
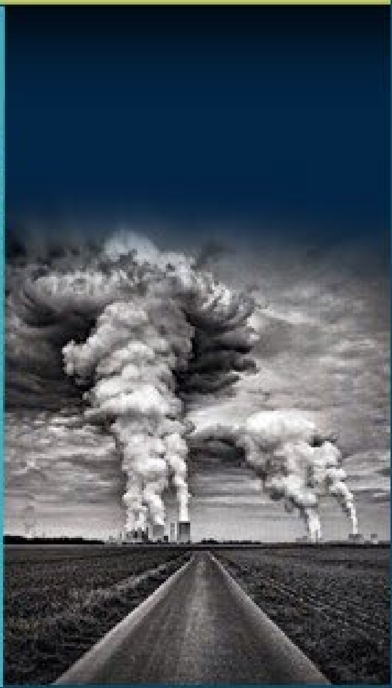

Climate Change Impact Assessment Commissioned By

NSOVO ENVIRONMENTAL CONSULTING

ON BEHALF OF KHANYAZWE FLEXPOWER

Project Reference 0124-P041-NSO Khanyazwe Flexpower CCIA

Date 24 June 2024

This report documents the results and findings of a climate change impact assessment in support of the proposed 1000MW natural gas-fired power plant in Malelane within the Nkomazi Local Municipality and Ehlanzeni District Municipality of the Mpumalanga Province.

EHRCON

EHRCON (Pty) Ltd

082 825 5919 (cell) 084 585 6690 (cell)

info@ehrcon.com - www.ehrcon.com

EXECUTIVE SUMMARY

EHRCON (Pty) Ltd (EHRCON) was commissioned by Nsovo Environmental Consulting (Nsovo Environmental) to assess the climate change impact associated with the 1000MW natural gas-fired power plant of Khanyazwe Flexpower (Pty) Ltd (KFP). The proposed project will be located on Portions 1, 4, and 116 of Farm Malelane 389 FP, in Malelane within the Nkomazi Local Municipality and the Ehlanzeni District Municipality of the Mpumalanga Province.

The project involves developing, constructing, and operating a 1000MW natural gas-fired power plant using reciprocating engine technology. The proposed project will comprise of a phased development approach, with Phase 1: 440MW to be built by 2028 and Phase 2: 560MW to be completed by 2030.

KFP will source gas from the Republic of Mozambique Pipeline Investments Company (ROMPCO), which has an existing gas pipeline that connects Mozambique's Pande Temane gas fields to Sasol's operations in South Africa, as well as several industrial and retail customers. Alternative gas sources may include imported Liquid Natural Gas (LNG) projects developed in Matola, which will provide additional gas into the ROMPCO pipeline. KFP is also proposing the development of approximately two 500 metre 275 KV and/or 132 kV overhead powerlines from the proposed power plant to the existing Eskom Khanyazwe substation. The power plant will provide a mid-merit power profile to the national grid.

The objectives of the climate change impact assessment were to characterise and describe Greenhouse Gas (GHG) emissions from the proposed power facility. The findings of the study are aimed at providing KFP, the Ehlanzeni District Municipality and other stakeholders with a fair account of the GHG emissions from the proposed KFP Power Plant.

The assessment considered a review of the relevant climate change framework, protocol, legislation, regulations and strategies. A process description and a greenhouse gas (GHG) inventory were compiled.

A global, national and regional climate change synopsis was provided. An assessment of the contribution and outcome of the KFP Power Plants' effect on climate change was conducted. The climate change impact of the GHG emissions was benchmarked against South Africa's national emissions inventory and the global greenhouse gas inventory.

A climate change vulnerability assessment reviewed the potential impact of climate change on the KFP Power Plant. A climate baseline was provided and future climate change scenarios were identified. Potential climate related risks were identified, scored and prioritised. Management and mitigation measures were proposed for the identified risks.

The climate change impact assessment concludes the following:

- The project falls within the Nkomazi Local Municipality and the Ehlanzeni District Municipality of the Mpumalanga Province. The Mpumalanga Climate Change Adaptation Strategy Report and the Ehlanzeni District Municipality's Climate Change Vulnerability Assessment and Response Plan have been developed.
- Construction operations will most probably include emissions from mobile and stationary combustion of diesel for construction operations. GHG emissions for the construction operations could not be determined due to a lack of data availability.
- KFP Power Plant's GHG emissions include Scope 1, Scope 2 and Scope 3 emissions. Scope 1 emissions include emissions from stationary combustion of natural gas and diesel. Scope 2 emissions consist of emissions from purchased electricity. Scope 3 include emissions from mobile diesel combustion contracted to third party suppliers.
- KFP Power Plant's annual calculated GHG emissions inventory amounts to **2 524 378.66 tCO_2e**. (2 524.37 Gg CO_2e) Scope 1 GHG emissions amounted to 2 523 732.74 tCO_2e (99.975%). Scope 2 GHG emissions were calculated at 541.75 tCO_2e (0.021%). Scope 3 GHG emissions totalled 104.18 tCO_2e (0.004%).
- KFP Power Plant's annual calculated GHG emissions inventory equites to **0.614%** of the Energy Sector emissions (410 685 Gg CO_2e).
- The total project life GHG emission rate was calculated at **63 109 407.78 tCO_2e** (63 109.40 Gg CO_2e).

- KFP Power Plant's total project life GHG emission rate amounts to **13.374%** of South Africa's carbon budget (510 Mt CO_2e).
- The facility's electricity emissions intensity was calculated at **0.280 tCO_2e/MWh**. By comparison, the power plant's emissions intensity is significant less than Eskom's current grid emissions factor of **0.985 tCO_2e/MWh**.
- The magnitude of the impact of GHG emissions from the construction operations were estimated to be negligible.
- The magnitude of GHG emissions from the KFP Power Plant's operations (2 524 378.66 tCO_2e) is considered **Very High**, as GHG emissions are greater than 1 000 000 tCO_2e annually.
- The impact of GHG emissions from the KFP Power Plant was rated **High** with or without mitigation measures.
- The project's GHG emissions will contribute to the local Energy Sector and to the global energy related GHG emissions.
- The project's GHG emissions will likely contribute to anthropogenic climate change. Climate change is likely to be accelerated and extended as GHG emissions accumulate in the atmosphere.
- Potential climate risks identified, based on the climate threat outline, include increased temperature, reduced rainfall, extreme events and wind impacts.
- The identified climate risks will have a direct and indirect impact on construction operations and KFP Power Plant's operations.
- All potential climate risks have been assessed as **Medium** without mitigation measures and **Medium** to **Low** with mitigation measures.
- Although mitigation will not alter the impacts of GHG emissions in terms of the extent, duration or probability of the impact, the intensity of the impact can be reduced, notably by reducing the quantity of GHG emissions.
- Basic mitigation strategies and specific tactics and actions have been outlined to reduce GHG emissions from the power generation activities.
- Risk mitigation / adaptation measures have been proposed for the identified climate risks.

DECLARATION AND REPORT APPROVAL

Report 0124-P041-NSO KFP CCIA issued on this day, 24 June 2024, is the sole property of Nsovo Environmental and Khanyazwe Flexpower (Pty) Ltd and supersedes any previous versions. No part of this report may be reproduced or transmitted in any form or by any means, unless in full and with the exclusive permission, in writing, from the author. EHRCON declares that –

- it acts as an independent specialist.
- all results and related data have been obtained through careful and precise execution of recognised methods of evaluation and are related to the scope of work covered in this report and of prevailing conditions at the time of the assessment.
- the opinions and interpretations are embraced through judgment, discernment and comprehension to the best of available knowledge and are outside the scope of any accreditation.
- it performed the work relating to this project in an objective manner, notwithstanding the results, views and findings.
- it has expertise in conducting the specialist report relevant to this project, including knowledge of the framework, protocol, legislation, regulations and strategies that may have relevance.
- it complies with the applicable framework, protocol, legislation, regulations and strategies.
- it has no, and will not engage in, conflicting interests in the undertaking of the activity.
- it undertakes to disclose to the client and authorities all material information it possesses that reasonably has or may have the potential of objectively influencing any decision based on the results and finings of this project.
- all the particulars furnished by EHRCON in this report are true and correct; and any false declaration is a punishable offence.

Report compile by EHRCON (Pty) Ltd

	24 June 2024
Jeandré Neveling (BBComms, BCom Fin)	**Date**
Carbon Analyst	

Report approved by Nsovo Environmental Consulting

	24 June 2024
Rejoice Aphane	**Date**
Environmental Consultant	

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1.1 PROJECT OUTLINE

EHRCON (Pty) Ltd (EHRCON) was commissioned by Nsovo Environmental Consulting (Nsovo Environmental) to assess the climate change impact associated with the 1000MW natural gas-fired power plant of Khanyazwe Flexpower (Pty) Ltd (KFP). The proposed project will be located on Portions 1, 4, and 116 of Farm Malelane 389 FP, in Malelane within the Nkomazi Local Municipality and the Ehlanzeni District Municipality of the Mpumalanga Province.

The project involves developing, constructing, and operating a 1000MW natural gas-fired power plant using reciprocating engine technology. The proposed project will comprise of a phased development approach, with Phase 1: 440MW to be built by 2028 and Phase 2: 560MW to be completed by 2030.

KFP will source gas from the Republic of Mozambique Pipeline Investments Company (ROMPCO), which has an existing gas pipeline that connects Mozambique's Pande Temane gas fields to Sasol's operations in South Africa, as well as several industrial and retail customers. Alternative gas sources may include imported Liquid Natural Gas (LNG) projects developed in Matola, which will provide additional gas into the ROMPCO pipeline. KFP is also proposing the development of approximately two 500 metre 275 KV and/or 132 kV overhead powerlines from the proposed power plant to the existing Eskom Khanyazwe substation. The power plant will provide a mid-merit power profile to the national grid.

The assessment considered a review of the relevant climate change framework, protocol, legislation, regulations and strategies. A process description and a greenhouse gas (GHG) inventory were compiled. A global, national and regional climate change synopsis was provided. An assessment of the contribution and outcome of the KFP Power Plant's effect on climate change was conducted. The climate change impact of the GHG emissions was benchmarked against South Africa's national emissions inventory and the global greenhouse gas inventory.

A climate change vulnerability assessment reviewed the potential impact of climate change on the KFP Power Plant. A climate baseline was provided and future climate change scenarios were identified. Potential climate related risks were identified, scored and prioritised. Management and mitigation measures were proposed for the identified risks.

The report was compiled with due consideration of all process information and specific conditions outlined by Nsovo Environmental and Khanyazwe Flexpower.

1.2 PROJECT DESCRIPTION

The study area is located in the Nkomazi Local Municipality, within the Ehlanzeni District Municipality of the Mpumalanga Province. Current land use includes agricultural, residential and commercial (See **Figure 1**).

The assessment of the potential climate change impact associated with the KFP Power Plant comprised the following terms of reference:

- A review of the relevant framework, protocol, legislation, regulations and strategies.
- A process description and GHG inventory.
- A global, national and regional climate change synopsis.
- Assessments of the contribution and outcome of the KFP Power Plant's effects on climate change.
- Benchmarking of the climate change impact of the GHG emissions against South Africa's national emissions inventory and the global GHG inventory.
- A climate change vulnerability assessment, assessing the potential impact of climate change on the proposed KFP Power Plant.
- A climate baseline was provided and future climate change scenarios were identified.
- Potential climate related risks were identified, scored and prioritised.
- Management and mitigation measures were proposed for the identified risks.

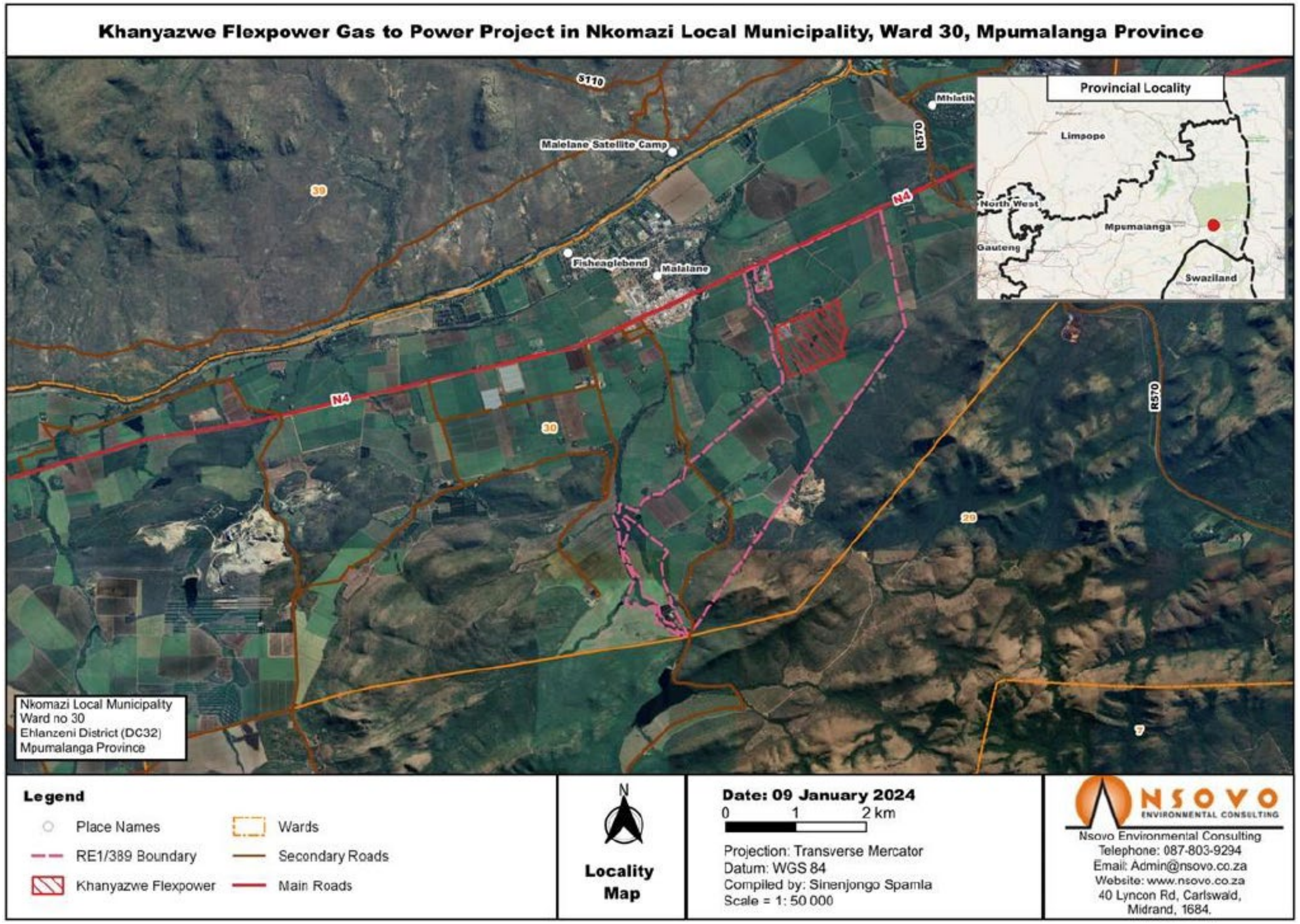

Figure 1: Khanyazwe Flexpower Power Plant Location

1.3 METHODOLOGICAL OVERVIEW

The compilation of the GHG emission inventory for the KFP Power Plant was based on *ISO/SANS 14064 Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals* (2006) and The Greenhouse Gas Protocol's *A Corporate Accounting and Reporting Standard (Revised Edition)* (2015).

The reporting boundary was set, GHG sources identified, quantification method established and the GHG emissions inventory was calculated.

Default emission factors, as set out in the Department of Forestry, Fisheries and the Environment's (DFFE) *Methodological Guidelines for Quantification of Greenhouse Gas Emissions* (2022) were used for the purpose of calculating the GHG emissions inventory. The electricity emission factor was sourced from *South Africa's 2021 Grid Emission Factors Report* (2024).

The climate change impact of the GHG emissions was benchmarked against South Africa's national emissions inventory and the global greenhouse gas inventory.

A climate change vulnerability assessment assessed the potential impact of climate change on the construction operations and proposed KFP Power Plant. A climate baseline was provided and future climate change scenarios were identified. Potential climate-related risks were identified, scored and prioritised. Management and mitigation measures were proposed for Medium and High risks identified in the risk assessment.

1.4. ASSUMPTIONS, EXCLUSIONS AND LIMITATIONS

Data limitations and assumptions associated with the climate change impact assessment in support of KFP Power Plant are listed below:

- The inventory included all sources that were practically and economically feasible to assess.
- The GHG inventory for the project includes the construction operations and the KFP Power Plant.
- Construction operations will most probably include emissions from mobile and stationary combustion of diesel for construction operations. GHG emissions for the construction operations could not be determined due to a lack of data availability.
- KFP Power Plant's GHG emissions include Scope 1, Scope 2 and Scope 3 GHG emissions.
- KFP Power Plant's project life is estimated at 25 years.
- Limitations exist with the use of climate change projections to inform future climate scenarios.

2. FRAMEWORK, PROTOCOL LEGISLATION AND REGULATIONS

2.1 UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

The United Nations Framework Convention on Climate Change (UNFCCC), formed in 1992, is an international treaty put in place by the United Nations. The objective of the treaty is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. South Africa acceded to the UNFCCC in 1997.

2.2 KYOTO PROTOCOL

The Kyoto Protocol is an international treaty among industrialised nations that sets mandatory limits on GHG emissions. The purpose of the Kyoto Protocol is to even out human-generated emissions at a level that will not inflict further harm on the atmosphere. There are currently 192 Parties to the Protocol. The Protocol is overseen by UNFCCC.

The Convention divides countries into three main groups. Annex 1 countries include industrialised countries. Annex 2 countries are developed countries that provide financial support for developing countries to undertake emission reduction projects. Non-Annex 1 countries are developing countries and do not have specific emission restraints.

South African ratified the Kyoto Protocol in 2002.

2.3 21ST CONFERENCE OF PARTIES PARIS AGREEMENT

An historic agreement to combat climate change towards a low carbon, resilient and sustainable future was agreed by 165 nations in Paris in December 2015. The 21st Conference of Parties (COP 21) Paris Agreement confirms the irreversible transition to a low carbon, safer and healthier world.

The COP 21 Paris Agreement's main aim is to keep the global temperature rise this century well below 2 degrees Celsius and to drive efforts to limit the temperature increase even further to 1.5 degrees Celsius above pre-industrial levels.

South African signed the Cop 21 Paris Agreement in 2016.

2.4 SOUTH AFRICAN NATIONAL CLIMATE CHANGE RESPONSE WHITE PAPER

The South African National Climate Change Response White Paper (White Paper), published by the Department of Environments, Forestry and Fisheries (DEFF, 2011), prioritises both climate change mitigation and adaptation in moving towards a climate-resilient and lower-carbon economy and society.

The climate change response objectives are to:

- Make a fair contribution to the global effort to achieve the stabilisation of greenhouse gas concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system.
- Effectively adapt to and manage unavoidable and potential damaging climate change impacts through interventions that build and sustain South Africa's social, economic and environmental resilience and emergency response capacity.

2.5 CLIMATE CHANGE BILL

On 8 June 2018, the Climate Change Bill (GG No. 41689, Notice 580) was published for public comment.

The purpose of the Bill is to communicate and implement an effective nationally determined climate change response, including mitigation and adaptation actions, that represents South Africa's fair contribution to the global climate change response.

The objectives of the Bill are to:

- Provide for a coordinated and integrated response to climate change and its impacts by all spheres of government in accordance with the principles of cooperative governance.
- Provide for the effective management of inevitable climate change impacts through enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to building social, economic, and environmental resilience and an adequate national adaptation response in the context of the global climate change response.
- Make a fair contribution to the global effort to stabilise greenhouse gas concentrations in the atmosphere at a level that avoids dangerous anthropogenic interference with the climate system within a timeframe and in a manner that enables economic, employment, social and environmental development to proceed in a sustainable manner.

2.6 GREENHOUSE GAS REGULATIONS

2.6.1 National Greenhouse Gas Emission Reporting Regulations

On 3 April 2017, the National Greenhouse Gas Emission Reporting Regulations (GG No. 40762, Notice 275) in terms of NEMAQA were published.

The purpose of the regulations is to introduce a single national greenhouse gas (GHG) reporting system, which will be used to inform policy formulation and help South Africa to meet its international obligations such as targets set under the United Nations Framework Convention on Climate Change. In addition, the regulations are intended to facilitate the establishment and maintenance of a National Greenhouse Gas Inventory.

In terms of the regulations, organisations engaging in the following activities are data providers and will be legally required to report on their GHG emissions:

- Energy – fuel combustion activities, fugitive emission from fuels and carbon dioxide transport and storage.
- Industrial processes and product use – mineral industry, chemical industry, metal industry, non-energy products from fuels and solvents use, electronics industry, product uses as substitutes for ozone depleting substances, other product manufacture and use and other.
- Agriculture, forestry and other land use – livestock, land, aggregate source and non-CO_2 emission sources on land and other.
- Waste sector – solid waste disposal, biological treatment of solid waste, incineration and open burning of waste and wastewater treatment and discharge.

The regulations state that data providers are required to submit the greenhouse gas emissions and activity data as set out in the Methodological Guidelines for Quantification of Greenhouse Gas Emissions, for each of the relevant greenhouse gases and emission sources, for all its facilities for the preceding calendar year, to the competent authority by 31 March of each year.

On 21 July 2017, the Minister of Environmental Affairs, published the Declaration of Greenhouse Gases as Priority Air Pollutants (GG 40996, Notice 710) and the National Pollution Prevention Plans Regulations (GG 40996, Notice 712).

The regulations declare the following six greenhouse gases as priority air pollutants:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF6)

The regulations further stipulate that the following entities will be required to submit Pollution Prevention Plans:

- An entity that emits more than 0.1 Megatonnes annually of the declared greenhouse gases, measured in carbon dioxide equivalent (CO_2e)
- An entity undertaking a production process, as a primary activity, as set out in Annexure A of the Declaration of Greenhouse Gases as Priority Air Pollutants

Companies that are liable to submit Pollution Prevention Plans will need to submit the plans within five months after the promulgation of the regulations. Companies are further required to submit an annual progress report by the 31 March, for the preceding calendar year.

The list of production processes as set out in Annexure A, include coal mining, production and/or refining of crude oil, production and/or processing of natural gas, production of liquid fuels from coal or gas, cement production, glass production, ammonia production, nitric acid production, carbon black production, iron and steel production, ferro-alloys production, aluminium production, polymers production, pulp and paper production and electricity production (combustion of fossil fuels, excluding the use of back-up generators).

2.7 CLIMATE CHANGE MITIGATION AND ADAPTATION

2.7.1 National Climate Change Adaptation Strategy

On 18 August 2020, the National Climate Change Adaptation Strategy (NCCAS) was published. The NCCAS serves as South Africa's National Adaptation Plan and fulfils South Africa's commitment to its international obligations as outlined in the Paris Agreement under the UNFCCC. The NCCAS will be used as the basis for meeting South Africa's obligations in terms of the adaptation commitments outlined in the National Determined Contributions.

The NCCAS provides a common vision of climate change adaptation and climate resilience for the country and outlines priority areas for achieving this vision.

South Africa's First National Determined Contribution, 2020 Updated Draft was approved by Cabinet on 24 March 2021.

2.7.2 Mpumalanga Province Climate Change Adaptation Strategies

The DEFF, in partnership with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) developed the Mpumalanga Climate Change Adaptation Strategy Report (2015). The report investigated climate change vulnerabilities within the Province, identified priority sectors and recommended adaptation measures that can build adaptive capacity in the relevant sectors.

2.7.3 Ehlanzeni District Municipality Climate Change Vulnerability Assessment and Response Plan

Ehlanzeni District Municipality's Climate Change Vulnerability Assessment and Response Plan (2016) was developed in partnership with DEFF and GIZ, through the Local Government Climate Change Support Program. The plan identified key climate change vulnerabilities, as well as climate change responses to address the vulnerabilities.

3. BACKGROUND ASSESSMENT

3.1 PROCESS DESCRIPTION

The project involves developing, constructing, and operating a 1000MW natural gas-fired power plant using either Gas Engines (or Internal Combustion Engines (ICE)) or Combined Cycle Gas Turbines (CCGT). The proposed project will comprise of a phased development approach, with Phase 1: 440MW to be built by 2028 and Phase 2: 560MW to be completed by 2030.

KFP will source gas from the Republic of Mozambique Pipeline Investments Company (ROMPCO), which has an existing gas pipeline that connects Mozambique's Pande Temane gas fields to Sasol's operations in South Africa, as well as several industrial and retail customers. Alternative gas sources may include imported Liquid Natural Gas (LNG) projects developed in Matola, which will provide additional gas into the ROMPCO pipeline.

An approximately 500 metre gas pipeline extension will be required to connect the power plant to the ROMPCO pipeline.

KFP is also proposing the development of approximately two 500 metre 275 KV and/or 132 kV overhead powerlines from the proposed power plant to the existing Eskom Khanyazwe substation.

An access road (temporary and permanent) will be constructed to link the proposed power station to the nearby existing road network. The current primary road to the proposed development site is a gravel road that connects to the N4. A new access point from the N4 has been proposed. This proposed access will tie in with the gravel road, and two access routes are proposed to access the power plant near the Eskom Khanyazwe substation.

Associated infrastructure will include:

- Water and lube oil tanks for the water and oil required for the gas turbine/engine generation process and cooling.
- Water treatment plant to produce the required quality of water for the generation process.
- Building infrastructure, which will include, but not be limited to, plant operational and maintenance building, ablution facilities and offices.
- Fencing to maximize the security of the plant.

The power plant will provide a mid-merit power profile to the national grid. It will be designed to operate for 25 years, after which, subject to prevailing circumstances, it will either be decommissioned or refurbished and extended. If decommissioned, the land where the power plant is located will undergo an extensive rehabilitation project, which will see the removal of all power plant equipment and reinstatement of the land back to its original purpose, which is sugar cane farming.

Figure 2 contains the layout diagram, while **Figure 3** contains the layout plan for the KFP Power Plant.

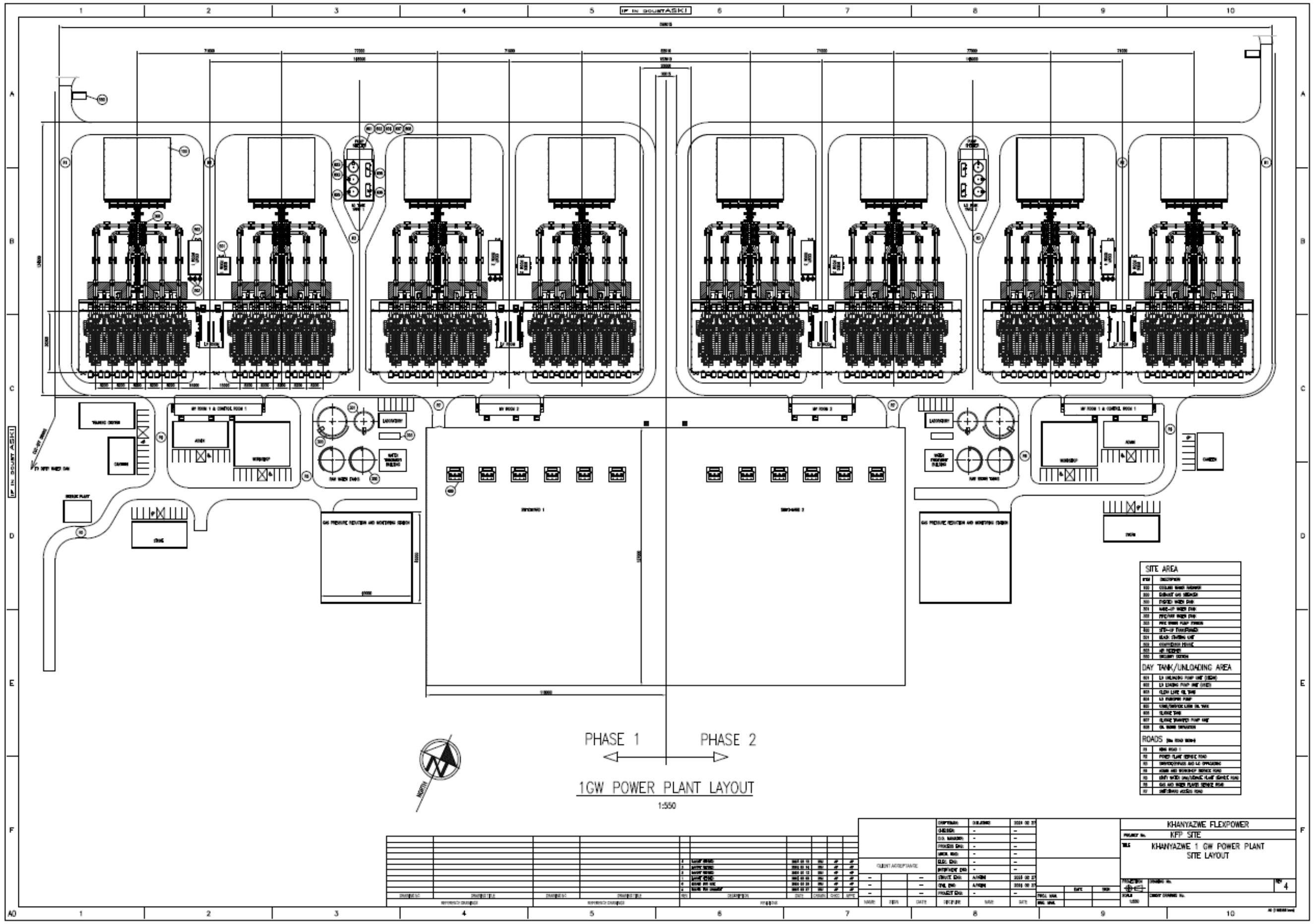

Figure 2: Khanyazwe Flexpower Layout Diagram

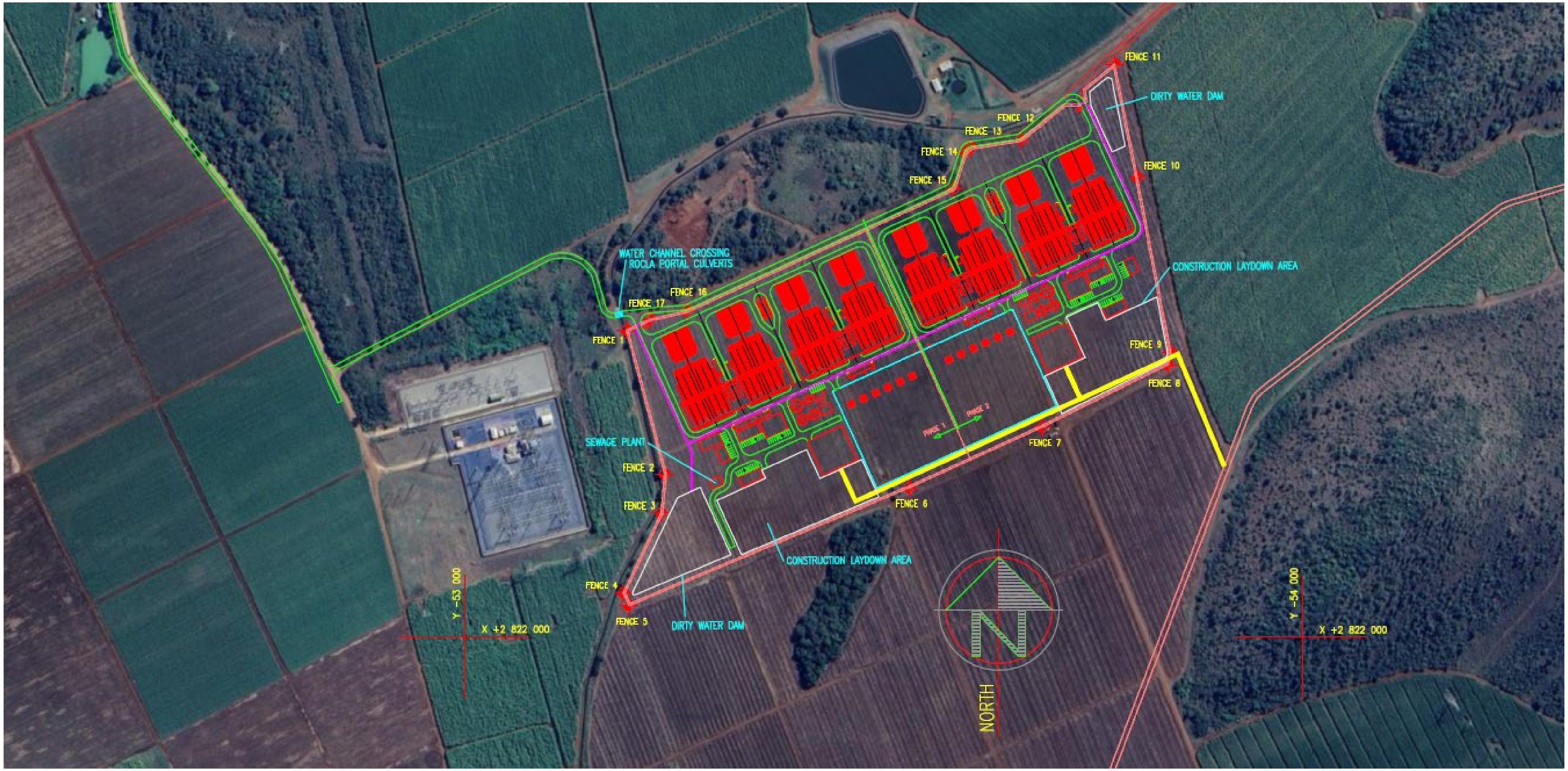

Figure 3: Khanyazwe Flexpower Layout Plan

3.2 EMISSION INVENTORY

The boundary for KFP Power Plant's climate change impact assessment was set according to *ISO/SANS 14064 Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals* (2006). The GHG inventory for the project includes the construction operations and the KFP Power Plant's operations and is based on the operational control approach.

Setting of the operational boundary includes the identification of emissions associated with the operations and the classification of the emissions into categories.

ISO/SANS 14064 Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals (2006) defines the categories as Direct GHG Emissions, Electricity Indirect GHG Emissions and Other Indirect GHG Emissions. The Greenhouse Gas Protocol's *A Corporate Accounting and Reporting Standard (Revised Edition)* (2015) refers to the categories as Scope1, Scope 2 and Scope 3 emissions (see **Figure 4**).

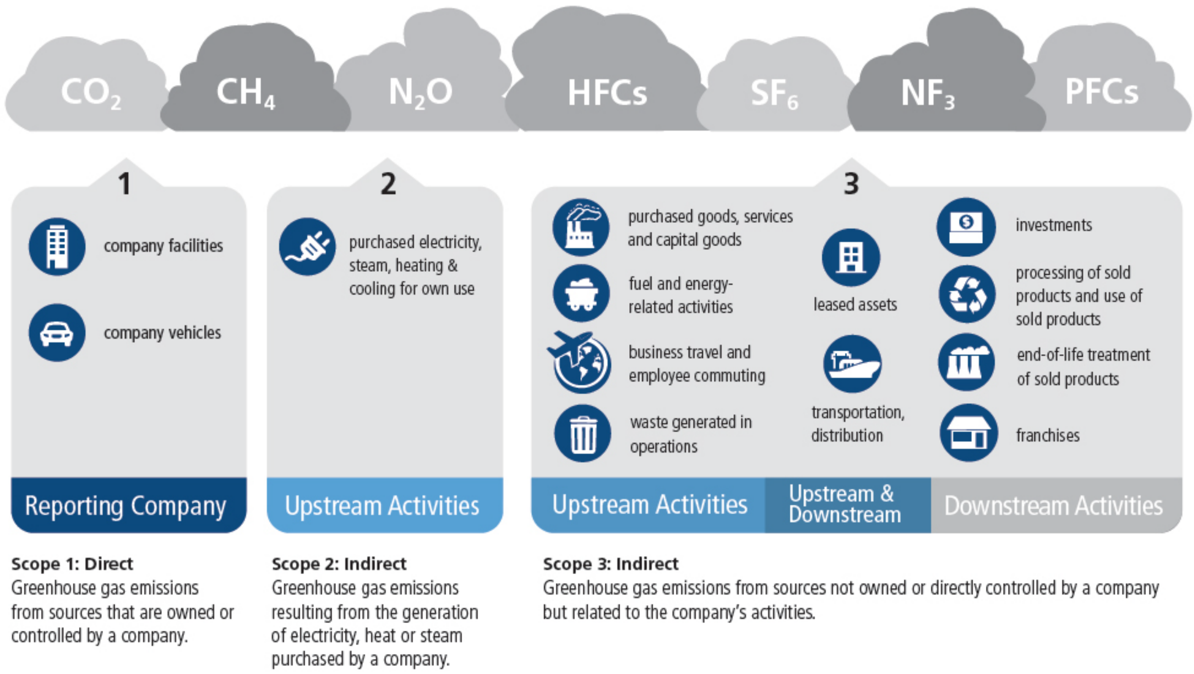

Figure 4: Overview of GHG Scopes and Emissions

Direct GHG Emissions are emissions from sources that are owned or controlled by KFP Power Plant. Electricity indirect GHG Emissions are emissions from purchased electricity consumed by the facility. Other Indirect GHG Emissions are the consequence of activities within the operational boundary, which occur from sources not owned or controlled by the facility.

KFP Power Plant's GHG inventory included all sources that were practically and economically feasible to assess. Scope 1 – Direct Emissions include emissions from the stationary combustion of natural gas, stationary combustion of diesel and fugitive emissions from gas operations. Scope 2 - Electricity Indirect GHG Emissions include emissions from purchased electricity. Scope 3 – Other Indirect GHG Emissions include emissions from mobile diesel combustion contracted to third party suppliers.

KFP Power Plant will source gas from the ROMPCO, via a pipeline. KFP Power Plant's GHG emission sources are summarised in **Table 1**:

Table 1: KFP Power Plant GHG Emission Sources

Scope 1 – Direct Emissions	Scope 2 – Energy Indirect Emissions	Scope 3 – Other Indirect Emissions
▪ Emissions from the combustion of natural gas – stationary.	▪ Emissions from purchased electricity.	▪ Emissions from the combustion of diesel – mobile.
▪ Emissions from the combustion of diesel – stationary.		
▪ Fugitive emissions – gas operations.		

3.3 EMISSION FACTORS, RATES AND INTENSITY RATINGS

Default emission factors, as set out in the DFFE' *Methodological Guidelines for Quantification of Greenhouse Gas Emissions (2022)* were used for the purpose of calculating the GHG emissions inventory. The electricity emission factor was sourced from *South Africa's 2021 Grid Emission Factors Report* (2024).

Emissions were reported in carbon dioxide equivalent (CO_2e) and measured in tonnes (tCO_2e).

The GHG inventory for the construction operations are summarised in **Table 2**. The KFP Power Plant GHG inventory is included in **Table 3**, **Table 4** and **Table 5**.

Table 2: KFP Power Plant Construction Operations – Scope 3 GHG Emission Factors

Emission Source	Emission Factors
Diesel – Stationary[1]	0.0026 tCO_2e/tonne
Diesel – Mobile[2]	0.0027 tCO_2e/tonne

Notes:

tCO_2e : Tonne carbon dioxide equivalent (tCO_2e).

1 : CO_2 emission factor: 74 638kg/TJ, CH_4 emission factor: 3kg/TJ and N_2O emission factor: 0.6kg/TJ.
Calorific value of diesel: 0.0000355 TJ/litre.
Default Emission Factors for Diesel, Stationary Combustion as set out in the Methodological Guidelines for Quantification of Greenhouse Gas Emissions (2022).

2 : CO_2 emission factor: 74 638kg/TJ, CH_4 emission factor: 4.15kg/TJ and N_2O emission factor: 28.6kg/TJ.
Calorific value of diesel: 0.0000355 TJ/litre.
Default Emission Factors for Diesel, Mobile Combustion as set out in the Methodological Guidelines for Quantification of Greenhouse Gas Emissions (2022).

Scope 3 GHG emissions could not be determined due to a lack of data availability.

Table 3: KFP Power Plant – Scope 1 GHG Emission Factors and Rates

Emission Source	Emission Factors	Emission Rates (tCO_2e)	
		Facility Project Life	Facility Annual Operations
Natural Gas – Stationary[1]	0.0021 tCO_2e/tonne	63 093 053.43	2 523 722.14
Diesel – Stationary[2]	0.0026 tCO_2e/tonne	206.18	10.60
Fugitive Emissions – Gas Operations[3]	Not defined	0	0
Total	-	**63 093 259.61**	**2 523 732.74**

Notes:

tCO_2e	:	Tonne carbon dioxide equivalent (tCO_2e).
Project life	:	Project life estimated at 25 years.
1	:	30 600 500 000 m^3 of stationary natural gas combusted during the project life. 1 224 020 000 m^3 of stationary natural gas combusted per annum. CO_2 emission factor: 55 709kg/TJ, CH_4 emission factor: 1kg/TJ and N_2O emission factor: 0.1kg/TJ. Conversion Factor of Natural Gas: 24.98 m^3/GJ. Calorific value of Natural Gas: 0.00003701 TJ/m^3. Tier 2 CO_2 Emission Factor for Natural Gas, Sasol South Africa. Default Emission Factors for Natural Gas as set out in the Methodological Guidelines for Quantification of Greenhouse Gas Emissions (2022).
2	:	1 000 000 litres of mobile diesel utilised during the project life. 4 000 litres of mobile diesel utilised per annum. CO_2 emission factor: 74 638kg/TJ, CH_4 emission factor: 3kg/TJ and N_2O emission factor: 0.6kg/TJ. Calorific value of diesel: 0.0000355 TJ/litre. Default Emission Factors for Diesel, Mobile Combustion as set out in the Methodological Guidelines for Quantification of Greenhouse Gas Emissions (2022).
3	:	Default Emission Factors for Fugitive Emission from Coal Mining, Oil and Gas Operations as set out in the Methodological Guidelines for Quantification of Greenhouse Gas Emissions (2022).

Table 4: KFP Power Plant – Scope 2 GHG Emission Factor and Rates

Emission Source	Emission Factors	Emission Rates (tCO_2e)	
		Facility Project Life	Facility Annual Operations
Purchase Electricity[1]	0.985 tCO_2e/MWh	13 543.75	541.75
Total	-	**13 543.75**	**541.75**

Notes:

tCO_2e	:	Tonne carbon dioxide equivalent (tCO_2e).
1	:	13 750 MWh electricity during the project life. 341.08 MWh electricity per annum. National Generation Grid Emission Factor as per South Africa's 2021 Grid Emission Factors Report.

Table 5: KFP Power Plant – Scope 3 GHG Emission Factor and Rates

Emission Source	Emission Factors	Emission Rates (tCO_2e)	
		Facility Project Life	Facility Annual Operations
Diesel – Mobile[1]	0.0027 tCO_2e/tonne	2 604.42	104.18
Total	-	**2 604.42**	**104.18**

Notes:

tCO_2e	:	Tonne carbon dioxide equivalent (tCO_2e).
1	:	982 500 litres of mobile diesel utilised during the project life. 39 300 litres of mobile diesel utilised per annum. CO_2 emission factor: 74 638kg/TJ, CH_4 emission factor: 4.15kg/TJ and N_2O emission factor: 28.6kg/TJ. Calorific value of diesel: 0.0000355 TJ/litre. Default Emission Factors for Diesel, Mobile Combustion as set out in the Methodological Guidelines for Quantification of Greenhouse Gas Emissions (2022).

Table 6 includes the emissions intensity ratings for the facility.

Table 6: KFP Power Plant – GHG Emissions Intensity Ratings

Aspect	Intensity Rating
Electricity Emissions Intensity[1]	0.400 tCO_2e/MWh

Notes:

tCO_2e	:	Tonne carbon dioxide equivalent (tCO_2e).
MWh	:	Megawatt Hour.
1	:	Total annual Scope 1 GHG emissions (2 523 732.74 tCO_2e) divided by total annual electricity output (assumed at 9 000 GWh).

3.4 CLIMATE CHANGE FRAMEWORK

3.4.1 Global Overview

Human influence has become a principal agent of change on the planet, often termed the Anthropocene. Global-level rates of human-driven change far exceed the rates of change driven by geophysical or biosphere forces that have altered the earth system trajectory in the past.

According to the UN Environment *Global Environmental Outlook – GEO6* (2019) climate change is a priority issue affecting both human systems and natural systems, including air, biological diversity, freshwater, oceans and land. Historical and ongoing GHG emissions have committed the world to an extended period of climate change, which is leading to global warming of air and ocean; rising sea-levels; melting glaciers, permafrost and Arctic sea ice; changes in carbon, biogeochemical and global water cycles; food security crises; freshwater scarcity and more frequent and extreme weather events.

Higher atmospheric concentrations of carbon dioxide also lead to ocean acidification and affect the composition, structure and functionality of ecosystems. This makes climate change a global driver of environmental, social, health and economic impact and heightened society-wide risks.

A carbon budget can be defined as a tolerable quantity of GHG emissions that can be emitted in total over a specified time (Worldwide Fund South Africa, 2014). It therefore constitutes a limited resource.

The Intergovernmental Panel on Climate Change (IPCC) *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report* (2014) noted a global CO_2 emissions limit of 2 900 Gt CO_2 at a probability of 66%. By 2011 approximately 1 900 Gt CO_2 had already been emitted, leaving a remaining budget of 1 000 Gt CO_2.

The IPCC *Special Report on Global Warming of 1.5°C* (2018) suggests a remaining carbon budget of about 420 Gt CO_2 for a 66% change of limiting warming to 1.5°C and a budget of 580 Gt CO_2 for a 50% change. The remaining budget is defined as cumulative CO_2 emission from the start of 2018 to the time of reaching net zero global emission. It implies that CO_2 emission reach carbon neutrality in about 30 years (2048) for a budget of 580 Gt CO_2 and 20 years (2038) for 420 Gt CO_2.

3.4.2 South African Context

According to the DFFE's *South Africa's Fourth National Communication Under the United Nations Framework Convention on Climate Change* (2021), Climate change remains a threat to sustainable development and livelihoods, thus there is an urgent need to scale up efforts to address the effects of climate change and further adhere to the UNFCCC.

The Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici's (Fondazione CMCC) *G20 Climate Risk Atlas South Africa* predicts that under a low emissions scenario projected temperature variations will remain contained under 1.5°C, both by 2050 and 2100. Under a high emissions scenario, with no reduction in GHG emissions, much greater temperature anomalies are expected by both 2050 and 2100. Precipitation trend shows a slight decrease in precipitation during the last part of 21st century. Variability is quite large considering all the scenarios, ranging from -1.2% under a low emissions scenario to -18.0% under a high emissions scenario.

Projected annual changes within the marine economic zone for seawater temperature changes are in line with the definitions of each scenario, with values ranging from +1% to +3°C in 2100. The latest projections indicate that, by 2050, global sea levels may rise between 0.18 metres, under a low emissions scenario and 0.23 metres, under a high emissions scenario.

Droughts are expected to increase in the future, driven by increasing water use and changing global climatic patterns. More frequent and stronger El Niño events are also possible. Changing rain patterns may affect the frequency and intensity of floods.

An expected rise in both frequency and duration of heatwaves are predicted The latest projections indicate that, by 2050, heatwave frequency may increase between 33%, under a low emissions scenario and 95%, under a high emissions scenario. Heatwave duration may increase between 263% and 4 825% under a low and high emissions scenario.

The changing climate is likely to have a range of impacts, including impacts on energy demand (in terms of achieving human comfort within buildings and factories), agriculture (e.g. reductions of yield crops under higher temperatures and reduced soil moisture), livestock production (e.g. higher mortality as a result of oppressive temperatures), water security (through reduced rainfall and enhanced evapotranspiration), infrastructure (mostly through the occurrence of more large-scale floods in particular regions), labour (labour supply and productivity) and health (heath-related deaths, air pollution related deaths and the spread of infectious diseases).

The DFFE's *South Africa's Fourth Biennial Update Report to the United Nations Framework Convention on Climate Change* (2021), notes that South Africa's GHG emissions, excluding Forest and Other Land Use (FOLU), were 448 874 Gg CO_2e in 2000 and these increased to 512 661 Gg CO_2e (14.2%) by 2017. Net emissions (including FOLU) in 2017 were estimated at 482 016 Gg CO_2e. Emissions increased gradually between 2000 and 2009 after which there was a decline to 2017. Between 2000 and 2017 the average annual growth was 0.6%.

The Energy sector was the largest contributor to South Africa's total emissions (excl. FOLU), contributing 80.1% to emissions. This was followed by the Agriculture, Forest and Other Land Use (AFOLU) sector (10.3%), the Industrial Process and Product Use (IPPU) sector (7.0%) and the Waste sector (3.7%).

Figure 5 provides an overview of the National GHG Inventory for the period 2000 to 2017.

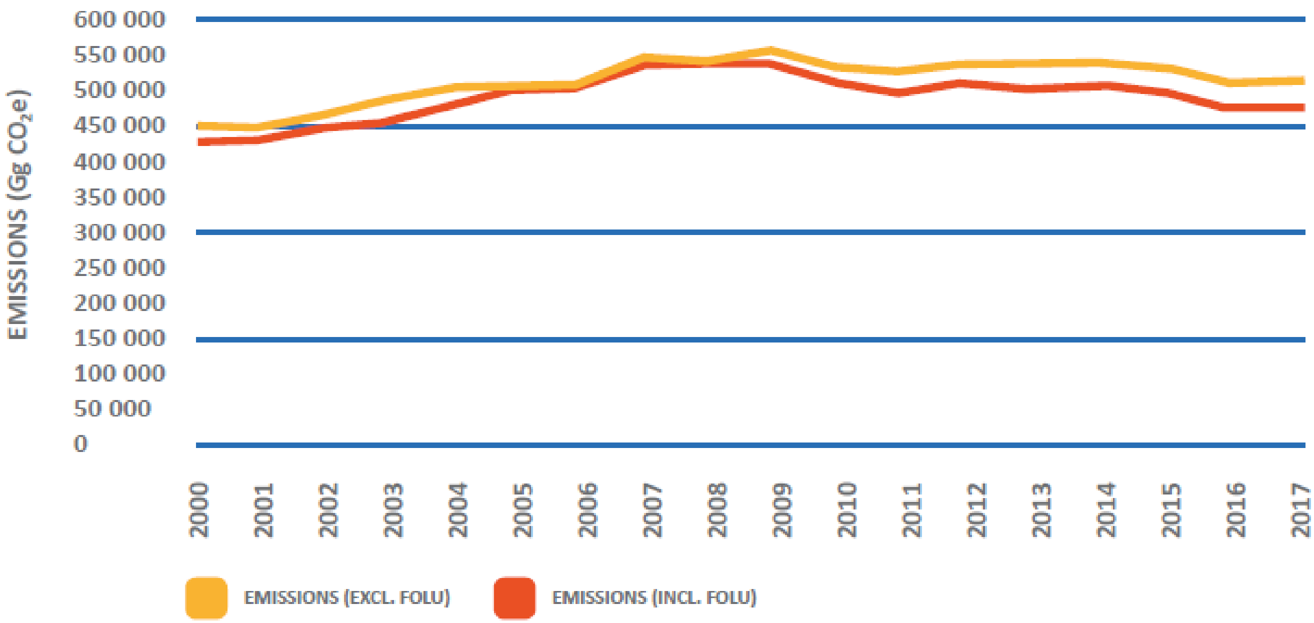

Figure 5: National GHG Inventory 2000 – 2017.

Figure 6 gives a sectoral contribution summary of the South African GHG emissions.

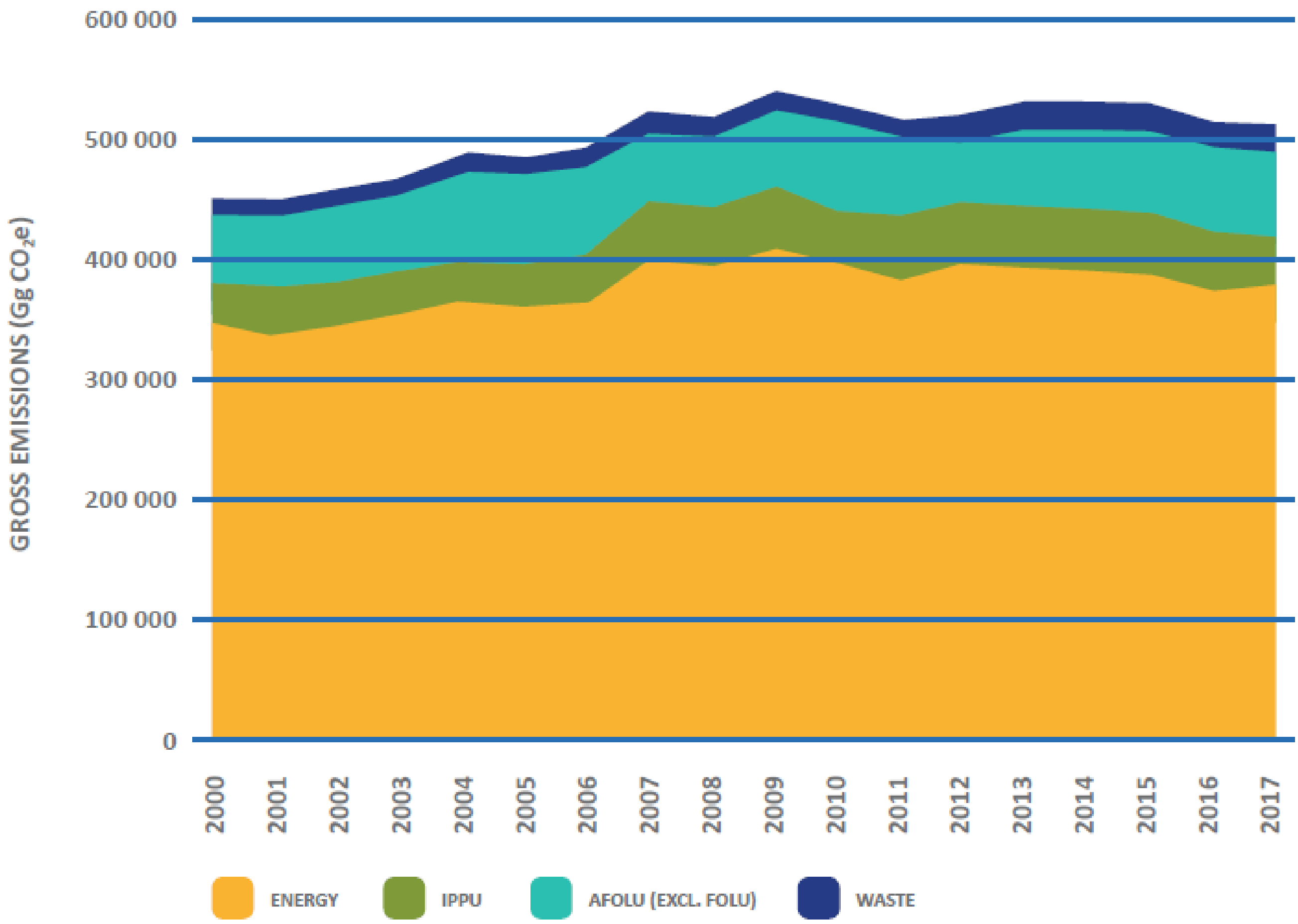

Figure 6: Sectoral Contribution Summary of the South African GHG emissions 2000 – 2017.

CO_2 gas is the largest contributor (83.21%) to South Africa's gross and net emissions. This is followed by CH_4 (10.3%) and then N_2O (6.45%). The contribution from CH_4 and N_2O declined between 2000 and 2017, while CO_2 and F-gases increased over the same period.

The global carbon budget is a scarce resource that needs to be divided fairly between countries. There is still no agreed method to allocate the global carbon budget between countries. The global carbon budget can be divided in many ways and include responsibility for historical emissions, state of economic development and the right to be able to develop to a certain level, size of population and per capita emissions, financial, technological and other capacity to reduce emissions.

In the absence of an international agreement on dividing up the global carbon budget, South Africa has derived its own total carbon allowance for the period 2010 to 2050. This has been done by adding up bottom-up approaches to see how much emissions could be reduced, setting reduction targets against a baseline and deriving a "benchmark national emissions trajectory range." This is what is being referred to as the country's "carbon budget" – the overall quantity of emissions that should not be exceeded.

The DFFE's *Long-Term Mitigation Scenarios* (LTMS) study (DFFE, 2007) modelled "required by science", "current development path" and "growth without constraints" trajectories for South Africa's emissions. "Growth without constraints" projects South Africa's emissions as much as 42 $GtCO_2e$. The study indicated that South Africa's annual emission levels would still rise, before the country would be able to level off and then reduce them – a "peak, plateau and decline" trajectory. The rise in emissions before peaking is due to some effects which could not be reversed and which would increase emissions in the shorter term, the time lag needed to put low-carbon initiatives in place, the need for South Africa to extend the benefits of development to all (including access to water and energy, housing and job creation).

In early 2010 South Africa made a voluntary, conditional commitment to the United Nation Framework Convention on Climate Change (UNFCCC) to cut emissions, informally referred to as our "Copenhagen commitment." It undertook emission reduction targets of 34% by 2020 and 42% by 2025 below an unspecified "business as usual" trajectory. It said this would allow emissions to "peak between 2020 and 2025, plateau for about a decade and decline in absolute terms thereafter." Holding to the assumptions made at the time of the Copenhagen commitment, the targets translate to total emissions of around 17 $GtCO_2e$.

We have seen the absolute amount of South Africa's carbon allowance creep up. After Copenhagen, LTMS calculations were to be revised to cater for higher emissions from coal-fired electricity supply plans which had not been factored in before. While the "growth without constraints" trajectory was modelled as a worst-case scenario, it was increasingly seen as the baseline against which the Copenhagen commitment cuts were to be made.

One of the papers which informed the White Paper indicated that the "current proposed allowance (for 2010 – 2050) is in the region of 19 Gt CO2e." Some now argue that even "growth without constraints" is too low to be used as the "business as usual" trajectory, because reality has already diverged from its starting points. This is the risk with a "carbon budget" derived from cuts below a baseline – the absolute budget expands or shrinks as the baseline is moved up or down.

Adopted in November 2011, the White Paper defines a "benchmark national GHG emissions trajectory range" with upper and lower limits. This translates into total emissions over the 40 years from 2010 to 2050 of between 15 and 23 Gt CO_2e. The upper limit of the "trajectory range" allows for a national emissions peak of 614 Mt CO_2e, plateauing from 2025 and declining from 2035. The upper limit holds the risk that some interests will take the upper limit as the target, rather than aiming as close as possible to the original LTMS-aligned line.

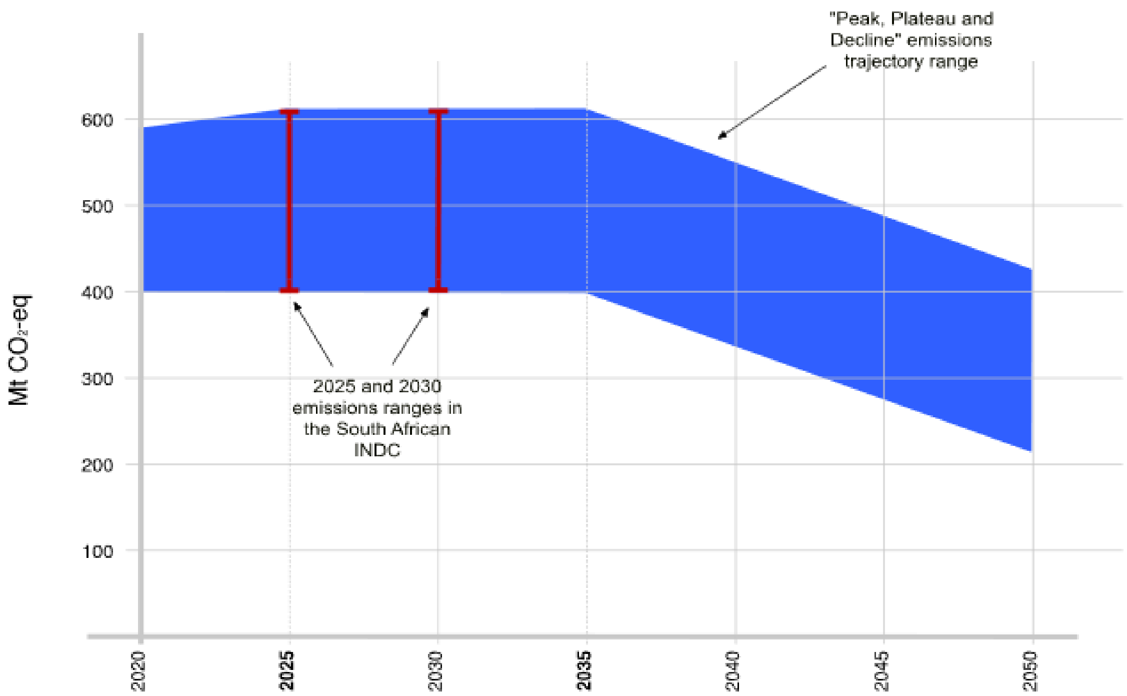

Figure 7: South Africa's GHG Emissions Trajectory Range.

WWF supports the White Paper for initiating real action to cut South Africa's emissions and recognising the overall framework of a carbon budget approach. However, WWF has some concerns regarding the "carbon budget" implied by the White Paper's emissions trajectory range:

- Emissions should not be allowed to exceed 550 Mt CO_2e at any time, which would happen if the upper range of the emissions trajectory is followed.
- Reduction in emissions in absolute terms should start from about 2025, rather than after 2035 as implied in the White Paper.

Delays in the date from which emissions begin to decline, makes later reductions both harder and more expensive to achieve. Furthermore, it will be more expensive to adapt to the ultimate impacts of climate change if these are more severe due to a low reduction effort. Work needs to be done to tighten up the very wide "benchmark range" into an indicative carbon budget the country is going to plan to remain within.

South Africa's First National Determined Contribution, 2020 Updated Draft's mitigation targets for 2021 – 2025 see annual GHG emission ranging from 398 to 510 Mt CO_2e. Updated mitigation targets for 2026 to 2030 will range from 398 to 440 Mt CO_2e.

For the climate change impact assessment South Africa's carbon budget was based on the upper annual GHG emission range of mitigation targets for 2021 – 2025, i.e. 510 Mt CO_2e.

3.4.3 Regional and Local Synopsis

Climate Baseline

Ehlanzeni District Municipality falls within the Lowveld Region of the Mpumalanga Province and has a subtropical climate strongly influenced by the proximity to the Indian Ocean.

In terms of temperature, there are a strong seasonality between the winter and summer months. The cooler winter months occur between May and August whilst the warmer summer months occur between December and February. Very moderate temperature variation occurs between winter and summer months.

The Nkomazi Local Municipality is located in the eastern part of Ehlanzeni District of Mpumalanga Province. The municipality is strategically positioned in a corner between Swaziland (north of Swaziland) and Mozambique (west of Mozambique). It is the smallest of the four municipalities in the district, making up 17% of its geographical area.

The Nkomazi Local Municipality's climate is subtropical with an average annual temperature of 28°C. The warmest month of the year is January with an average temperature of 26.2°C, while the lowest average temperatures in the year occur in June, around 18.4°C.

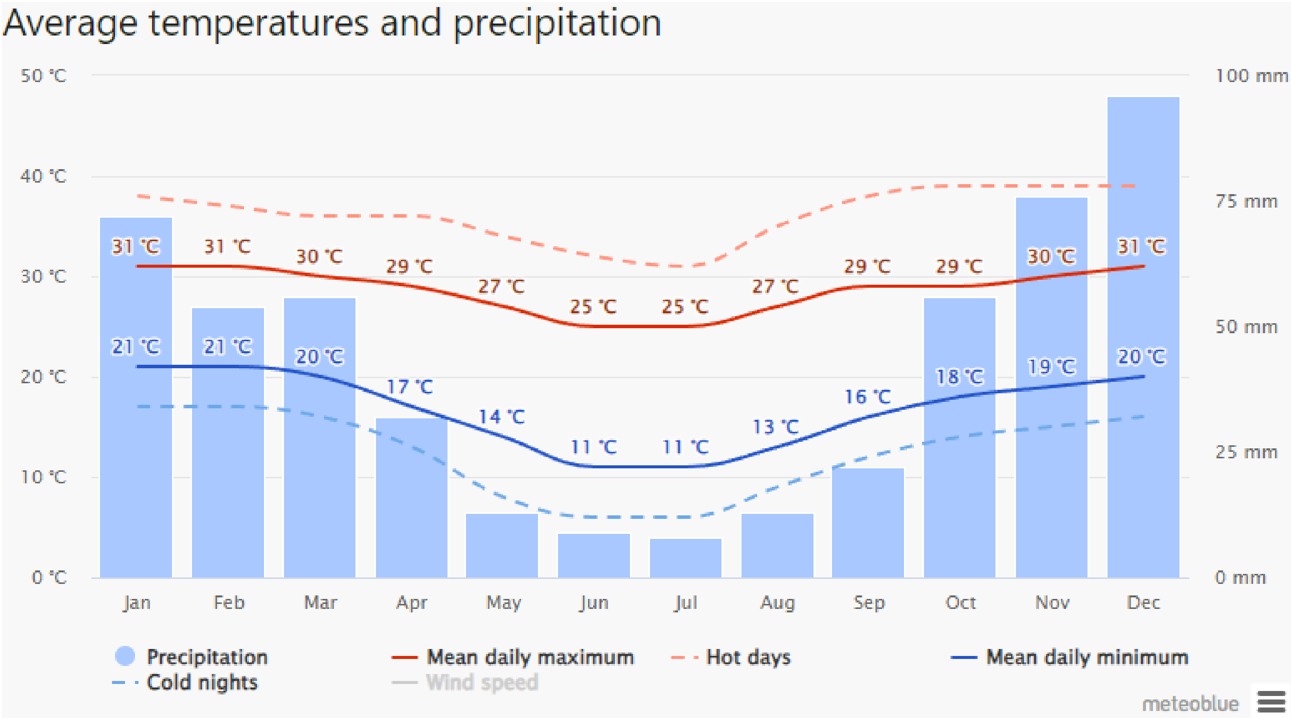

Figure 8: Malelane Average Temperature and Precipitation for the Period 1993 – 2023

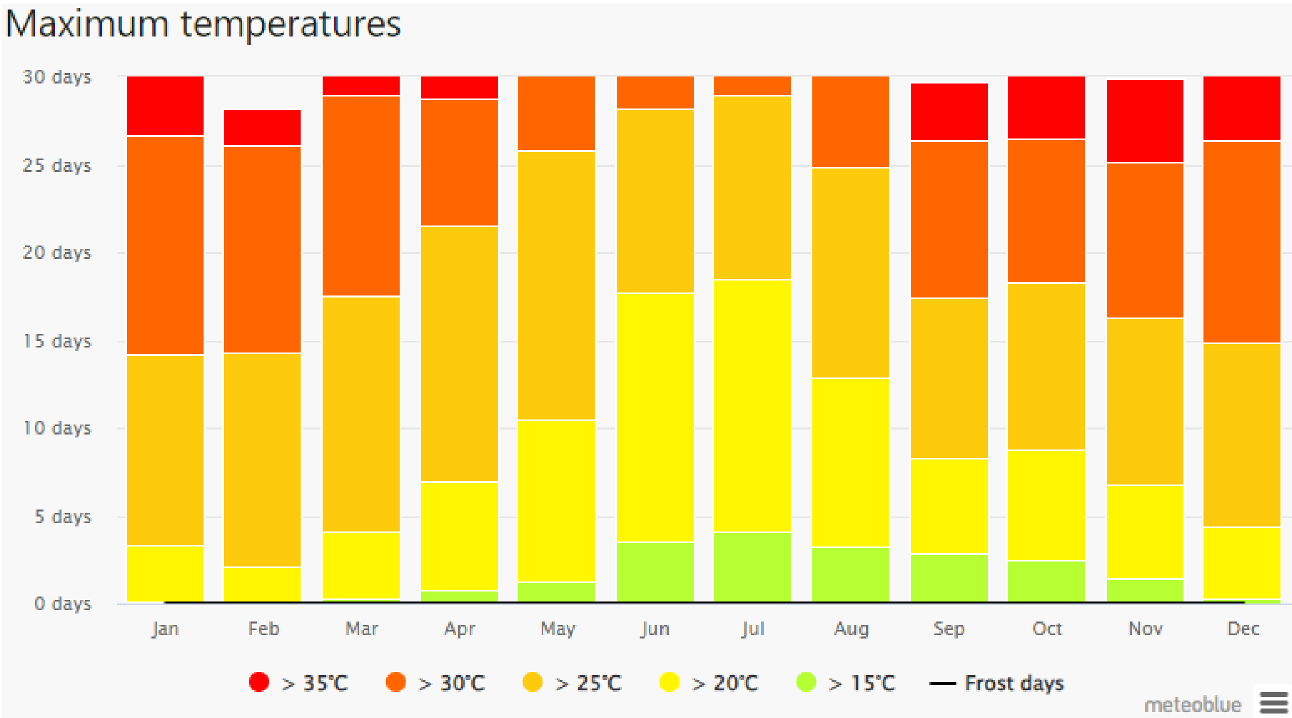

Figure 9: Malelane Maximum Temperatures 1993 – 2023

Ehlanzeni District Municipality is subject to subtropical summer rainfall. Rainfall is largely experienced from September to March with the highest amount of rainfall falling in the late summer months (December to February). The District also experiences summer thunderstorms as well as hailstorms, both of which are associated with periods of heavy flooding. Winter rainfall is rare.

The Nkomazi Local Municipality reports an average rainfall of 775 mm. The driest month is July, with the highest amount of rainfall received in January, with an average of 127 mm.

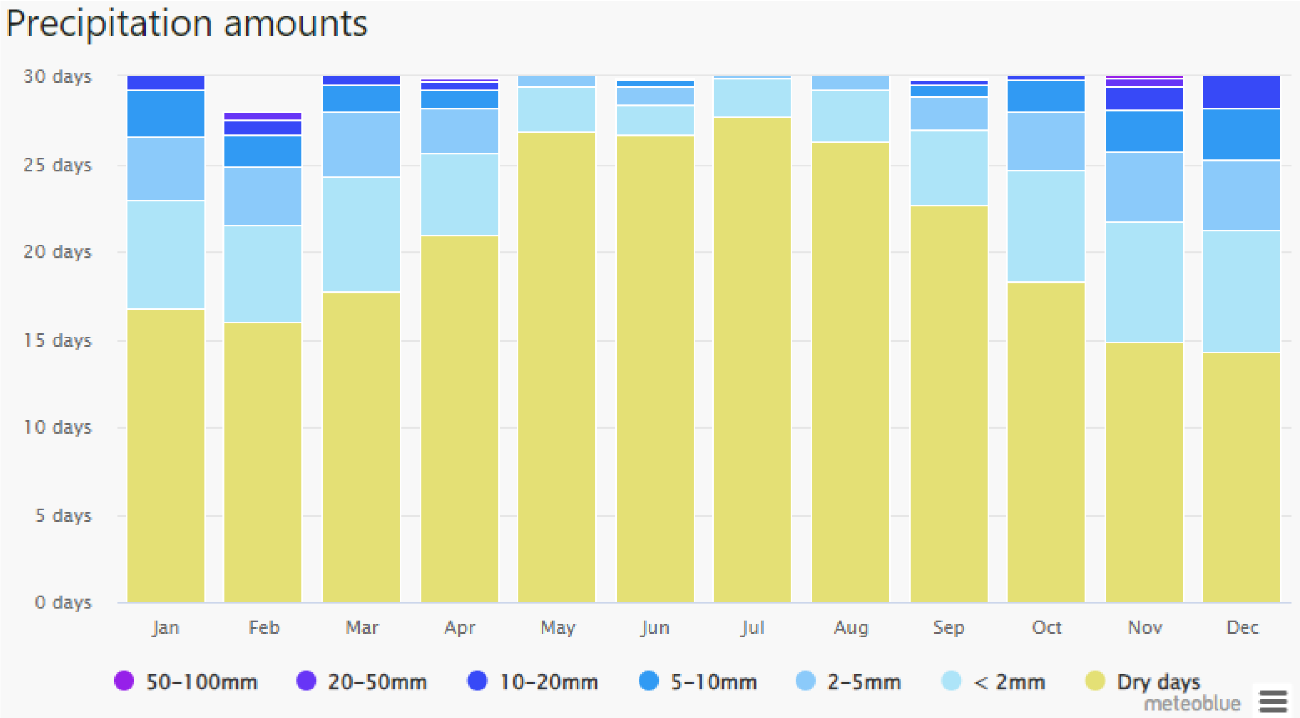

Figure 10: Malelane Average Monthly Rainfall for the Period 1993 – 2023

The predominant wind direction for Malelane is from the southeastern sector. Wind speeds of between 5 and 18 km/h are generally observed. The strongest winds of around 30 km/h usually blow in October. From August to October this wind sometimes swings to blow from the north; this is usually a hot dry wind. Occasionally cyclones do occur.

Wind roses comprise of 16 spokes which represents the direction from which the winds blew during the period under review. The colours reflect the different categories of wind speeds. The circles provide information regarding the frequency of occurrence of wind speed and direction categories. The value given in the centre of the circle describe the frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s.

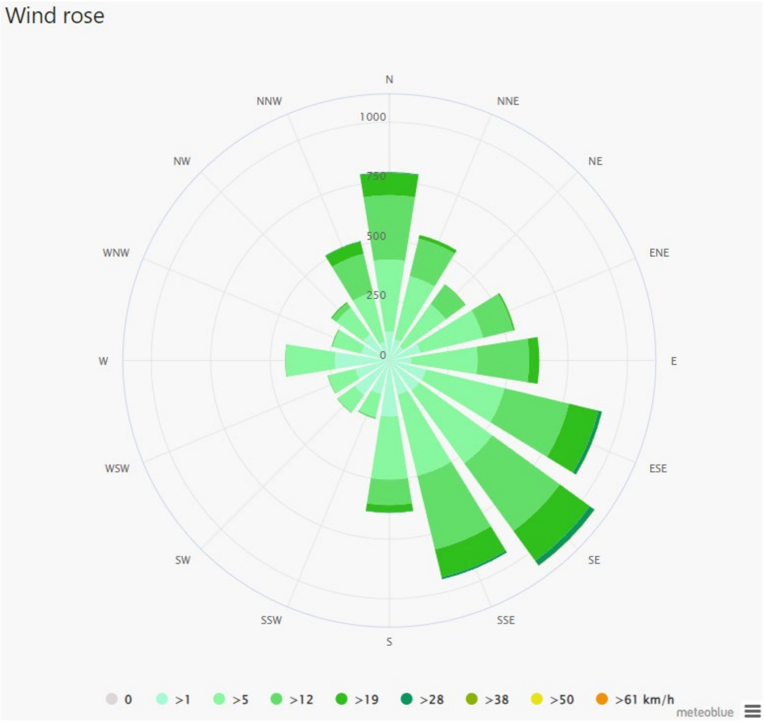

Figure 11: Malelane Wind Rose for the Period 1993 – 2023

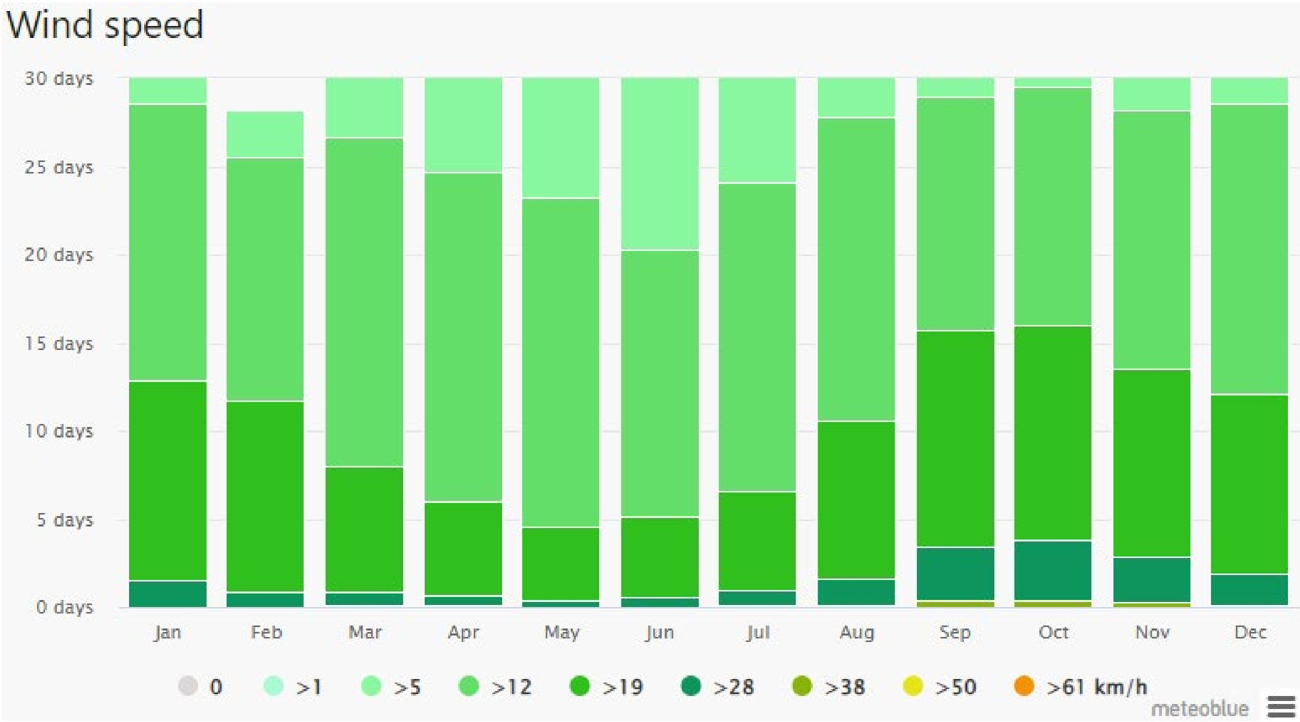

Figure 12: Malelane Average Wind Speed for the Period 1993 – 2023

Future Climate Scenarios

According to the DFFE's *South Africa's Third National Communication Under the United Nations Framework Convention on Climate Change* (2019), a lack of stations with sufficiently long homogeneous temperature records complicates the identification of temperature trends over Mpumalanga. It is plausible though that the trends are strong, given the drastic temperature increases recorded over Gauteng to the west, Limpopo to the north and KwaZulu-Natal to the south. There is no evidence of statistically significant trends in annual rainfall or extreme daily precipitation events, but there are indications of spatially coherent increases in rainfall over the Highveld areas in the west and decreases over the Lowveld areas in the east.

The DFFE' *South Africa's Third National Communication Under the United Nations Framework Convention on Climate Change* (2019), identified the following narratives for Mpumalanga:

Narrative 1: A Hot and Dry Future

Mpumalanga may plausibly experience a climate future that is significantly hotter and drier compared to the present-day climate. Under low mitigation, temperature increases as large as 2 °C by 2035 may occur, with associated drastic decreases in rainfall. Such a climate regime will also be associated with an increase in the frequency of occurrence of heat-wave days and high fire-danger days.

Narrative 2: A Warmer Future with Increased Rainfall

The main alternative narrative for Mpumalanga still implies significant increases in temperature, consistent with narrative 1. The main difference in this scenario is that rainfall totals increase under climate change, rather than to decrease. Such an increase may imply the more frequent occurrence of land-falling tropical lows over the Lowveld regions, with potentially significant impacts on tourism and infrastructure. Under such a scenario drought will not be such a major problem, but the increased occurrence of pests and pathogens may well pose an alternative set of challenges.

The Ehlanzeni District Municipality drafted a *Climate Change Vulnerability Assessment and Response Plan* (CCVRS) in 2016. The CCVRS noted the key potential climatic changes within the District as set out in **Table 7** below:

Table 7: Key Potential Climate Changes for the Ehlanzeni District Municipality.

Variable	Projected Change
Temperature	Average temperatures are expected to increase. Both maximum and minimum temperatures are expected to increase.
Rainfall	Average rainfall is projected to decrease.
Extreme Events	Increases in the frequency and intensity of extreme events are projected. This includes more severe storms and flooding, as well as more severe droughts.
Water Resources	As temperatures and evaporation increase, and rainfall decreases, already-scarce water resources will become further depleted. Existing problems of water quality will be further exacerbated by an increase in severe storms and flooding.

It was found that the foreseen impacts of climate change on the Ehlanzeni District Municipality are generally negative and are likely to impact on, amongst others, agriculture, biodiversity, human health, human settlements, water resources and quality within the District.

The Ehlanzeni District Municipality proposed five key objectives to address the impacts of climate change and reduce carbon emissions:

- Mitigation.
- Adaptation.
- Education and Capacity-Building.
- Climate Finance, Incentives and Taxation.
- Monitoring, Reporting and Verification.

3.5 CLIMATE CHANGE VULNERABILITY ASSESSMENT

3.5.1 Climate Risks

Power plants are likely to be affected by the impacts of climate change since they are often located in areas with heightened sensitivity to climate change (such as in coastal zones and on estuaries), operated over a long period (20 years or more), reliant on fuel supplies that could be disrupted and reliant on water as an integral part of generation.

Climate-related effects may result in new engineering challenges and increased capital costs for accessing and developing energy resources. It may also affect the reliability of transportation, logistics, and distribution channels. In addition to the direct effects of climate-induced volatility, companies will continue to experience increased political pressure, as well as rising consumer and investor expectations for emissions accountability and the exploration of renewable energy supply.

According to the Business for Social Responsibility's *Adapting to Climate Change: A Guide for the Energy and Utility Industry* (2011) changing climatic conditions will have both direct and indirect impacts on the energy industry:

Changing Access to Energy Fuel Supplies

Projected rises in sea level and more frequent and severe weather events, along with evolving consumer demands, may significantly affect access to energy sources. Increased resource shortages and scarcity can increase procurement costs.

Greater Demand for Energy Management Solutions

Temperature extremes and severe weather, partnered with a changing energy mix are leading consumers, utilities, and energy companies toward management solutions for a changing climate.

Changes in temperature can impact equipment operations, including above ground pipelines, heat exchange and cooling processes, leading to increased costs for equipment modifications. Temperature increase can lead to reduction in plant efficiencies and available generation capacity. The power output of natural gas-fired combustion turbines is estimated to decrease by approximately 0.6% – 0.7% for a 1°C increase in air temperature. Unpredictable weather and temperature changes may lead to a greater fluctuation in consumer demand for energy, increasing strain on the grid.

Water Availability

As global temperatures increase, levels of both freshwater and seawater will change, depending on location, affecting operations. Water supply shortage may constrain cooling operations. Increased competition for water supplies among sectors and communities can lead to higher costs, reduced availability and regulation of water permits.

Policy and Investor Pressure

The expectation of carbon-reducing climate change policies and in turn, investor concerns about companies' ability to effectively respond, puts significant pressure on companies to show how they are positioned to thrive in a low-carbon economy. Investors may seek companies with fewer risks related to fossil fuels and greater opportunities for renewable energy and technology development. Increased public scrutiny may lead to company reputational risk.

Workforce Safety and Security

Adverse weather conditions may lead to increases in health and safety risks, along with workplace security, including accessibility. As severity and frequency of storms increase, physical risks to employees may rise and accessibility to the workplace could be hindered. It may also affect the reliability of transportation, logistics, and distribution channels. Higher temperatures and deteriorating water quality may increase the spread of disease.

Table 8 summarises the potential climate risks identified based on the climate threats outlined in the **3.4.3 Regional and Local Synopsis – Future Climate Scenarios**.

Table 8: KFP Power Plant Potential Climate Risks

Variable	Potential Climate Risk
1. Increased temperature	1.1 Increased temperature and heatwaves can pose a health risk to employees. 1.2 Increased temperature and heatwaves can influence productivity. 1.3 Increased temperature and heatwaves can reduce plant efficiencies and available generation capacity. 1.4 Increase temperature and heatwaves can cause transmission line losses and extension of transmission line cables. 1.5 Wildfires may cause physical risks to employees. 1.6 Wildfires may damage infrastructure and facilities. 1.7 Increased temperature, heatwaves and wildfires may increase financial liability.
2. Reduced rainfall	2.1 Water scarcity and drought can constrain operations. 2.2 Water scarcity and drought can lead to water conflicts with communities. 2.3 Water scarcity and draught may further exacerbate water quality. 2.4 Water scarcity and drought may increase financial liability.
3. Extreme events	3.1 Floods, cyclones and storms may cause physical risks to employees. 3.2 Floods, cyclones and storms may affect water quality an increase the spread of disease. 3.3 Floods, cyclones and storms may cause discharge of contaminated water into surrounding areas. 3.4 Floods, cyclones and storms may cause damage to infrastructure and facilities. 3.5 Floods, cyclones and storms may cause reduced accessibility due to flooding of roads. 3.6 Lightning may cause a short circuit in transmission lines. 3.7 Floods, cyclones and storms may increase financial liability.
4. Wind impacts	4.1 High wind speeds and gusts may damage infrastructure. 4.2 High wind speeds and gusts may increase financial liability.

4. IMPACT ASSESSMENT

4.1 SIGNIFICANCE ANALYIS

4.1.1 Significance Analysis Approach

The assessment of impacts was largely based on the DEFF's *Sector Guidelines for Environmental Impact Assessment Regulations* (2010). The assessment considers impacts arising from the proposed project activities, both before and after the implementation of applicable mitigation measures.

For each predicted impact, criteria were applied to establish the significance of the impact based on the extent, duration, magnitude (intensity or severity) and probability of occurrence.

The magnitude of the impact was based on several reporting thresholds adopted by the IFC Standards, the European Bank for Reconstruction and Development's (EBRD) GHG assessment methodology and the Equator Principles (EP).

IFC Reporting Threshold

The IFC's *Performance Standard 3: Resource Efficiency and Pollution Prevention* (IFC, 2012) defines a reporting threshold for annual GHG emissions of 25 000 tCO_2e. The IFC requires clients to consider alternatives and implement technically and financially feasible and cost-effective options to reduce project related GHG emissions during the design and operation of the project.

EBRD Reporting Threshold

An annual GHG emissions threshold of 25 000 t CO_2e has been adopted by the EBRD within its *Environmental and Social Policy* (November 2014). The EBRD requires annual client quantification and reporting of these emissions.

EP Reporting Threshold

The EP require all projects, in all locations, to conduct an alternatives analysis to evaluate less GHG intensive alternatives when combined Scope 1 and Scope 2 operational emissions are expected to be more than 100 000 tCO_2e annually. In addition, the EP require that the client report combined Scope 1 and Scope 2 emissions, publicly on an annual basis, during the operational phase for projects emitting over 100 000 tCO_2e annually. It notes further that clients would be encouraged to report publicly on projects emitting over 25 000 t of CO_2e (EP, 2014).

Professional judgement was applied to ascribe a numerical rating for each criterion (see **Table 9**).

Table 9: Methodology for Determining the Significance of Potential Climate Change and Vulnerability Impacts

Status of Impact
The impacts are assessed as either having a: ▪ Negative effect (i.e. at a "cost" to the environment) ▪ Positive effect (i.e. a "benefit" to the environment) ▪ Neutral effect on the environment.
Extent of the Impact
(**1**) Site (site only) (**2**) Local (site boundary and immediate surrounds) (**3**) Regional (within the province or region) (**4**) National (**5**) International
Duration of the Impact
The length that the impact will last for: (**1**) Immediate (<1 year) (**2**) Short term (1-5 years) (**3**) Medium term (5-15 years) (**4**) Long term (ceases after the operational life span of the project) (**5**) Permanent
Magnitude of the Impact
The intensity or severity of the impact: (**0**) Negligible (emissions up to 5 000 tCO_2e annually) (**2**) Minor (emissions between 5 000 and 25 000 tCO_2e annually) (**4**) Low (emissions between 25 000 and 100 000 tCO_2e annually) (**6**) Moderate (emissions between 100 000 and 500 000 tCO_2e annually) (**8**) High (emissions between 500 000 and 1 000 000 tCO_2e annually) (**10**) Very high / Unsure (emissions greater than 1 000 000 tCO_2e annually)

Magnitude of the Impact – Vulnerability Assessment
The intensity or severity of the impact: (**0**) Negligible (**2**) Minor (**4**) Low (**6**) Moderate (**8**) High (**10**) Very high / Unsure
Probability of Occurrence
The likelihood of the impact occurring: (**0**) None (the impact will not occur) (**1**) Improbable (probability very low due to design or experience) (**2**) Low probability (unlikely to occur) (**3**) Medium probability (distinct probability that the impact will occur) (**4**) High probability (most likely to occur) (**5**) Definite.

To determine the significance of an impact the sum of the extent (**E**), duration (**D**) and magnitude (**M**) is determined and multiplied by the probability (**P**) of the impact.

$$S = (E+D+M) \times P$$

Depending on the numerical result, the impact's significance would be defined as either low, medium, or high. These categories are provided in **Table 10**.

Table 10: Application of Significance Ratings.

Range	Significance	Criteria
< 30	Low	Where the impact will not have a direct influence on the decision to develop in the area.
30 – 60	Medium	Where the impact could influence the decision to develop in the area unless it is effectively mitigated.
> 60	High	Where the impact will have an influence on the decision process to develop in the area.

4.1.2 Significance Analysis Assessment

Table 11 and **Table 12** include an assessment of the impact of GHG emissions from the construction operations and the KFP Power Plant operations on climate change. **Table 13** considers the construction operations and the KFP Power Plant's vulnerability to climate change.

Table 11: Climate Change Significance Analysis – KFP Power Plant Construction Operations

<table>
<tr><th rowspan="2">Issue</th><th rowspan="2">Corrective Measures</th><th colspan="5">Impact Rating Criteria</th><th rowspan="2">Significance</th></tr>
<tr><th>Nature</th><th>Extent</th><th>Duration</th><th>Magnitude</th><th>Probability</th></tr>
<tr><td colspan="8">The impact of GHG emissions from the construction operations was rated medium with or without mitigation measures.</td></tr>
<tr><td colspan="8">Construction Operations – GHG Emissions</td></tr>
<tr><td rowspan="2">KFP Power Plant Construction Operations.</td><td>No</td><td>Negative</td><td>5[1]</td><td>3[1]</td><td>0[2]</td><td>4</td><td>Medium 32</td></tr>
<tr><td>Yes</td><td>Negative</td><td>5[1]</td><td>3[1]</td><td>0[2]</td><td>4</td><td>Medium 32</td></tr>
<tr><td colspan="8">Notes
1 : Most greenhouse gases have atmospheric lifetimes greater than 2 years, much longer than tropospheric mixing times and hence their lifetimes are not significantly altered by the location of sources within the troposphere (TAR Climate Change 2001: The Scientific Basis, IPCC, 2001). Greenhouse gases transcend local, regional and continental boundaries.
2 : Estimate, GHG emission rates need to be calculated.</td></tr>
<tr><td colspan="8">Mitigation Measures</td></tr>
<tr><td colspan="8">Mitigation will not alter the impacts of GHG emissions in terms of the extent, duration, or probability of the impact. The magnitude of the impact can however be reduced, notably by reducing the quantity of GHG emissions.
Mitigation strategies include (see 5.1 Recommendations for detailed discussion):
▪ Optimising of construction activities and logistics – performing as efficient and effective as possible.
▪ Implementing a fuel management strategy, which encourages more efficient use of vehicles, planning, logistics, driver education and maintenance.</td></tr>
<tr><td colspan="8"></td></tr>
</table>

Table 12: Climate Change Significance Analysis – KFP Power Plant Operations

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
Calculated GHG emissions inventory for the KFP Power Plant amounts to 12.374% of South Africa's carbon budget (510 Mt CO_2e). The impact of GHG emissions from the operations was rated **High** with or without mitigation measures.							
KFP Power Plant – GHG Emissions							
KFP Power Plant Operations.	No	Negative	5[1]	5[1]	10[2]	5	High 100
	Yes	Negative	5[1]	5[1]	10[2]	5	High 100

Notes

1 : Most greenhouse gases have atmospheric lifetimes greater than 2 years, much longer than tropospheric mixing times and hence their lifetimes are not significantly altered by the location of sources within the troposphere (TAR Climate Change 2001: The Scientific Basis, IPCC, 2001). Greenhouse gases transcend local, regional and continental boundaries.

2 : Annual GHG emission rate of 2 524 378.66 tCO_2e. The magnitude of GHG emissions from the project is considered **Very High** (emissions greater than 1 000 000 tCO_2e).

Mitigation Measures

Mitigation will not alter the impacts of GHG emissions in terms of the extent, duration, or probability of the project impact. The magnitude of the impact can however be reduced, notably by reducing the quantity of GHG emissions.

Mitigation strategies include (see **5.1 Recommendations** for detailed discussion):

- Optimising energy utilisation efficiency.
- Utilising the cleanest fuel economically available.
- Selecting the best power generation and pollution control technology for the chosen fuel.
- Utilising high-performance monitoring and process control techniques, good design and maintenance of the combustion system.
- Developing and implementing of a GHG management plan.
- Developing and implementing a leak detection and repair program.

From the emissions inventory for the construction operations and the KFP Power Plant operations the following observations can be made:

- GHG emissions for the construction operations could not be determined due to a lack of data availability.
- KFP Power Plant's annual calculated GHG emissions inventory amounts to **2 524 378.66 tCO_2e** (2 524.37 Gg CO_2e). Scope 1 GHG emissions amounted to 2 523 732.74 tCO_2e (99.975%). Scope 2 GHG emissions were calculated at 541.75 tCO_2e (0.021%). Scope 3 GHG emissions totalled 104.18 tCO_2e (0.004%).
- KFP Power Plant's annual calculated GHG emissions inventory equites to **0.614%** of the Energy Sector emissions (410 685 Gg CO_2e).
- The total project life GHG emission rate was calculated at **63 109 407.78 tCO_2e** (63 109.40 Gg CO_2e).

From the climate change significance analysis for the construction operations and the KFP Power Plant operations the following observations can be made:

- The magnitude of GHG emissions from the construction operations was estimated to be negligible.
- Calculated GHG emissions inventory for the KFP Power Plant amounts to 12.374% of South Africa's carbon budget (510 Mt CO_2e). The magnitude of annual GHG emissions (2 524 378.66 tCO_2e) from the project is considered **Very High** (emissions greater than 1 000 000 tCO_2e).
- The impact of GHG emissions from the KFP Power Plant was rated **High** with or without mitigation measures.
- Mitigation will not alter the impacts of GHG emissions in terms of the extent, duration, or probability of the project impact. The magnitude of the impact can however be reduced, notably by reducing the quantity of GHG emissions.

Table 13: Climate Vulnerability Significance Analysis – Construction Operations and KFP Power Plant Operations

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
The impacts of increased temperature on operations were rated **Medium** without mitigation measures and **Medium** to **Low** with mitigation measures.							
Construction Operations and KFP Power Plant Operations – Increased Temperature							
Increased temperature and heatwaves can pose a health risk to employees.	No	Negative	2	4	6	3	Medium 36
	Yes	Negative	2	4	4	3	Medium 30
Mitigation Measures							
▪ Integrating the risk and management of heat related illnesses in the Occupational Health and Safety Plans. ▪ Educating staff to recognise early symptoms of heat stress.							
Increased temperature and heatwaves can influence productivity.	No	Negative	2	4	4	3	Medium 30
	Yes	Negative	2	4	2	3	Low 24
Mitigation Measures							
▪ Monitoring of temperature and humidity levels. ▪ Providing adequate cooling and ventilation. ▪ Introducing systems to limit exposure to heat.							

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
Increased temperature and heatwaves can reduce plant efficiencies and available generation capacity.	No	Negative	4	4	6	3	Medium 42
	Yes	Negative	4	4	4	3	Medium 36
Mitigation Measures							
▪ Monitoring of ambient temperature levels. ▪ Improving operations and infrastructure to enhance safety, reliability and performance of transmission and distribution systems.							
Increased temperature and heatwaves can cause transmission line losses and extension of transmission line cables.	No	Negative	4	4	6	3	Medium 42
	Yes	Negative	4	4	4	3	Medium 36
Mitigation Measures							
▪ Monitoring of ambient temperature levels. ▪ Improving operations and infrastructure to enhance safety, reliability and performance of transmission and distribution systems, including increasing line tension and adding coolers to transformers.							

<table>
<tr><th rowspan="2">Issue</th><th rowspan="2">Corrective Measures</th><th colspan="5">Impact Rating Criteria</th><th rowspan="2">Significance</th></tr>
<tr><th>Nature</th><th>Extent</th><th>Duration</th><th>Magnitude</th><th>Probability</th></tr>
<tr><td rowspan="2">Wildfires may cause physical risks to employees.</td><td>No</td><td>Negative</td><td>2</td><td>4</td><td>4</td><td>3</td><td>Medium 30</td></tr>
<tr><td>Yes</td><td>Negative</td><td>2</td><td>4</td><td>2</td><td>3</td><td>Low 24</td></tr>
<tr><td colspan="8">Mitigation Measures</td></tr>
<tr><td colspan="8">▪ Assessing the risk of wildfires in relation to infrastructure and facilities.
▪ Implementing adequate monitoring, fire detection and suppression systems.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td rowspan="2">Wildfires may damage infrastructure and facilities.</td><td>No</td><td>Negative</td><td>4</td><td>4</td><td>4</td><td>3</td><td>Medium 36</td></tr>
<tr><td>Yes</td><td>Negative</td><td>4</td><td>4</td><td>2</td><td>3</td><td>Medium 30</td></tr>
<tr><td colspan="8">Mitigation Measures</td></tr>
<tr><td colspan="8">▪ Assessing the risk of wildfires in relation to infrastructure and facilities.
▪ Implementing adequate monitoring, fire detection and suppression systems.</td></tr>
<tr><td colspan="8"></td></tr>
</table>

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
The impacts of reduced rainfall on operations were rated **Medium** without mitigation measures and **Medium** to **Low** with mitigation measures.							
Construction Operations and KFP Power Plant Operations – Reduced Rainfall							
Water scarcity and draught can constrain operations.	No	Negative	4	4	6	3	Medium 42
	Yes	Negative	4	4	4	3	Medium 36
Mitigation Measures							
▪ Conducting regular monitoring of operational water requirements and available resources. ▪ Developing a contingency response plan in the event of short, medium, or long-term water shortages. ▪ Developing a water policy as to manage and minimise water usage. Setting clear objectives and targets to improve efficiency.							
Water scarcity and draught can lead to water conflicts with communities.	No	Negative	3	4	4	3	Medium 33
	Yes	Negative	3	4	2	3	Low 27
Mitigation Measures							
▪ Conducting regular monitoring of operational water requirements and available resources. ▪ Developing a contingency response plan in the event of short, medium, or long-term water shortages. ▪ Developing a water policy as to manage and minimise water usage. Setting clear objectives and targets to improve efficiency. ▪ Considering community participation with regards to water infrastructure and management.							

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
Water scarcity and draught may further exacerbate water quality.	No	Negative	3	4	4	3	Medium 33
	Yes	Negative	3	4	2	3	Low 27

Mitigation Measures

- Conducting regular monitoring of operational water requirements and available resources.
- Developing a contingency response plan in the event of short, medium, or long-term water shortages.

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
The impacts of floods, cyclones and storms were rated **Medium** without and with mitigation measures.							
Construction Operations and KFP Power Plant Operations – Extreme Events							
Floods, cyclones and storms may cause physical risks to employees.	No	Negative	2	4	6	4	Medium 48
	Yes	Negative	2	4	4	4	Medium 40
Mitigation Measures							
▪ Integrating the risk related to floods and storms in the Occupational Health and Safety Plans.							
Floods, cyclones and storms may affect water quality and increase the spread of disease.	No	Negative	2	4	4	4	Medium 40
	Yes	Negative	2	4	2	4	Medium 32
Mitigation Measures							
▪ Integrating the possible effects of floods and storms on water quality and the possible spread of disease in the Occupational Health and Safety Plans.							
Floods, cyclones and storms may cause discharge of contaminated water into surrounding areas.	No	Negative	2	4	6	4	Medium 48
	Yes	Negative	2	4	4	4	Medium 40
Mitigation Measures							
▪ Conducting a site-specific risk assessment to identify areas vulnerable to flooding.							

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
Floods, cyclones and storms may cause damage to infrastructure and facilities.	No	Negative	4	4	6	4	Medium 56
	Yes	Negative	4	4	4	4	Medium 48
Mitigation Measures							
▪ Conducting a site-specific risk assessment to identify areas vulnerable to flooding and infrastructure vulnerable to cyclones and storms. ▪ Developing a contingency response plan should operations become inaccessible due to floods.							
Floods, cyclones and storms may cause reduced accessibility due to flooding of roads.	No	Negative	2	4	6	4	Medium 48
	Yes	Negative	2	4	4	4	Medium 40
Mitigation Measures							
▪ Conducting a site-specific risk assessment to identify areas vulnerable to flooding and infrastructure vulnerable to cyclones and storms. ▪ Developing a contingency response plan should operations become inaccessible due to floods.							
Lightning may cause damage a short circuit in transmission lines.	No	Negative	4	4	6	4	Medium 56
	Yes	Negative	4	4	4	4	Medium 48
Mitigation Measures							
▪ Increasing lightning protection of the site.							

Issue	Corrective Measures	Impact Rating Criteria					Significance
		Nature	Extent	Duration	Magnitude	Probability	
The impacts of high wind speeds and gusts were rated **Medium** without and with mitigation measures.							
Construction Operations and KFP Power Plant Operations – Wind Impact							
High wind speeds and gusts may damage infrastructure.	No	Negative	4	4	6	4	Medium 56
	Yes	Negative	4	4	4	4	Medium 48
Mitigation Measures							
▪ Conducting a site-specific risk assessment to identify areas vulnerable to high wind speeds and gusts.							

From the climate vulnerability assessment for the construction operations and KFP Power Plant the following observations can be made:

- Potential climate risks identified, based on the climate threat outline, include increased temperature, reduced rainfall, extreme events and wind impact.
- The identified climate risks will have a direct and indirect impact on the construction operations and KFP Power Plant operations.

From the climate vulnerability significance analysis for the construction operations and KFP Power Plant operations the following observations can be made:

- All potential climate risks have been assessed as **Medium** without mitigation measures and **Medium** to **Low** with mitigation measures.

4.2 DISCUSSION

The Energy Sector was the largest contributor to South Africa's total emissions in 2017, 410 685 Gg CO_2e, comprising 80.1% of total emissions. KFP Power Plant's annual calculated GHG emissions inventory (2 524.37 Gg CO_2e) equites to 0.614% of the Energy Sector emissions.

KFP Power Plant's electricity emissions intensity was calculated at 0.280 tCO_2e/MWh based on total calculated annual GHG emissions and total electricity output. Eskom's emissions intensity rating, as published in *South Africa's 2021 Grid Emission Factors Report* was 0.985 tCO_2e/MWh. By comparison KFP Power Plant's emissions intensity is significant less than the current grid emissions factor.

KFP Power Plant's total project life GHG emission rate (63 109 407.78 tCO_2e) amounts to 12.374% of South Africa's carbon budget (510 Mt CO_2e). The magnitude of GHG emissions (2 524 378.66 tCO_2e) from the project is considered Very High (emissions greater than 1 000 000 tCO2e), based on reporting thresholds adopted from international lender standards. The impact of GHG emissions from the operations was rated High with or without mitigation measures.

The global GHG inventory, according to the Global Carbon Budget 2023, is currently projected at 40.9 Gt CO_2e. Preliminary estimates based on data available suggest fossil CO_2 emissions will increase further in 2023 to reach 36.8 Gt CO_2e. Emissions from coal, oil, and gas in 2023 are all expected to be slightly higher (by 1.1 %, 1.5 %, and 0.5 %, respectively).

KFP Power Plant's GHG emissions will contribute to global energy related GHG emissions. Due to the global scope and prolonged time frames of GHG emissions, KFP Power Plant's GHG emissions will likely contribute to anthropogenic climate change. Climate change is likely to be accelerated and extended as GHG emissions accumulate in the atmosphere.

Power plants are likely to be affected by the impacts of climate change. Climate-related effects may result in new engineering challenges and increased capital costs for accessing and developing energy resources. It may also affect the reliability of transportation, logistics, and distribution channels. In addition to the direct effects of climate-induced volatility, companies will continue to experience increased political pressure, as well as rising consumer and investor expectations for emissions accountability and the exploration of renewable energy supply.

In response to these risks, companies are pursuing a range of adaptive practices to stay ahead of climate-related impacts. In some cases, these practices are intended to protect value of existing assets and systems. In others, practices are aimed more at creating value through innovation and meeting new needs that stem from climate change effects.

KFP should take a proactive approach to climate adaptation by considering the following key components:

- Customer engagement – engaging customers about energy use and identifying innovative ways to reduce GHG emissions.
- Policy formulation and incentives – companies providing sustainable energy sources and management tools stand to see long-term commercial benefits, improved reputation and an expanded customer base.
- Cross-sector collaboration for new technology – companies can work with other key sectors to identify new, mutually beneficial investments, including opportunities to develop GHG-reducing technology.
- Risk and innovation for climate readiness – companies should approach climate change management on two fronts. Investing in risk management that may include various weather instruments to help monitor change over time and developing innovative business models that address key sector needs.
- Expand community engagement to include climate change risks – companies should focus on community engagement. Community outreach and social investment activities offer venues for addressing climate change adaptation with peers and other industries.

5. EPILOGUE

5.1 RECOMMENDATIONS

Although mitigation will not alter the impacts of GHG emissions in terms of the extent, duration or probability of the impact, the intensity of the impact can be reduced, notably by reducing the quantity of GHG emissions. There are many ways to reduce GHG emissions from gas-to-power facilities, which include basic mitigation strategies to specific tactics and actions.

Some measures, such as choice of fuel and use of measures to increase energy conversion efficiency, will reduce emissions per unit of energy generation. Optimising energy utilisation efficiency of the generation process depends on a variety of factors, including the nature and quality of fuel, the generation cycle type chosen (e.g. reciprocating engine, single or combined cycle gas turbine, steam turbine), its configuration (e.g. electricity generation or co-or tri-generation of electricity, heating and cooling), the operating temperature of the combustion turbines, the operating pressure and temperature of steam turbines, the local climatic conditions, the type of cooling system used and potential for nearby heat users.

The IFC and Work Bank Group *Environmental, Health and Safety Guidelines for Thermal Power Plant* (2017), recommended measures to prevent, minimise, and control emissions include:

- Use of the cleanest fuel economically available (for example natural gas is preferable to oil, which is preferable to coal). For most large power plants, fuel choice is often part of the national energy policy, and fuels, combustion technology and pollution control technology, which are all interrelated, should be evaluated very carefully upstream of the project to optimise the project's environmental performance.
- Selection of the best power generation and pollution control technologies for the fuel chosen to balance the environmental and economic benefits. Some examples include the use of higher energy-efficiency systems, such as combined cycle gas turbine system for natural gas.
- Designing stack heights and configurations according to Good International Industry Practice (GIIP) to avoid excessive ground level concentrations and minimise impacts.
- Considering use of combined heat and power (CHP, or co-generation) facilities. By combining useful heat output with power production, CHP facilities can achieve thermal efficiencies of 70 – 90%, compared with the 30 – 60% electrical efficiencies available from thermal power-only plants, which can contribute to primary energy savings.
- Other elements of the plant can also affect efficiency such as steam cycle parameters (e.g., pressure and temperature) for power plants based on the steam cycle, cooling and abatement technologies, electrical efficiency (e.g., electrical motors for fans and pumps), energy conversion efficiency and energy conservation.
- Use of high-performance monitoring and process control techniques, good design and maintenance of the combustion system so that initially designed efficiency and GHG emission performance can be maintained.
- Where feasible, include transmission and distribution loss reduction and demand side measures. For example, an investment in peak load management could reduce cycling requirements of the generation facility thereby improving its operating efficiency. The feasibility of these types of off-set options may vary depending on whether the facility is part of a vertically integrated utility or an independent power producer.

- Consider fuel cycle emissions and off-site factors such as fuel supply, proximity to load centres, potential for off-site use of waste heat.
- Developing and implementing of a GHG management plan.
- Developing and implementing a leak detection and repair program.

In the context of climate change, mitigation of risks associated with climate related impacts is referred to as "adaptation". Climate adaptation can be described as the implementation of actions to increase resilience towards climate related changes and impacts. Adaptation measures can include "hard" and "soft" measures.

Hard adaptation measures are measures incorporated into the design, including engineering measures. These measures are often more capital-intensive that soft adaptation measures. Soft adaptation measures are measures incorporated into operational processes. Soft adaptation measures often offer more flexibility in terms of responding to climate change impacts that hard adaptation measures.

A key concept to climate change adaptation is "adaptive management", the process whereby climate related risks are continually monitored, measurements implemented, tailored and revised in relation to climate change.

Risk mitigation measures for the identified climate risks are summarised in **Table 14** below.

Table 14: KFP Power Plant – Climate Change Risk Mitigation Measures

Potential Climate Risk	Risk Mitigation / Adaptation Measures
1. Increased temperature, heatwaves and wildfires	The risk and management of heat related illnesses should be integrated in the Occupational Health and Safety Plans. Measures may include monitoring of temperature and humidity levels, providing of adequate cooling and ventilation, introducing systems to limit exposure to heat and educating staff to recognise early symptoms of heat stress. Operational and infrastructure improvements should be implemented to enhance safety, reliability and performance of transmission and distribution systems. Safety, reliability and performance of transmission and distribution systems can be improved by increasing line tension and adding coolers to transformers. The risk of wildfires in relation to infrastructure and facilities should be assessed. Adequate monitoring, fire detection and suppression systems should be implemented.
2. Water scarcity and drought	Regular monitoring of operational water requirements and available resources should be conducted. A contingency response plan should be developed in the event of short, medium, or long-term water shortages. A water policy should be developed as to manage and minimise water usage, setting clear objectives and targets to improve efficiency. Regular monitoring of water quality should be implemented. A contingency response plan should be developed in the event that water quality deteriorates. Measure may include additional water treatment infrastructure development. A contingency response plan should be developed for dust suppression in the event of dry spells and periods of elevated dust generation. Community participation should be considered with regards to water infrastructure and management.

Potential Climate Risk	Risk Mitigation / Adaptation Measures
3. Floods, cyclones and storms	The possible risk related to floods, cyclones and storms and the effects of floods, cyclones and storms on water quality and the possible spread of disease should be integrated in the Occupational Health and Safety Plans. A site-specific risk assessment should be conducted to identify areas vulnerable to flooding and infrastructure vulnerable to cyclones and storms. A contingency response plan should be developed should operations become inaccessibility due to floods. The improved design of insulators, careful siting and enhanced maintenance can mitigate vulnerability to flashover faults across high voltage insulators and short circuits in high voltage circuit breakers caused by heavy rain. Adequate lightning protections should be installed to prevent damage to infrastructure. Transmission towers' vulnerability to lightning strikes can be reduced by adding earth wire above live conductors and to substations and fitting spark gaps and surge arresters.
4. High wind speeds and gusts	A site-specific risk assessment should be conducted to identify areas vulnerable to high wind speeds and gusts. Adaptation options for transmission lines may include designing transmission structures to withstand the highest projected wind loadings, more frequent inspections and maintenance.

5.2 KEY FINDINGS

The climate change impact assessment concludes the following:

- The project falls within the Nkomazi Local Municipality and the Ehlanzeni District Municipality of the Mpumalanga Province. The Mpumalanga Climate Change Adaptation Strategy Report and the Ehlanzeni District Municipality's Climate Change Vulnerability Assessment and Response Plan have been developed.
- Construction operations will most probably include emissions from mobile and stationary combustion of diesel for construction operations. GHG emissions for the construction operations could not be determined due to a lack of data availability.
- KFP Power Plant's GHG emissions include Scope 1, Scope 2 and Scope 3 emissions. Scope 1 emissions include emissions from stationary combustion of natural gas and diesel. Scope 2 emissions consist of emissions from purchased electricity. Scope 3 include emissions from mobile diesel combustion contracted to third party suppliers.
- KFP Power Plant's annual calculated GHG emissions inventory amounts to **2 524 378.66 tCO_2e**. (2 524.37 Gg CO_2e) Scope 1 GHG emissions amounted to 2 523 732.74 tCO_2e (99.975%). Scope 2 GHG emissions were calculated at 541.75 tCO_2e (0.021%). Scope 3 GHG emissions totalled 104.18 tCO_2e (0.004%).
- KFP Power Plant's annual calculated GHG emissions inventory equites to **0.614%** of the Energy Sector emissions (410 685 Gg CO_2e).
- The total project life GHG emission rate was calculated at **63 109 407.78 tCO_2e** (63 109.40 Gg CO_2e).
- KFP Power Plant's total project life GHG emission rate amounts to **13.374%** of South Africa's carbon budget (510 Mt CO_2e).
- The facility's electricity emissions intensity was calculated at **0.280 tCO_2e/MWh**. By comparison, the power plant's emissions intensity is significant less than Eskom's current grid emissions factor of **0.985 tCO_2e/MWh**.
- The magnitude of the impact of GHG emissions from the construction operations were estimated to be negligible.

- The magnitude of GHG emissions from the KFP Power Plant's operations (2 524 378.66 tCO_2e) is considered **Very High**, as GHG emissions are greater than 1 000 000 tCO_2e annually.
- The impact of GHG emissions from the KFP Power Plant was rated **High** with or without mitigation measures.
- The project's GHG emissions will contribute to the local Energy Sector and to the global energy related GHG emissions.
- The project's GHG emissions will likely contribute to anthropogenic climate change. Climate change is likely to be accelerated and extended as GHG emissions accumulate in the atmosphere.
- Potential climate risks identified, based on the climate threat outline, include increased temperature, reduced rainfall, extreme events and wind impacts.
- The identified climate risks will have a direct and indirect impact on construction operations and KFP Power Plant's operations.
- All potential climate risks have been assessed as **Medium** without and **Medium** to **Low** with mitigation measures.
- Although mitigation will not alter the impacts of GHG emissions in terms of the extent, duration or probability of the impact, the intensity of the impact can be reduced, notably by reducing the quantity of GHG emissions.
- Basic mitigation strategies and specific tactics and actions have been outlined to reduce GHG emissions from the power generation activities.
- Risk mitigation / adaptation measures have been proposed for the identified climate risks.

5.3 ABBREVIATIONS

AFOLU	:	Agriculture, Forestry and Other Land Use
AQIS	:	Air quality impact study
AQMP	:	Air quality management plan
°C	:	Degree Celsius
CH_4	:	Methane
CO	:	Carbon monoxide
CO_2	:	Carbon dioxide
CO_2e	:	Carbon Dioxide Equivalent
DEFF	:	Department of Environment, Forestry and Fisheries
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan
GHG	:	Greenhouse Gas
GIZ	:	Deutsche Gesellschaft für Internationale Zusammenarbeit
HAPs	:	Hazardous air pollutants
IDP	:	Integrated Development Plan
IPCC	:	Intergovernmental Panel on Climate Change
kg	:	Kilogram
kg/l	:	Kilogram per litre
km	:	Kilometre
km/h	:	Kilometre per hour
LNG	:	Liquid Natural Gas
LPG	:	Liquid Petroleum Gas

LTAD	:	Long Term Adaptation Scenarios
m^3	:	Cubic metre
mg	:	Milligrams
$mg/m^2/day$	:	Milligrams per square metre per day
mm	:	Millimetres
MW(th)	:	Megawatt (thermal)
Nm^3/h	:	Normal cubic metres per hour
m/s	:	Meters per second
NAAQS	:	National Ambient Air Quality Standards
NCCAS	:	National Climate Change Adaptation Strategy
NCCRP	:	National Climate Change Response Policy
NEMAQA	:	National Environmental Management: Air Quality Act (Act no. 39 of 2004)
NO	:	Nitrogen oxide
NO_2	:	Nitrogen dioxide
N_2O	:	Nitrous oxide
NO_x	:	Oxides of nitrogen
NPI	:	National Pollutant Inventory
O_3	:	Ozone
Pb	:	Lead
$PM_{2.5}$	:	Inhalable particulate matter with a mean aerodynamic diameter less than 2.5 micrometre
PM_{10}	:	Inhalable particulate matter with a mean aerodynamic diameter less than 10 micrometre
SANS	:	South African National Standards
SAWS	:	South African Weather Service

SO_2	:	Sulphur dioxide
SF_6	:	Sulphur hexafluoride
tCO_2e	:	Tonnes of Carbon Dioxide Equivalent
t/h	:	Tonnes per hour
TJ/tonne	:	Terajoule per tonne
TSP	:	Total Suspended Particulates
UNFCCC	:	The United Nations Framework Convention on Climate Change
USEPA	:	United States Environmental Protection Agency
VOCs	:	Volatile organic compounds
WHO	:	World Health Organisation

5.4 GLOSSARY

Act means the National Environmental Management: Air Quality Act, 2004 (Act No.39 of 2004).

Adaptation is the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Atmospheric emission or **emission** means any emission or entrainment process emanating from a point, non-point or mobile source that results in air pollution.

Biomass means non fossilised and biodegradable organic material originating from plants, animals and micro-organisms excluding (a) sewage; and (b) treated or coated wood waste which may contain halogenated organic compounds or heavy metals.

Boundaries the inventory boundaries determine which emissions are accounted for and reported. Boundaries include organisational and operational.

Climate change refers to a change in the state of the climate that can be identified (i.e. by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use.

CO_2e carbon dioxide equivalent – standardisation of all measured greenhouse gases to reflect their warming equivalent to carbon dioxide (CO_2). This is used to report different greenhouse gases against a common basis.

Direct emissions greenhouse gas emissions from facilities or sources owned or controlled by the reporting company.

Design capacity means capacity as installed.

Dust means solid materials suspended in the atmosphere in the form of small irregular particles, many of which are microscopic in size.

Emission means pollution discharged into the atmosphere from a range of stationary and mobile sources. These include smokestacks, vents and surface areas of commercial or industrial facilities; residential sources; motor vehicles and other transport related sources.

Emission control technology means technology that aims to reduce emissions into the atmosphere.

Emission inventory means a listing or register of the amount of pollution entering the atmosphere from all sources within a given time and geographic boundaries.

Emission factor means a representative value, relating the quantity of a pollutant to a specific activity resulting in the release of the pollutant to atmosphere.

Emission rate means the rate at which a pollutant is emitted from a source of pollution.

Emission reduction strategy means an intervention designed to reduce emissions into the atmosphere.

Environment means the surroundings within which humans exist and that are made up of the land, water and atmosphere of the earth; micro-organisms, plant and animal life and the interrelationships among and between them; and the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.

Environmental management systems mean a part of the management system of an organisation in which specific competencies, behaviours, procedures and demands for the implementation of an environment policy are defined.

Fugitive emissions mean emissions that are released into the atmosphere by any other means than through an intentional release through stack or vent including extraction, processing, delivery and burning for energy production of fossil fuels, including leaks from industrial plant and pipelines.

Greenhouse gas means gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation, and includes carbon dioxide, methane and nitrous oxide.

GHG inventory a listing of the greenhouse gas emission sources that are attributable to a company.

Mitigation is a human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Mobile source means a single identifiable source of atmospheric emission which does not emanate from a fixed location.

Monitoring means periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.

Operational boundary the boundary to establish the operations and sources of emissions included in the greenhouse gas inventory.

Ozone-depleting substance means a substance having chemical or physical properties which, by its release into the atmosphere, can cause a depletion of the stratospheric ozone layer.

Oxides of nitrogen (NO_X) means the sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide (NO_2)

Particulate matter (PM) means total particulate matter, that is the solid matter contained in the gas stream in the solid state as well as the insoluble and soluble solid matter contained in entrained droplets in the gas stream. The collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface and includes dust, smoke, soot, pollen and soil particles.

Precipitation means ice particles or water droplets large enough to fall at least 100 m below the cloud base before evaporating.

Resilience is the ability of a social, economic, or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self- organisation and the capacity to adapt to stress and change.

Scope 1 emission is direct emission from company-owned or controlled assets.

Scope 2 emission is indirect emission from the consumption of purchased electricity.

Vulnerability is the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

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