompanying hurricanes and tropical storms may lead to erosion and thus submerge coastal infrastructure.

7.3 PHYSICAL RISK - SUMMARY

The Climate Change Risk Assessment considers infrastructure components for the operations phase of the Project. Through the qualitative risk assessment, it is identified that the site may be affected by climate risks however no unacceptable risks were identified.

Although the mitigation measures have the potential to reduce climate risks, the measures need to be monitored for their performance through an ongoing monitoring and surveillance process. As a part of this, a continual improvement process could be developed to integrate climate change risks and opportunities in this process. This continual improvement process could be created to align with TotalEnergies Risk Management framework and outline the decision-making process for when action needs to be taken to improve climate resilience. The continual improvement process could be updated over the lifetime of the Project.

The results from the monitoring programs would be integrated to test the effectiveness of resilience and mitigation actions and manage the unexpected outcomes.

8 CUMULATIVE IMPACTS

The EIA Regulations, 2014 (as amended) require the consideration of the "cumulative impact", which includes the 'reasonably foreseeable future impact of an activity'. Cumulative impacts refer to the gradual process whereby impacts arising from multiple sources become increasingly more severe over time. Cumulative impacts must be considered when assessing the risk and potential impacts of a particular project. Practically, the identification and management of cumulative impacts are limited to those effects which are recognised as important by the affected communities (International Finance Corporation Good Practice Handbook, 2013).

Climate change is a global phenomenon of climate transformation, with long-term impacts on the economy, society and the physical environment. The cumulative impact of the Project and planned projects in the proximity cannot be linked directly to local environmental impacts as they contribute towards global anthropogenic climate change.

As GHG emissions from human activities increase, they build up in the atmosphere and warm the climate, leading to various changes around the world—in the atmosphere, on land, and in the oceans. Observed changes include increases in global air and ocean temperature, rising global sea levels, long-term sustained widespread reduction of snow and ice cover, and changes in atmospheric and ocean circulation as well as regional weather patterns, which influence seasonal rainfall conditions. GHGs stay in the atmosphere for tens to hundreds of years after being released, and as a result, their warming effects on the climate persist over a long time and can therefore affect both present and future generations.

The impact of climate change is varied and complex. Long-term climatic changes could result in increased ambient temperatures, prolonged periods of drought as well as increased intensity and volume of rain or extreme events. The impacts are not determined precisely, but rather through the use of possible future scenarios as defined in Table 4-3 .

Due to the nature of climate change as discussed above, the cumulative impact is described as the Project's total potential contribution to South Africa's national inventory. Existing and proposed projects within reasonable proximity to the proposed Project, will each contribute to global climate change through the release of GHG's, which will be assessed in their respective EIA's. In terms of direct GHG emissions, the Project will emit 1.5 $MtCO_2e$ of Scope 1 emissions over its lifetime of 27 years. In comparison to South Africa's total national inventory in 2030 of 350 $MtCO_2e$, the Project's average annual emissions of 56 kT CO_2ewill increase the national inventory by 0.016%. The GHG emissions from the F-A platform, which is an associated facility to the Project amounts to approximately 4 $MtCO_2e$ over a 25-year production period.

It is noted that the Project's GHG emissions could increase due to an occurrence of an unplanned event. An unplanned event refers to an unexpected incident or occurrence that deviates from the normal course of operations and has the potential to impact the safety, environment, or productivity of the drilling operation. These events can vary in their severity and consequences. Some examples of unplanned events at offshore gas drilling operations include blowouts, explosions, equipment failure and gas leaks. The proposed Project is designed with multiple safety systems and redundant measures to minimise the risk of accidents or unplanned events. These include safety training programs, regular equipment inspections, emergency response plans, and the presence of safety equipment such as fire suppression systems, blowout preventers, and gas detection systems.

The primary cumulative impact of concern relates to fact that the purpose of the Project is to extract fossil resources for energy use.

According to a report by the UN Climate Change, shifting to a low-carbon economy can unlock new jobs and opportunities but it must be done in a way that is as socially and economically fair as possible for everyone.

The Just Energy Transition Investment Plan (JET IP) seeks to decarbonise the South African economy to within the NDC target range of 350-420 $MtCO_2e$ by 2030 (JET IP, 2022). The plan recognises the direct and indirect impact that the energy transition has on livelihoods, workers and communities. It is not disputed that south Africa needs a clear policy position on oil and gas exploration and production that is aligned with its climate change commitments. The JET IP is centred on decarbonisation through three priority areas, electricity sector, new energy vehicles and green hydrogen. However, the plan also recognises that gas power generation will form part of the energy decarbonisation transition. To meet the current supply crisis and the need to meet climate change mitigation objectives and compliance challenges, in relation to air pollution regulations, gas will need to form part of the energy capacity.

As South Africa transitions to net-zero, energy must still be provided now, and therefore, if viable resources that can contribute to South Africa's energy security, exist offshore, this should play a key part in diversifying South Africa's energy portfolio. South Africa is currently too reliant on imports and coal electricity for generation, and gas could help to transition to low carbon emission targets, if nothing more than to reduce the country dependency on coal, which according to the JET IP, contributed 66.2% of the GHG emissions for South Africa in 2021.

The Energy Action Plan, announced in July 2022, is South Africa's plan to end load shedding and achieve energy security. One of the bold actions in the plan is to fast-track the procurement of new generation capacity which is inclusive of gas. 4 000 MW of gas is also part of Eskom's green energy transition plan. The South African Government has also embarked on a Gas Independent Power

Producer (IPP) Programme that will procure up to 3 000 MW of gas with the objective of ensuring grid connection by 2026/27.

This Project can thus be considered a valuable part of an energy transition in South Africa, as it's end-use products can be used as a lower carbon fossil fuel. As such, the cumulative impact of this project should rather be considered as a substitute for coal energy and when doing this the cumulative impact on GHG emissions for South Africa would be seen as positive.

9 CONCLUSION

The Climate Change Impact Assessment of Block 11B/12B activities considered both the contribution of the Project on climate change, and the impact of climate change on the Project.

The impact of the Project on climate change was assessed based on the GHG emissions anticipated from the Project. In terms of direct emissions, the Project will emit 1.5 $MtCO_2e$ of Scope 1 emissions over its 27-year lifetime. South Africa's climate change mitigation target as updated in the 2021 Nationally Determined Contribution (NDC) is in a range of 350 – 420 Mt CO_2e for the period of 2026 to 2030. In comparison to South Africa's targeted total national inventory for 2030 of 350 $MtCO_2e$, the Project's average annual emissions of 56 $kTCO_2e$ will increase the national inventory by 0.016%.

There are no Scope 2 emissions associated with the Project as the Project will not be importing electricity.

The GHG emissions from the F-A platform, which is an associated facility to the Project, amounts to approximately 4 $MtCO_2e$ over a 25-year of production period. This is a Scope 3 (i.e. not operated by TEEPSA) indirect Project emission. A full Scope 3 emissions assessment of the development project cannot be quantified at this time due to insufficient detail that would result in uncertainty in the estimates. However, it is noted that natural gas can replace coal for numerous applications such as power generation and manufacturing. It is thus a valuable part of an energy transition as it is a lower carbon fossil fuel.

The climate risk assessment is a qualitative assessment of the physical climate risks associated with the Project. The physical risk assessment considers infrastructure components for the production phase of the Project. No unacceptable physical risks were identified.

Although the mitigation measures have the potential to reduce climate risks, the measures need to be assessed for their performance through an ongoing monitoring and surveillance process. This process could be created to align with TotalEnergies Risk Management framework and outline the decision-making process for when action needs to be taken to improve climate resilience. The continual improvement process could be updated through an ongoing process over the lifetime of the Project.

Overall, the proposed TEEPA Project is aligned to the Just Energy Transition Investment Plan, as it could assist with the country's goals of creating quality jobs, increasing energy security, decreasing GHG's from the country's current reliance on coal and contribute toward economic growth.

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Appendix A

SPECIALIST CV

Verushka Singh

Environment & Planning, Planning & Advisory – Climate Change, Principal Associate

CAREER SUMMARY

Verushka is a Principal Associate with a Chemical Engineering (BSc Hons) degree obtained from the University of the Witwatersrand. She is currently employed at the Johannesburg branch of WSP and has worked on various greenhouse gas assessments, climate change impact assessments, climate change disclosure and carbon credit projects for a variety of clients over the past twelve years. She has provided consulting support to various client industries including petrochemical, mining, metallurgical, manufacturing and government bodies among others. She is also certified as both an Energy Manager (CEM) and a Management & Verification Professional (CMVP).

1 year with WSP

12 years of experience

Area of expertise

Climate Change

Greenhouse Gas Assessments

Climate Risks and Opportunities

CDP

TCFD Reporting

Carbon Credits

Language

English – Fluent

EDUCATION

BSc Eng (Hons) Chemical Engineering – University of the Witwatersrand, Gauteng, SA 2009

ADDITIONAL TRAINING

Integrating Climate Change into Environmental Impact Assessments 2022

Certifies Measurement & Verification Professional, Association of Energy Engineers 2015

Climate Reality Leadership Training by Al Core 2014

Certified Energy Manager, Association of Energy Engineers 2014

Verushka Singh

Environment & Planning, Planning & Advisory – Climate Change, Principal Associate

The United Nations Environmental Programme Finance initiative (UNEP F1) – Climate Change: Risk & Opportunities for the Finance Sector 2011

PROFESSIONAL HISTORY

WSP Group Africa (Pty) Ltd	May 2022 - present
Climate Business Harmony	2020 – April 2022
National Business Initiative	2018 -2019
Clean Energy Africa	2016 – 2018
Deloitte	2014 – 2016
Promethium Carbon	2014
ERM	2013 – 2014
Promethium Carbon	2011 – 2013
Nedbank	May 2010 – December 2010
Lurgi South Africa	2008 – April 2010

PROFESSIONAL EXPERIENCE

Dangote Refinery, GHG Assessment, Nigeria
Year 2022
Project Manager

Calculation and analysis of greenhouse gases associated with the construction and operation of the refinery as well as analysis of alternatives for the project.

Glencore, Climate Change Technical Guideline, South Africa
Year 2022
Project Manager

The development of a technical guideline and standard on incorporating climate change into water studies by using downscaled climate modelling for a number of mine sites.

Sibanye-Stillwater, Climate Change Assessment for Mine Closure, South Africa
Year 2022
Project Manager

Analysis of climate-related risks and opportunities for the closure phase of ten mine sites.

Sibanye-Stillwater, Climate Compliance with GISTM for Marikana Mine, South Africa
Year 2022
Project Manager

Verushka Singh

Environment & Planning, Planning & Advisory – Climate Change, Principal Associate

Analysis of climate-related principles in the GISTM for Marikana Mine using downscaled climate modelling.

Endeavour Mining, Climate Change and Future Ready Study, Cote d'ivoire; Burkina Faso and Senegal
Year 2022
Climate Change Specialist

Analysis of the transition risks for gold mining operations in West Africa in line with TCFD.

Sasol, Green Hydrogen Prefeasibility Study, South Africa
Year 2022
Climate Change Specialist

Climate Change Impact Assessment

Climate Business Harmony
2020 – April 2022
Independent Climate Consultant

As an independent consultant, I worked for corporates and consultancies on all climate change related issues. This included CDP, TCFD, carbon reporting, life cycle analysis, climate change strategies and carbon credit registration and trading. Some of my main engagements are listed below.

VAT IT: Carbon Tax, Energy and Resource Efficiency, South Africa

Carbon consulting projects including: Carbon Tax management ▪ Policy Advisory and Regulatory Compliance ▪ Foot-printing and Resource Efficiency Assessments ▪ Management Plans and Systems ▪ CDP ▪ Science Based Targets ▪ Task Force on Climate-related Financial Disclosures ▪ Tax Incentives for energy efficiency ▪ Waste management

ENKING: Country Head, South Africa

Carbon credit developer and supplier. My role included carbon credit sales and project registration consultation under the Clean Development Mechanism (CDM), Verified Carbon Standard (VCS), Gold Standard, Global Climate Council and Renewable Energy Credits.

National Business Initiative
2018 – 2019
Program Manager of Climate Change and Energy

This work has included advocacy on broader sustainability issues with the South African Private Sector, mobilization of collective action on Energy Efficiency, Strategic leadership of partnerships and projects such as the **Carbon Disclosure Project** and **We Mean Business**, aimed at transforming Business Action toward a low carbon and green economy. My role entailed:

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Facilitation and management of international partnerships and engagement.
Build the capacity of our members to engage with environmental issues and to respond through effective management practices
Facilitate the implementation of collaborative projects and practical solutions in areas related to climate change, energy, waste, biodiversity and the green economy.
Provide companies with access to strong science in accessible formats to allow them to adequately and assess the risk of climate change.
Build the capacity of business to manage climate change, supporting the reduction of greenhouse gas emissions and improving the resilience of business, society and the economy. Improve trust between business and government and investors by providing platforms for transparency and technical assistance to government bodies.
Raise the importance of climate change by establishing the connection between climate change and economic health
Science Based Targets
Task Force on Climate-related Financial Disclosure

Clean Energy Africa
2016 – 2018
Group Head of Carbon and Sustainability
I worked in developing energy projects, as a company we worked at seeing the opportunity to add value to underutilised resources and, through applying applicable technology, unlocking value. My role entailed:
GHG Accounting across all the business units within the company and overseeing and providing climate change and sustainability advise to all business units.
Identifying new sustainability projects across business units.
Registration of a waste to energy carbon credit project with the CDM (Climate disclosure project).
Energy modelling for companies to claim a government tax incentive.

Deloitte
2014 – 2016
Senior Consultant
My role entailed:
Carbon Tax (Legislation and risk analysis).
Greenhouse gas and energy reporting.
Compliance with developing regulatory requirements.
Energy Efficiency Motivations for the Section 12I Industrial Policy Projects applied for on behalf of clients. The energy related function includes establishing baseline, baseline modelling, baseline reports and energy efficiency saving calculations.
Section 12L related groundwork for clients wishing to apply for the tax benefit. The energy related function includes establishing baseline, baseline modelling, baseline reports and energy efficiency saving calculations.
Working with clients to identify and collate support for claims for the enhanced tax relief available for R&D activities.

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Preparing the necessary documents as required by the Department of Science and Technology for preapproval of research and development activities.

Promethium Carbon
2014 Senior
Carbon Advisor

My role entailed:

Management of energy savings projects.
I developed and reviewed carbon footprints and life cycle assessments for a number of companies and processes. Industries experience includes coal and platinum mining; the steel industry; the cement industry; petroleum refining as well as information and communications technology.
I assisted with issuance of carbon credits and methodology revision for Clean Development Mechanism (CDM) projects under the United Nations Framework Convention on Climate Change (UNFCCC). A new biogas methodology was successfully approved by the UNFCCC.
I was responsible for writing the Carbon Disclosure Programme (CDP) reports of a number of companies that scored in the upper 10 of the Carbon Disclosure Performance Leadership band of the JSE Top 100. Completing the reports involves an analysis of climate change related risks and opportunities, specifically with regard to anticipated legislative developments.
Writing chapters for South Africa's first Biennial Update Report under the UNFCCC.

ERM
2013 – 2014
Sustainability and Climate Change Consultant

My role entailed:

Sustainability reporting and assurance.
Investigation of the feasibility of projects by valuing sustainability into financial models for new mining projects and improving supply chain management.
Water balances and Water Disclosure Reporting (WDP).
I assisted with reviewing South Africa's greenhouse gas inventory with the Department of Environmental Affairs under the UNFCCC.

Promethium Carbon
January 2011 – 2013
Carbon Advisor

My role entailed:

I managed the process and developed the full set of required documentation for successfully registered Clean Development Mechanism (CDM) projects under the United Nations Framework Convention on Climate Change (UNFCCC) as well as assisted with issuance of carbon credits and methodology revision.
Registered projects include a wind farm and a trigeneration facility.
Responsible for writing the Carbon Disclosure Programme (CDP) reports of a number of companies that scored in the upper 10 of the Carbon Disclosure Performance Leadership band of the JSE Top 100. Completing the reports involves an analysis of climate change related risks and opportunities, specifically with regard to anticipated legislative developments.

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Nedbank

May 2010 – December 2010

Credit Risk Analyst

My role entailed:

Data analysis and modelling for credit risk.
Building scorecards and analytics models.
Analysis and monitoring of credit risk exposures, assessing compliance with investment guidelines and internal controls.
The review of extensive amounts of documentation to extract, analyse and mitigate key issues.

Lurgi South Africa

November 2008 – April 2010

Graduate Process Engineer

My role entailed:

The development of Process Flow Diagrams and Piping and Instrumentation Diagrams.
Performance of process simulations and the derivation of mass and energy balances.
Gained knowledge of process software tools such as Aspen, HTRI and Fathom.
The design of process equipment (Distillation Columns, Drums, Tanks, pumps, heat exchangers and filters and other related process equipment).
In charge of the process control requirements and specifications for the optimised control of Process Units.
Responsible for the technical integrity of the process engineering and design work.
Gained knowledge of the various phases of project execution, i.e. concept development, Basic Engineering, Detailed engineering, Construction and Commissioning.

AWARDS

Lurgi Academic Scholarship 2007 - 2009

Scholarship from the University of the Witwatersrand 2004

Achieved six higher grade distinctions in Grade 12 National Exams (English, Afrikaans, Physical Science, Mathematics, Biology and Accounting)

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