Climate Change Risk Assessment for the Karreebosch Wind Energy Facility, Northern & Western Cape Provinces

DRAFT REPORT

Karreebosch Wind Farm (RF) (Pty) Ltd

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Executive Summary

Introduction

SLR Consulting (South Africa) Proprietary Limited (hereinafter referred to as SLR) has been appointed by Karreebosch Wind Farm (RF) (Pty) Ltd to undertake a climate change risk assessment (CCRA) for the Karreebosch Wind Energy Facility in the Northern and Western Cape provinces of South Africa (hereinafter referred to as the "Project").

In accordance with the requirements of the Equator Principles 4 (EP4), this CCRA has assessed:

1. The impact of climate change on the Project.
2. The Project's greenhouse gas ("GHG") emissions.

In addition, the CCRA also considers:

- The potential impact of the Project on communities and the provision of priority ecosystems services that may be already adversely affected by climate change.
- The impact of the Project on sites of demonstrated importance to climate change mitigation and adaptation.

2. Legal and Policy Framework

The Project is being developed within the context of several South African climate-related statutes, policies, and plans (e.g., Nationally Determined Contribution, National Climate Change Adaptation Strategy, Low-Emission Development Strategy 2050, and so on), as well as international treaties, standards, and guidelines (e.g., Equator Principles and International Finance Corporation's Performance Standards on Environmental and Social Sustainability, and so on).

3. Project Description

The Applicant is proposing to develop a wind energy facility, near the towns of Matjiesfontein (40 km south) and Sutherland (40 km north) in the Northern and Western Cape provinces of South Africa. The total installed capacity is approximately 149.9 MW, resulting in an estimated annual yield of 497.90 GWh. The Project includes wind turbines, cables, onsite substation, overhead transmission line and connection, access road, and internal roads.

3. Methodology

The identification of climate-related risks was based on a desktop review of information sourced from the World Bank Group, Intergovernmental Panel on Climate Change, and published journal articles. The climate-related risks were assessed in terms of impact and likelihood.

The Project's GHG emissions were quantified in accordance with international guidelines and standards, including the Greenhouse Gas Protocol. This included the GHG emissions for the construction and operational phases. The Project's GHG emissions are assessed in terms of three criteria:

- A comparison of technology alternatives.
- The contribution to South Africa's modelled domestic pathways.
- Benchmarking against pre-defined thresholds.

4. Description of the Affected Environment

The Central Karoo and Namakwa District Municipalities, in which the Project is proposed to be located, face several climate hazards which could negatively impact the Project. Wildfire

has been assigned a high hazard rating, while extreme heat has been assigned a medium hazard rating. The risk of cyclones and river floods have both been assigned very low hazard ratings.

For the Northern Cape province, average mean surface air temperature is projected to increase by an average of 4.1% to 4.9%, relative to average for the respective baseline period (1950 – 2014).The average maximum surface air temperature is projected to increase by an average of 3.4% to 3.9%, relative to average for the respective baseline period Similarly, the number of very hot days, with temperatures greater than 35°C, is projected to increase by an average of 54% to 60.7%, relative to maximum number of very hot days for the baseline period. Precipitation is projected to decrease by an average of 2.4% to 4.3%, relative to the average for the respective baseline period. The largest 1-day cumulative precipitation event is projected to decrease by 0.2% to 0.6% relative to largest 1-day rainfall for the baseline period.

For the Western Cape province, average mean surface air temperature is projected to increase by an average of 3.5% to 4.2%, relative to average for the respective baseline period. The average maximum surface air temperature is projected to increase by an average of 2.7% to 3.3%, relative to average for the respective baseline period. Similarly, the number of very hot days, with temperatures greater than 35°C, is projected to increase by an average of 48.1% to 57.3%, relative to maximum number of very hot days for the baseline period. Precipitation is projected to decrease by an average of 2.9% to 3%, relative to the average for the respective baseline period. The largest 1-day cumulative precipitation event is projected to either increase by 2.0% or decrease by 0.0% relative to largest 1-day rainfall for the baseline period.

The site layout is predominantly classified as land of ‘low agricultural sensitivity’, historically utilised for grazing with limited crops and pastures. The final amendment of the site avoids any land rated as more than ‘medium sensitivity’. Additionally, the site layout results in the limited transformation and negligible cumulative loss of natural habitat. Consequently, the climate-related risks for Project-affected communities, priority ecosystem services, and sites of demonstrated importance to climate change adaptation are deemed to be negligible.

5. Risk and Opportunity Assessment

The table below presents a summary of the Project’s climate-related risks and opportunities, as well as the outcomes of the assessment.

Category	Impact Description	Risk or impact
Climate-related risks for the Project		
Physical, acute impact	Increased risk of wildfires adversely affecting critical project infrastructure, potentially leading to increased capital costs, reduced generating capacity, and revenue losses.	Low
Physical, acute impact	Increased risk of extreme heat adversely affecting the health of employees.	Low
Transition, policy and legal risk	Increased risk of more stringent climate policies and legislation which could lead to higher operational costs.	Low
Transition, policy and legal risk	Increased risk of more stringent waste policies and legislation.	Low
Assessment of the Project’s GHG emissions		
Comparison of technology alternatives	As the lifecycle GHG emissions of the preferred technology are lower than that of feasible technology alternatives, the	Positive (+)

Category	Impact Description	Risk or impact
	impact of the Project's GHG emissions from an alternatives analysis perspective, is deemed to be Positive.	
Contribution to South Africa's modelled domestic pathways	The calculated contribution of the Project's GHG emissions to the country's four modelled pathways ranges between 0.0002% (Highly Insufficient pathway) and 0.0028% (1.5°C Paris Agreement Compatible pathway).	Not formally assessed.
Benchmark against pre-defined thresholds	During the operational phase, the Project's annual GHG emissions were benchmarked against the European Bank of Reconstruction and Development's (EBRD) thresholds and it was found that they would be classified as **Low**.	Low

6. Recommended Mitigation Measures

The recommended mitigation measures are listed below.

- Climate-related risks and opportunities:
    - A comprehensive employee health awareness program must be designed and implemented to inform both employees and contractors about the hazards associated with heat stroke and dehydration, as well as effective strategies for prevention and mitigation.
    - Employees should be provided with appropriate personal protective equipment to reduce sun exposure and risk of heat stroke/ dehydration.
    - On very hot days (i.e., >30°C), work should be undertaken in accordance with the thermal requirements of the Occupation Health and Safety Act 85 of 1993 (as amended). Additional mitigation measures include:
        - Rescheduling hard manual labour to cooler parts of the day.
        - Providing more frequent rest breaks.
        - Providing shaded rest areas.
    - An assessment of the best practicable environmental option for the end-of-life blades must be undertaken. This plan must be reviewed and updated at least every five years. During the review, it is essential to re-evaluate the 'best practicable environmental option' by considering new and emerging waste technologies and processes.
- Impact of the Project's GHG emissions:
    - Diesel generators should be sized appropriately so that they run at their optimal workload (e.g., 70% to 100% of total load rating).
    - Diesel generators should be regularly maintained in accordance with the manufacturers service schedule.
    - Construction materials should be sourced as close to the work front as possible to reduce transport distances and GHG emissions.
    - For the transport of materials and equipment, the vehicle load should be maximised to increase fuel efficiency and reduce emissions.
    - Truck drivers should receive training on good driving practices to improve fuel economy and reduce carbon emissions.

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Acronyms and Abbreviations

Acronym	Definition
CAT	Climate Action Tracker
CCKP	Climate Change Knowledge Portal
CCRA	Climate change risk assessment
CMIP6	Coupled Model Inter-Comparison Project No. 6
CSP	Concentrating solar power
CV	Curriculum Vitae
DFFE	Department of Forestry, Fisheries, and the Environment
EBRD	European Bank of Reconstruction and Development
EF	Emission Factor
EIA	Environmental impact assessment
EHS	Environmental, Health, and Safety
EMPr	Environmental management programme
EP4	Equator Principles: EP4
gCO_2e/kWh	Grammes of carbon dioxide equivalent per kilowatt-hour
GHG	Greenhouse gas
GIIP	Good international industry practice
Guidance Note	Guidance Note on Climate Change Risk Assessment
HSE	Health, Safety, and Environment
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
IRP 2019	Integrated Resource Plan 2019
ISO	International Organisation for Standardisation
Karreebosch	Karreebosch Wind Farm (RF) (Pty) Ltd
MWh	Megawatt hours
NDC	Nationally Determined Contribution
PV	Photovoltaic
PPE	Personal Protective Equipment
RCP	Representative Concentration Pathway
SA-LEDS	South Africa’s Low-Emission Development Strategy 2050
SCC	Species of Conservation Concern
SLR	SLR Consulting (South Africa) Proprietary Limited

SSPs	Shared Socio-economic Pathways
TCDF	Task Force on Climate-related Financial Disclosures
tCO_2e	Tonnes of carbon dioxide equivalent
UNFCCC	United Nations Framework Convention on Climate Change
WEF	Wind Energy Facility

1. Introduction

SLR Consulting (South Africa) Proprietary Limited (hereinafter referred to as "SLR") has been appointed by Karreebosch Wind Farm (RF) (Pty) Ltd (hereinafter referred to as "Karreebosch") to undertake a climate change risk assessment (CCRA) for the Karreebosch Energy Facility (WEF) Project, located between the towns of Matjiesfontein and Sutherland, spanning the Northern and Western Cape Provinces, South Africa (hereafter referred to as the "Project").

2. Scope and Purpose

The following section sets out the scope and purpose of this CCRA.

In accordance with the requirements of the Equator Principles (EP4)[1], this CCRA has assessed:

1. The climate-related risks for the Project.
2. The Project's greenhouse gas (GHG) emissions.

In addition, the CCRA also considers:

- The potential impact of the Project on communities and the provision of priority ecosystems services that may be already adversely affected by climate change.
- The impact of the Project on sites of demonstrated importance to climate change mitigation and adaptation.

The scope of this assessment was as follows:

- Desktop review of the applicable South African legislation, policies, and plans, and relevant international guidelines, standards, and treaties (**Section 3**).
- Overview of the Project's main activities, components, timelines, and layout (**Section 4**).
- Summary of the approach and methods used in conducting the CCRA (**Section 5.0**).
- Desktop review of the latest climate data to determine the observed and projected changes in climate (**Section 6**).
- Quantification the Project's direct (scope 1) and indirect (scope 2) GHG emissions for the construction and operation phases (**Section 7**).
- Assessment of the Project's GHG emissions in terms of (i) a comparison of technology alternatives, (ii) the contribution to South Africa's modelled domestic pathways, and (iii) pre-defined thresholds (**Section 8**).
- Qualitative assessment of the physical (i.e., related to physical impacts of climate change) and transitional risks (i.e., impacts related to the transition to a lower-carbon economy) to the Project, as well as the opportunities that may arise from the transition to a lower carbon economy. The risks to Project-affected communities, priority ecosystem services, and sites of demonstrated importance to climate mitigation and adaptation, if relevant, is also be assessed (**Section 9**).

[1] Equator Principles Association (2020). *Equator Principles: EP4: July 2020*. URL: https://equator-principles.com [accessed on 23 April 2025].

- Identification of appropriate, high-level measures to mitigate any identified climate-related risks and the Project's GHG emissions (**Section 10**).

In accordance with the EP4, the scope of this assessment was tailored to be proportionate to the nature and scale of the risks, impacts and development stage of the proposed Project. This CCRA has also broadly adhered to the recommendations of the Equator Principles Guidance Note on Climate Change Risk Assessment (hereinafter referred to as the "Guidance Note")[2].

3. Legal and Policy Framework

The following section provides a brief overview of the policy and legislative context within which the Project will be developed and how the Project complies with and responds to the relevant policies and legislation. This framework includes South Africa's climate-related legislation, policies, and plans, as well as the relevant international treaties, guidelines, and standards.

[2] Equator Principles Association (2023). *Guidance Note on Climate Change Risk Assessment*. URL: https://equator-principles.com [accessed on 22 April 2025].

Table 3-1: Summary of legal and policy framework

Title	Year	Type	Purpose	Relevant sections
Local legislation, policies, and plans				
The Climate Change Act 22 of 2024[3]	2024	Legislation	The purpose of the Act is to enable the development of an effective climate change response and a long-term, just transition to a low-carbon and climate-resilient economy and society for South Africa in the context of sustainable development.	Chapters 3 and 4 which set out the requirements for the local, provincial and national response to climate change. Chapter 5 which sets out the requirements for GHG emissions and removals, including determining the national GHG emissions trajectory. Although the Act does not have any specific requirements for the Project, the potential impact of the Project's GHG emissions on the country's modelled domestic pathways is assessed in **Section 8.2**.
National Guideline for Consideration of Climate Change Implications in Applications for Environmental Authorisation, Atmospheric Emission Licences, and Waste Management Licences[4]	2021	Guidelines	The purpose of the guideline is to give guidance on the consideration of climate change impacts in environmental impact assessment (EIA) processes linked to Environmental Authorisations, Atmospheric Emission Licences, and Waste Management Licences.	Section 5 which sets out the principles for involving climate change specialists in EIA processes. Section 7 which sets out the role and timing of the specialist study within the EIA process. Section 8 which sets out the roles and responsibilities. Section 9 which sets out the extent and content of the climate change assessments. Section 10 which sets out the requirements for the application of impact mitigation measures. Section 11 which provides guidance for addressing direct, indirect, and cumulative impacts. Section 12 which provides guidance for climate change adaptation.

[3] Climate Change Act 22 of 2024 (as amened).

[4] *The National Guideline for Consideration of Climate Change Implications in Applications for Environmental Authorisation, Atmospheric Emission Licences, and Waste Management Licences* published in Government Gazette No. 44761 on 25 June 2021.

Title	Year	Type	Purpose	Relevant sections
				Section 13 which sets out the environmental management programme (EMPr) requirements Although the guideline is not yet in effect, this CCRA broadly aligns with its requirements, and in particular, the guidance on the extent and content of climate change assessments.
South Africa First Nationally Determined Contribution (NDC) (Updated September 2021)[5]	2021	Policy	The purpose of South Africa's NDC is to outline the country's plans to mitigate GHG emissions and to adapt to climate change. South Africa's first NDC was updated in September 2021 to align with the Paris Agreement, and to reduce the country's GHG emissions target range to 398 - 510 million tonnes carbon dioxide equivalents ($MtCO_2e$) by 2025 and 350 - 420 $MtCO_2e$ by 2030. The targets include all sectors except natural land disturbance. According to the NDC, South Africa's long-term decarbonisation of the economy will focus primarily on the electricity sector in the 2020s. In the 2030s, the focus will be on a deeper transition of the electricity sector together with a transition in the transport sector towards low emission vehicles. In the 2040s, the focus will be on hard-to-mitigate sectors of the economy. The implementation of the Integrated Resources Plan, 2019 (IRP 2019) is an integral part of South Africa's NDC. The IRP 2019 contemplates a massive investment in renewable energy over the next decade.	Section 4 which sets out South Africa's national GHG emission reduction targets. Although the NDC does not contain requirements specific to the Project, the potential contribution of the Project's GHG emissions on the country's modelled domestic pathways is assessed in **Section 8.2**.
National Climate	2019	Strategy	The purpose of the National Climate Change Adaptation Strategy is to provide a common vision	Section 3 which sets out the strategic objectives, interventions, and actions of the Strategy.

[5] Republic of South Africa (2021*). South Africa First Nationally Determined Contribution (Updated September 2021)*. URL: https://unfccc.int [accessed on 23 April 2025].

Title	Year	Type	Purpose	Relevant sections
Change Adaptation Strategy[6]			of climate change adaptation and climate resilience for the country, and to outline priority areas for achieving this vision.	Although this Strategy does not have any specific requirements for the Project, the Project should, to the extent possible, ensure that it is compatible with the vision and strategic objectives, interventions, and actions of this Strategy.
IRP 2019[7 8]	2019	Plan	The purpose of the IRP 2019 is to provide an electricity infrastructure development plan based on least-cost electricity supply and demand balance, accounting for security of supply and the environment (i.e. minimise emissions and water usage). The IRP 2019 acknowledges that renewable energy sources present an opportunity to diversify the country's energy mix, to produce distributed generation, and provide off-grid electricity. Renewable technologies also present an opportunity for the creation of new industries, job creation, and localisation across the value chain.	Section 5.2 which sets out the emerging long-term plan. Section 5.3 which sets out the key considerations and actions. This includes the principles for a just transition to a diversified energy mix as reflected in South Africa's long-term plan. Although the Plan does not contain requirements specific to the Project, the Project broadly aligns with the IRP 2019 in terms of developing renewable energy infrastructure. The Project is thus in keeping with and furtherance of this Plan.
Carbon Tax Act[9]	2019	Legislation	The purpose of the Carbon Tax Act 15 of 2019 is to provide for the imposition of a tax on carbon dioxide equivalent of greenhouse gas emissions.	Schedule 2 which sets out the activities and thresholds for which tax is payable. Parts I to IV which set out the requirements for calculating the amount of tax payable, the allowances, limitation of allowances, the tax period, and payment of tax. Based on an initial screening of the listed activities and threshold, it is unlikely that the Project will be liable for the payment of carbon tax.

6 Department of Environment, Forestry, and Fisheries (2019). *National Climate Change Adaptation Strategy*. https://www.dffe.gov.za [accessed on 23 April 2025].

7 At the time that this report was prepared, the Integrated Resources Plan 2023 had not been formally gazetted, and IRP 2019 is, therefore, still applicable.

8 Department of Mineral Resources and Energy (2019). *Integrated Resource Plan 2019*. https://www.energy.gov.za [accessed on 23 April 2025].

9 Carbon Tax Act 15 of 2019 (as amended)

Title	Year	Type	Purpose	Relevant sections
South Africa's Low-Emission Development Strategy 2050[10]	2018	Strategy	The purpose of South Africa's Low-Emission Development Strategy 2050 (SA-LEDS) is to provide a path going forward in order to place the country on a low-carbon trajectory, while at the same time ensuring broader socio-economic development. The SA-LEDS acknowledges that a number of South Africa's existing coal-fired power stations will need to be retired between 2030 and 2050, and that large investments in additional generation capacity will be needed in order to meet the projected electricity demand and sustain economic growth.	Section 5 which sets out measures to drive low carbon development in the energy sector. Although the Strategy does not contain requirements specific to the Project, the Project broadly aligns with the SA-LEDS in terms of developing additional generation capacity.
Declaration of Greenhouse Gases as Priority Air Pollutants[11]	2017	Legislation	The purpose of this Declaration is to declare the GHGs indicated therein as priority air pollutants. This includes carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride. The Regulations also require persons falling within a category specified in Annexure A and exceeding the threshold of 1 $MtCO_2e$ per annum to prepare and submit to the Minister a pollution prevention plan for approval.	Based on an initial screening of the listed categories, it is unlikely that the Project will require a pollution prevention plan as electricity production, which is included as a listed process in Annexure A, is limited to the combustion of fossil fuels.
National Greenhouse Gas Emissions Reporting	2016	Legislation	The purpose of these regulations is to introduce a single national reporting system for the transparent reporting of greenhouse gas emissions, which will be used (a) to update and maintain a National Greenhouse Gas Inventory, (b) for South Africa to meet its reporting obligations under the UNFCCC,	Based on an initial screening of the listed activities, it is unlikely that the Project will be required to report its GHG emissions on an annual basis as renewable energy is not listed in Annexure 1.

[10] Department of Environment, Forestry, and Fisheries (2018). *South Africa's Low-Emission Development Strategy 2050*. https://unfccc.int/ [accessed on 23 April 2025].

[11] Department of Environmental Affairs (2017). Declaration of Greenhouse Gases as Priority Air Pollutants. Published in Government Notice 6 in *Government Gazette* 39578 on 08 January 2016.

Title	Year	Type	Purpose	Relevant sections
Regulations, 2016[12]			and (c) to inform the formulation and implementation of legislation and policy. The regulations apply to the categories of emission sources listed in Annexure 1 and a corresponding data provider as classified in Regulation 4	
DRAFT Post-2015 National Energy Efficiency Strategy[13]	2016	Strategy	The purpose of the DRAFT Post-2015 National Energy Efficiency Strategy is to respond to the increasing demand for energy alongside a growing commitment to improving resource use and reducing South Africa's national environmental footprint.	Section 5.4 which sets out the pathway to realising South Africa's energy efficient future in the industry and mining sector. Although the Strategy does not contain requirements specific to the Project, the Project should, to the extent possible, be compatible with the objects of the Strategy and any regulations for renewable energy that may be published in the future.
National Energy Act[14]	2008	Legislation	The purpose of the National Energy Act 34 of 2008 is to: • Ensure that diverse energy resources are available, in sustainable quantities and at affordable prices, to the South African economy in support of economic growth and poverty alleviation, taking into account environmental management requirements and interactions amongst economic sectors. • Provide for energy planning, increased generation and consumption of renewable energies, contingency energy supply, holding of strategic energy feedstocks and carriers,	Chapter 1 which sets out the objectives of the Act, and in particular, the availability of diverse energy resources and increased generation and consumption of renewable energies. Although the Act does not contain requirements specific to the Project, it should, to the extent possible, be compatible with the objectives of the Act. This includes compliance with any regulations for energy efficiency that may be published in the future.

[12] Department of Environment, Forestry and Fisheries (2016). National Greenhouse Gas Emissions Reporting Regulations. Published in Government Notice 275 in Government Gazette *40762* on 03 April 2017 (as amended).

[13] Department of Mineral Resources and Energy (2016). DRAFT Post-2015 National Energy Efficiency Strategy. https://cer.org.za [accessed on 23 April 2025].

[14] National Energy Act 34 of 2008 (as amended).

Title	Year	Type	Purpose	Relevant sections
			adequate investment in, appropriate upkeep and access to energy infrastructure.	
National Environment Management: Air Quality Act 39 of 2004[15]	2004	Legislation	Reforms the law regulating air quality in order to protect the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development while promoting justifiable economic and social development, as well as providing for national norms and standards regulating air quality monitoring, management and control by all spheres of government.	Although the Act does not contain requirements specific to the Project, it should, to the extent possible, be compatible with the objectives of the Act.
International treaties, guidelines, and standards				
EP4[16]	2020	Standards	The Equator Principles are a financial industry benchmark for assessing and managing social and environmental risks in project financing, including the requirements for climate change risk assessment and reporting on GHG emissions.	Principle 2 which sets out the requirements for a climate change risk assessment. Annex A which sets out the requirements for alternatives analysis and reporting of GHG emissions. This CCRA broadly aligns with the Guidance Note.
Recommendations of the TCFD[17]	2017	Guidelines	Establishes recommendations for disclosing clear, comparable, and consistent information about the risks and opportunities presented by climate change.	Part B which provides a useful framework for categorising the climate-related risks and opportunities to promote greater alignment and standardisation across the different sectors. This framework is used in **Section 9** to categorise the Project's climate-related risks and opportunities.
The Paris Agreement[18]	2016	Treaty	This treaty aims to limit global warming to well below 2, preferably to 1.5 degrees Celsius,	Article 2 which sets out the objectives of the agreement.

[15] National Environment Management: Air Quality Act 39 of 2004 (as amended).

[16] Equator Principles Association (2020). *Equator Principles: EP4: July 2020*. URL: https://equator-principles.com [accessed on 23 April 2025].

[17] TCFD (2017). *Recommendations of the Task Force on Climate-related Financial Disclosures*. https://assets.bbhub.io [accessed on 23 April 2025].

[18] United Nations (2015). *Paris Agreement*. URL: https://treaties.un.org [accessed on 23 April 2025].

Title	Year	Type	Purpose	Relevant sections
			compared to pre-industrial levels. South Africa ratified the Paris Agreement on 1 November 2016.	Articles 3 and 4 which set out the requirements for the submission of plans for climate action known as NDCs. Article 5 which sets out the requirements for the conservation of carbon sinks and reservoirs, such as forests. Article 7 which sets out the requirements for enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change. Although the Paris Agreement does not contain requirements specific to the Project, the potential contribution of the Project's GHG emissions on South Africa's Paris aligned pathway is assessed in **Section 8.**
International Finance Corporation (IFC): Performance Standards on Environmental and Social Sustainability[19]	2012	Standards	These standards cover the IFC's strategic commitment to sustainable development, as well as its approach to risk management. The standards cover guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project-level activities.	This CCRA adheres with the requirements of the following standards: • Performance Standard 1 which requires the consideration of climate change in environmental and social assessments. • Performance Standard 3 which requires the quantification of the project's GHG emissions and identification of mitigation measures. • Performance Standard 4 which requires the consideration of climate change on project-affected communities and priority ecosystem services. • Performance Standard 6 which requires the consideration of climate change on biodiversity and project-affected natural ecosystems.

[19] International Finance Corporation (2012). *Performance Standards*. URL: https://www.ifc.org [accessed on 23 April 2025].

Title	Year	Type	Purpose	Relevant sections
Environmental, Health, and Safety (EHS) General Guidelines[20]	2007	Guidelines	These guidelines are the World Bank Group's technical reference documents with general and industry-specific examples of good international industry practice.	Although the guidelines are only applicable to projects funded by the IFC, this CCRA broadly adheres with the requirements of Section 1.1, which provides guidance for the reduction and control of GHG emissions, to align with GIIP.
The Kyoto Protocol[21]	1997	Treaty	This Treaty aims to operationalize the UNFCCC by committing industrialised countries and economies in transition to limit and reduce GHG emissions in accordance with agreed individual targets. South Africa ratified the Kyoto Protocol on 31 July 2002.	Article 12 which makes provision for a Clean Development Mechanism to assist countries not listed in Annex B with achieving sustainable development. Annex B which lists countries that are required to have a quantified emission limit or reduction commitment. Although the Protocol does not contain requirements specific to the Project, it should, to the extent possible, be compatible with the objectives of the Protocol
United Nations Framework Convention on Climate Change (UNFCCC)[22]	1992	Framework	This Convention aims to prevent "dangerous" human interference with the climate system. South Africa ratified the UNFCCC on 29 August 1997.	Article 2 which sets out the objectives of the treaty. Article 3 which sets out the principles of the treaty. Article 4 which sets out the commitments of the parties to the treaty. Although the Framework does not contain requirements specific to the Project, it should, to the extent possible, be compatible with the objectives of framework.

[20] World Bank (2007). *Environmental, Health, and Safety General Guidelines*. URL: https://www.ifc.org [accessed on 23 April 2025].

[21] United Nations (1997). *Kyoto Protocol to the United Nations Framework Convention on Climate Change*. URL: https://treaties.un.org [accessed on 23 April 2025.]

[22] United Nations (1992). *United Nations Framework Convention on Climate Change*. URL: https://treaties.un.org [accessed on 23 April 2025.]

4. Project Description

Table 4-1 presents a general description of the activities of the Project, which are vulnerable to the adverse effects of climate change or contribute to Project-related GHG emissions. The preferred location and layout of the Project is presented in **Figure 4-1**.

Table 4-1: Description of the main activities

Activity	Description
Project site[23]	
Nearest towns	Matjiesfontein (40 km south) and Sutherland (40 km north)
Local municipality	• Karoo Hoogland Local Municipality • Laingsburg Local Municipality
District municipality	• Namakwa District Municipality • Central Karoo District Municipality
Province	• Northern Cape Province • Western Cape Province
Extent	Total property size is 15,770 ha.
Land use	Site positioned almost entirely on land of very low agricultural potential, historically utilised for grazing and minimal agriculture (Agricultural Zone 1).
Surrounding land uses	• The Project site and immediate surrounds are presently used for minimal livestock grazing, with limited crop cultivation. • Irregular farm settlements/residences. • The site is located approximately 15 km south of the point where the R356 splits into the R354. The site is accessed via the R354.
Project components	
Wind turbines	• Although the construction of up to 40 wind turbines is authorised under the more recent Environmental Authorisation, the current plan only includes the construction of 25 of the 40 permitted wind turbines. • Each turbine consists of a steel tower, nacelle, and a rotor with its associated blades. • The total installed capacity is around 149.90 MW. • Estimated annual yield is 497.90 GWh.
Per turbine footprint	• up to 1.2 hectares per turbine. • Foundation holes mechanically excavated with blasting utilised with circumspection where necessary
Substations[24]	One on-site electrical substation (33/132Kv), 150 m x 200 m, receiving generated power via underground distribution cabling from each wind turbine.

[23] Karreebosch Wind Farm and Associated Infrastructure, Northern Cape & Western Cape Provinces. Final Environmental Management Programme). WSP. 2022. https://sahris.sahra.org.za/. [Accessed 05/06/2025]

[24] Amendment of the Environmental Authorisation Issued on 29 January 2016 for the Karreebosch Wind Farm and Associated Infrastructure in the Karoo Hoogland and Laingsburg Local Municipalities, Northern and Western Cape Provinces. Department of Forestry, Fisheries and the Environment. 2022.

Activity	Description
Transmission line[25]	• Underground cabling between turbines along internal access roads with sections of overhead, 33 kV lines where required (steeper terrain)
Access road	Several gravel surface access roads off the R354.
Internal access roads	• Several gravel surface internal access roads linking wind turbine units (4 – 9 m in width)
Laydown and workshop areas	Operation and maintenance building for storage and maintenance.
Project timelines	
Construction	2025-2026 (~ 24 months).
Operations	2027-2046 (~ 20 years).
Closure	• Decommissioning planned for 2047. • Possible extension of up to 5 years (2047-2051).

[25] Amendment of the Environmental Authorisation Issued on 29 January 2016 for the Karreebosch Wind Farm and Associated Infrastructure in the Karoo Hoogland and Laingsburg Local Municipalities, Northern and Western Cape Provinces. Department of Forestry, Fisheries and the Environment. 2022.

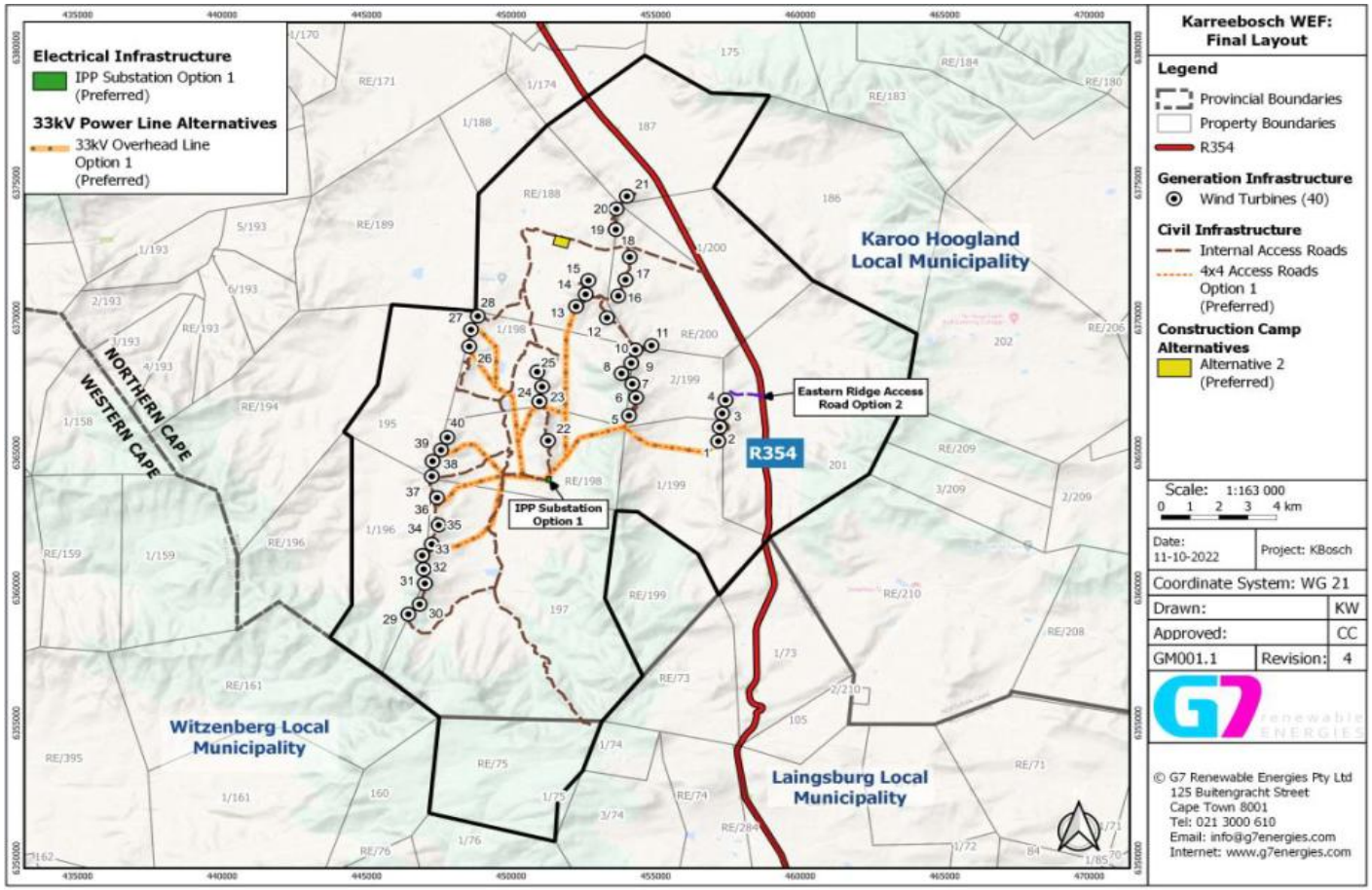


Figure 4-1: Preferred location and authorised **layout of the Project**[26,27]

[26] Karreebosch Wind Farm and Associated Infrastructure, Northern Cape & Western Cape Provinces. Final Environmental Management Programme). WSP. 2022. https://sahris.sahra.org.za/. [Accessed 05/06/2025]

[27] The map illustrates the layout of the 40 wind turbines that received approval under the most recent Environmental Authorisation. Of these, only 25 turbines are scheduled for construction during the current development phase.

5. Approach and Methodology

5.1 Climate-Related Risks and Opportunities

5.1.1 Data Sources

This assessment is largely based on climate-related information sourced from the World Bank Climate Change Knowledge Portal (CCKP), the Intergovernmental Panel on Climate Change (IPCC), and published journal articles.

The CCKP was created to provide an online tool for accessing global, country, and regional level information to better understand the observed and projected changes in climate under a range of future scenarios[28]. Given that this is a high-level analysis, the level of detail provided by the CCKP is deemed to be sufficient for this assessment.

The CCKP presents information based on the Coupled Model Inter-Comparison Project No. 6 (CMIP6). CMIP6 is also used by the IPCC in the Sixth Assessment Report, which was released at the end of 2021[29], and is the most recent IPCC Assessment Report. CMIP6 data is presented at a spatial resolution, 1° x 1° (~100 km x ~100 km). The benefit of using CMIP6 is that it is an ensemble of over 100 different climate models from 49 modelling centres across the world and thus includes information on a wide range of possible future climate change outcomes and uncertainties.

5.1.2 Climate Scenarios

Figure 5-1 presents the projected change of global surface temperature (relative to the reference period (1950 – 2014)) under the different Shared Socio-economic Pathways (SSPs)[30]. SSPs are used in CMIP6 to represent different global policy responses to climate change.

To account for the uncertainty regarding the future, and aligned to best practice, this assessment considers two climate scenarios:

- **SSP2-4.5 (“middle of the road”)** – GHG emissions continue at current levels until 2050.
- **SSP5-8.5 (“fossil fuelled development”)** – High GHG emissions levels due to the continued and intensive use of fossil fuels.

These two scenarios were selected as they represent an upper extreme (SSP5-8.5) where mitigation is difficult due to the high reliance on fossil fuels, and an intermediate scenario (SSP2-4.5) between the upper extreme and lower extreme (i.e. SSP1-1.9, “Sustainability” with significant mitigation).

[28] World Bank Group (2022). About Us. https://climateknowledgeportal.worldbank.org [accessed on 27 May 2025]

[29] IPCC (2021). Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change. Switzerland.

[30] *Ibid*

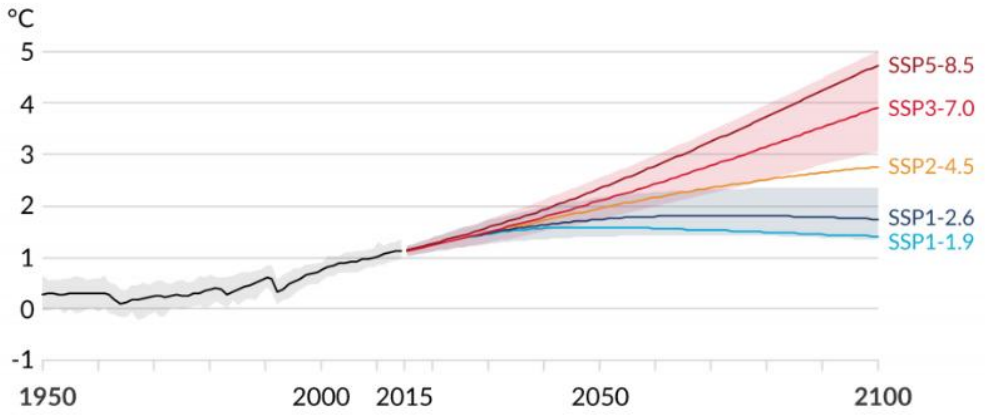


Figure 5-1: Projected change of global surface temperature (relative to the reference period 1950 – 2014) under the range of SSPs[31]

5.1.3 Assessment of Climate-Related Risks

5.1.3.1 Categorisation of Climate Impacts and Opportunities

The Project's physical climate-related risks are firstly identified through the desktop study and categorised according to the TCFD disclosure framework (**Table 5-1**). The TCFD distinguishes between two types of climate-related risks, namely physical risks and transitional risks, as well as climate-related opportunities[32]:

- **Physical risks** resulting from climate change can have a direct impact on the Project, or an indirect impact on the Project's supply chains. Physical risks are further divided into acute and chronic impacts.
- **Transition risks** refer to the financial and reputational impact to Projects with the global transition to a lower-carbon economy. The level of risks is dependent on the nature, speed, and focus of the transition. Transition risks are further divided into policy and legal, technology, market and economic, and social and reputational impacts.
- The **opportunities** that may arise for organisations from efforts to mitigate and adapt to climate change.

Table 5-1: Climate-related risks disclosure framework[33]

Category	Type	Description
Physical risks	Acute	Impacts that are event-driven, including increased severity of extreme weather events, such as cyclones, hurricanes, or floods.
	Chronic	Impacts arise from longer-term shifts in climate patterns (e.g., sustained higher temperatures), that may cause sea level rise or chronic heat waves.

[31] *Ibid*.

[32] TCFD (2017). *Recommendations of the Task Force on Climate-related Financial Disclosures*. URL: https://assets.bbhub.io [accessed on 06 June 2025].

[33] *Ibid*.

Category	Type	Description
Transitional risks	Policy and legal impacts	Impacts arise from policy actions that attempt to constrain actions that contribute to climate change or seek to promote adaptation to climate change. Impacts also arise from climate-related litigation claims being brought before the courts by property owners, municipalities, states, insurers, shareholders, and public interest organisations.
	Technology	Impacts arise from new technologies displacing old technologies and disrupting some parts of the existing economic system. This transition leads to winners and losers, and uncertainty in assessing technological impact.
	Market and Economic	Impacts arise from shifts in supply and demand for certain commodities, products, and services as climate-related impacts and opportunities are increasingly taken into account.
	Social and Reputational	Impacts arise from changing customer or community perceptions of an organisation's contribution to or detraction from the transition to a lower-carbon economy.
Opportunities	Resource efficiency	Opportunities arise from improving efficiency across production and distribution processes and employing innovation in technology.
	Energy source	Opportunities arise from the uptake of low emission alternative energy sources.
	Products and services	Opportunities arise from the innovation and development of new low-emission products and services, allowing organisation to improve their competitive position and to capitalise on shifting consumer and producer preferences.
	Markets	Opportunities arise from accessing new markets or types of assets, allowing organisations to diversify their activities and better position themselves for the transition to a lower carbon economy.
	Resilience	Opportunities arise from developing adaptive capacity to better manage climate-related risks and seizing climate-related opportunities.

5.1.3.2 Risk Assessment Methodology

South Africa currently does not have any legislation regulating the assessment of climate change risks. This CCRA, therefore, uses a risk matrix (**Table 5-4**), which is a commonly used tool in risk assessments, to assess climate-related risks for the Project. This matrix consists of two axes, one for impact (**Table 5-2**), and one for likelihood (**Table 5-3**).

In the context of this CCRA, risk refers to the likelihood that a certain event will occur and the potential consequences of such an event should it occur. This differs from impact which refers to the actual consequences or effects that result from a certain event. As the focus of the CCRA is on the risks associated a changing climate, particularly given the uncertainty associated with climate change, the standard SLR impact assessment methodology is not deemed to be appropriate for assessing climate-related risks, and has, thus, not been applied in this CCRA.

Table 5-2: Impact ratings

Rating	Description
Severe	Operational disruptions longer than 10 days / significant disruption with emergency response required /extreme monetary loss of > 90%.
Major	Operational disruptions longer than 5 days / major monetary loss of 50–90%.
Significant	Operational disruptions less than 5 days / moderate monetary loss of 10–50%.
Minor	Operational disruptions less than 24 hours / monetary loss of < 10%.
Slight	Little to no impact on operational uptime or revenue.

Table 5-3: Likelihood ratings

Rating	Description
Rare	Recurrent risk: The unwanted event has not occurred or is unlikely to occur within 30 years. Single event: Negligible; probability small, almost zero.
Unlikely	Recurrent risk: The unwanted event has happened at some time or could happen about once in 30 years. Single event: Unlikely but not negligible: probability noticeably greater than zero.
Possible	Recurrent risk: The unwanted event has happened at some time; or could happen within 10 years. Single event: Less likely than not but still appreciable: probability less than 50% but still quite high.
Likely	Recurrent risk: Unwanted events occur infrequently and could arise about once per year. Single event: As likely as not: probability greater than 50% but less than 80%.
Almost certain	Recurrent risk: The unwanted event could occur several times per year and is likely to recur within 1 year. Single event: More likely than not: probability greater than 80%.

Table 5-4: Risk matrix

Final rating		**Likelihood**				
		Rare	Unlikely	Possible	Likely	Almost Certain
Impact	Severe	Low	Moderate	High	High	High
	Major	Low	Moderate	Moderate	High	High
	Significant	Low	Low	Moderate	Moderate	High
	Minor	Low	Low	Low	Moderate	Moderate
	Slight	Low	Low	Low	Low	Low

5.2 Project GHG Emissions

The approach to the quantification of Project's GHG emissions is guided by the following reference documents:

- Greenhouse Gas Protocol: *Corporate Accounting and Reporting Standard*[34].
- IPCC: 2006 *IPCC Guidelines for National Greenhouse Gas Inventories*[35].
- International Organization for Standardization: *ISO 14064-1:2019: Greenhouse gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*.

5.2.1 Organisational Boundaries

Organisations vary in their legal and organisational structures and, like financial accounting, reporting on the GHG emissions of operations is dependent on the structure of the organisation, and whether the operations are wholly owned, joint ventures or subsidiaries[36]. It is expected that the organisation boundaries will state the makeup of the company, and the operations that the organisation owns or controls.

In defining the organisational boundaries, there are generally two distinct consolidation approaches:

- With the **equity share approach**, the organisation accounts for GHG emissions from operations according to its share of equity in the operation. Typically, the equity share is equivalent to the organisation's percentage ownership.
- With the **control approach**, the organisation accounts for 100% of the GHG emissions from operations over which it has control. In terms of this approach, an organisation is not accountable for operations in which it owns a percentage but has no control. Control can be in the form of either financial control, in which the organisation directs the financial and operational policies of the operation, or operational control, where the organisation has the full authority to introduce and implement operational policies.

This assessment reports on the Project's GHG emissions in terms of the operational control approach, where Karreebosch accounts for 100% of the estimated direct (scope 1) and indirect (scope 2) GHG emissions. Should the Project be developed and/or operated by a different entity, responsibility for GHG emissions will transfer to the party assuming operational control.

5.2.2 Operational Boundaries

In defining the operational or reporting boundaries, the GHG emissions associated with the organisation's operations are identified and characterised as either direct or indirect emissions[37]. Three 'scopes' are used for GHG emissions accounting and reporting to characterise direct and indirect emission sources. The use of scopes not only improves

[34] WBCSD and WRI (2015). *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*. URL: https://ghgprotocol.org [accessed on 17 April 2025].

[35] IPCC (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. https://www.ipcc-nggip.iges.or.jp [accessed on 17 April 2025].

[36] WBCSD and WRI (2015). *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*. URL: https://ghgprotocol.org [accessed on 17 April 2025].

[37] *Ibid.*

transparency and consistency in reporting but also ensures that organisations do not account for different emissions in the same scope (i.e., double counting).

A brief description of the three scopes is provided below:

- **Scope 1: Direct GHG emissions:** Occur from sources that are owned or controlled by the organisation. This includes for example, emissions from heavy machinery, generators, delivery vehicles, forklifts, temporary lighting, and so on.
- **Scope 2: Indirect GHG emissions from purchased energy:** Occur from the generation of purchased electricity or steam that is brought onto the organisation's property.
- **Scope 3: Other indirect GHG emissions:** Occur from sources that are not owned or controlled by the organisation. This includes for example, purchased materials, transportation of materials, and business travel.

Figure 5-2 presents an overview of scope 1, scope 2, and scope 3 emissions across the value chain of an organisation.

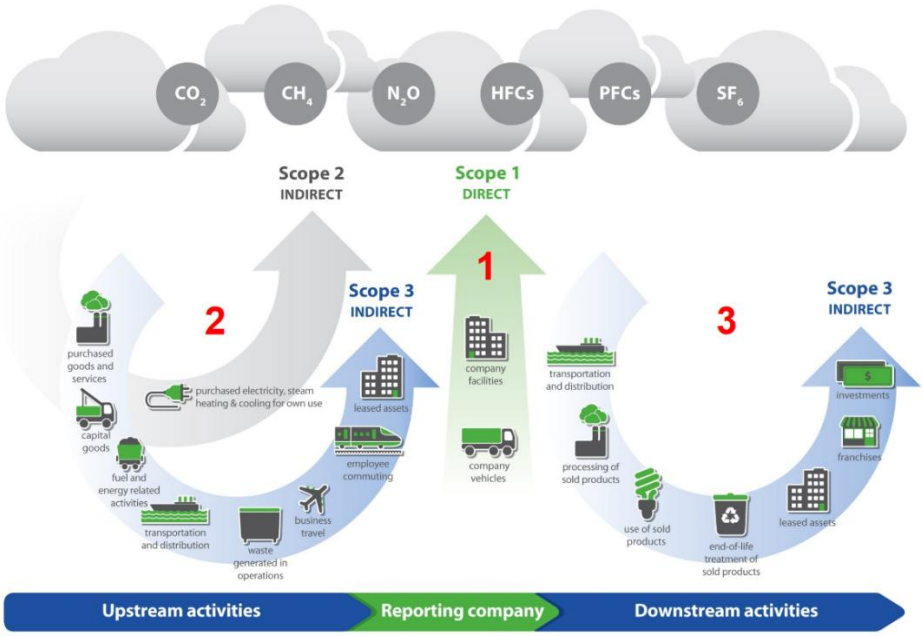


Figure 5-2: Overview of scope 1, scope 2, and scope 3 emissions across the value chain[38]

In terms of the GHG Protocol, organisations are required to report on both scope 1 and scope 2 emissions. This also a requirement of IFC Performance Standard 3 for projects that are expected to produce more than 25,000 tCO_2e annually[39], and of the EP4 for projects that are expected to produce more than 100,000 tCO_2e annually[40].

[38] Greenhouse Gas Protocol (2011). *Corporate Value Chain (Scope 3) Accounting and Reporting Standard*. URL: https://ghgprotocol.org [accessed on 17 April 2025] (pg. 5).

[39] Equator Principles Association (2020). *The Equator Principles: July 2020*. URL: https://equator-principles.com [accessed on 17 April 2025].

[40] International Finance Corporation (2012*), Environmental and Social Performance Standards*. https://www.ifc.org [accessed on 17 April 2025]

5.2.2.1 GHG Emissions Sources Included in the Assessment

Table 5-5 presents the GHG emission sources which were included in the assessment, as well as the activity data on which the GHG emissions were calculated.

Table 5-5: GHG emission sources included in the assessment.

Project phase	Scope	Emissions source	Activity data	Unit
Construction	1	Diesel consumption of heavy-duty vehicles transporting plant, materials, and equipment to site and the combustion of diesel in the site's fixed generators.	Mobile and stationary diesel consumption	Litres (ℓ)
Construction	1	Kilometres travelled to transport workers to the construction site	Kilometres travelled	Kilometres (km)
Operations	1	Diesel consumption of light duty vehicles, and the energy requirements for the maintenance and replacement (if required) of the equipment.	Annual energy yield	kWh

5.2.2.2 GHG Emission Sources Excluded from the Assessment

Table 5-6 presents the GHG emission sources which were excluded from the assessment, as well as the reason for the exclusion.

Table 5-6: GHG emission sources excluded from the assessment.

Operations	Scope	Emissions source(s)	Reason
Construction and operations	1	Fugitive emissions from equipment leaks (e.g., air conditioners, refrigerators, and so on).	Based on previous studies, this is unlikely to be a material source of GHG emissions relative to mobile combustion sources. Moreover, modern and newly installed equipment generally has insignificant leakage, if any.
Construction and Operations	1	Emissions resulting from the offsite treatment of sewage effluent.	Based on previous studies, it is unlikely to be a material source of GHG emissions relative to mobile combustion sources.
Operations	1	Sulphur hexafluoride leaks from electrical equipment (e.g., transformers).	Based on previous studies, it is unlikely to be a material source of GHG emissions relative to mobile combustion sources. Moreover, modern and newly installed equipment generally has insignificant leakage, if any.
Closure	1	Diesel consumption of heavy machinery, generators, delivery vehicles, cranes, and so on.	Not applicable as there are presently no plans to decommission the Project at the end of its useable life (the Project's end-of-life date may be extended).

Operations	Scope	Emissions source(s)	Reason
All phases	3	Indirect emissions from value chains. This includes purchased goods and services, capital goods, fuel- and energy-related activities, upstream and downstream transportation and distribution, waste generated in operations, business travel, employee commuting, upstream and downstream leased assets, processing, and use, and end-of-life treatment of sold products.	Scope 3 emissions have been excluded from this assessment, as their quantification and reporting are not required under the provisions of the IFC Performance Standards on Environmental and Social Sustainability and EP4. The lifecycle GHG emissions of alternative technologies, using onshore wind energy as a reference, is assessed in **Section 8.1.**
Other sources			
Construction	Land use, land use change, and forestry[41]	Emissions from site clearance activities and land use change.	Unlikely to be a material source of GHG emissions due to the limited development footprint (~80 ha). Moreover, the development is generally restricted to the shrubland areas, which generally have lower carbon stocks relative to the thicket and thicket areas. Additionally, wind energy facilities tend to disturb a lesser extent of local natural flora than alternative technologies.

5.2.3 Quantification of the Project's GHG Emissions

5.2.3.1 Construction Phase

During the construction phase, GHG emissions will result from mobile diesel consumption, transporting plant materials and equipment to the site. The emissions from mobile combustion are calculated using the following equation:

$$GHG\ emissions_{(tCO2e)} = Diesel\ consumption\ (\ell) * Emission\ factor_{(kgCO_2e / \ell)} * 0.001$$

Additionally, GHG emissions will be emitted from consumption in the site's diesel generators during site development activities. The emissions from stationary combustion are calculated using the following equation:

$$GHG\ emissions_{(tCO2e)} = Diesel\ consumption\ (\ell) * Emission\ factor_{(kgCO_2e / \ell)} * 0.001$$

[41] In terms of the IFC Performance Standards or the Equator Principles, it is considered to be good international industry practice.

Finally, construction phase emissions are anticipated to arise from employee transport to and from the site. The emissions from employee transportation are calculated using the following equation:

$$GHG\ emissions_{(tCO2e)} = Kilometres\ travelled\ (km) * Emission\ factor_{(kgCO_2e\ /\ km)} * 0.001$$

5.2.3.2 Operations Phase

During the operations phase, GHG emissions will result from the diesel consumption of light duty vehicles, and the energy requirements for the maintenance and replacement (if required) of the equipment.

The GHG emissions for the operations phase are calculated using the following equation:

$$GHG\ emissions_{(tCO2e)} = Total\ energy\ yield_{(kWh)} * Emission\ factor_{(gCO2e\ /\ kWh)}$$

5.2.4 Assessment of the Project's GHG Emissions

This assessment did not apply the standard SLR impact assessment methodology as this approach is not deemed to be appropriate for assessing GHG emissions. This is because this methodology tends to overstate the significance of the impact despite the relatively insignificant contribution of a Project's GHG emissions. This is due to the global extent of the impact, long-term duration (~100 years), and high probability of the impact occurring.

This assessment, therefore, assesses the Project's GHG emissions in terms of three criteria:

- Comparison to alternative technologies.
- Contribution to South Africa's modelled domestic pathways.
- Pre-defined thresholds.

5.2.4.1 Comparison to Alternative Technologies

The first criterion for assessing the Project's GHG emissions is a comparison of the lifecycle GHG emissions of the preferred technology (i.e., wind energy) and other technologies alternatives (i.e., coal, natural gas, nuclear, solar photovoltaic (PV), and concentrating solar power (CSP)).

If the lifecycle emissions of the preferred technology are lower than that of feasible alternative technologies, the impact is considered to be Positive. If, however, the lifecycle emissions are lower than that of feasible alternative technologies, the impact is considered to be Negative.

5.2.4.2 Contribution to South Africa's Domestic Pathways

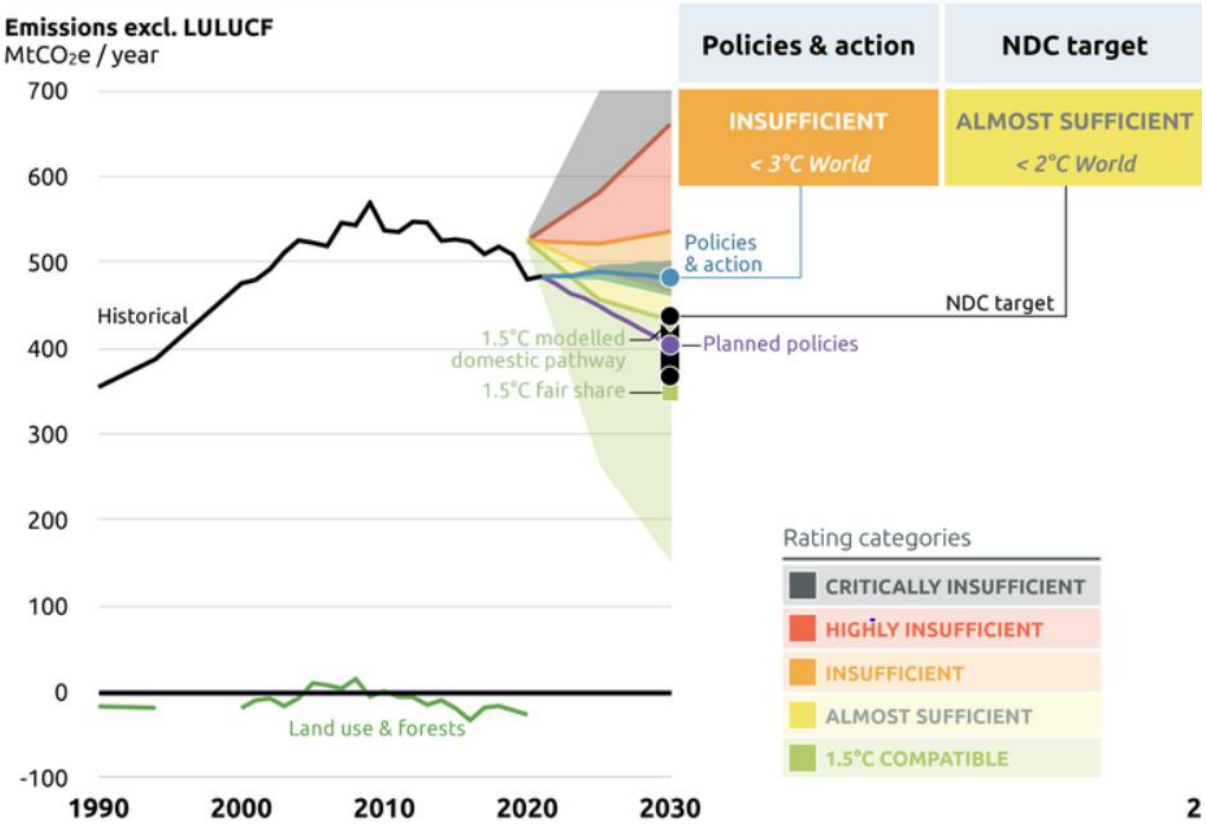
The second criterion for assessing the Project's GHG emissions is the potential contribution to South Africa's modelled domestic pathways.

Climate Action Tracker (CAT) uses rating categories and modelled domestic pathways to evaluate whether a country's targets and policies are on track towards decarbonisation in

line with 1.5°C temperature limit of the Paris Agreement[42]. CAT derives country-level pathways from modelled global pathways, taking into account a "fair share range" for each country. CAT uses the following rating categories for the modelled domestic pathways:

- **1.5°C Paris Agreement compatible:** Indicates that a country's climate policies and commitments are consistent with the Paris Agreement's 1.5°C temperature limit.
- **Almost sufficient:** Indicates that a country's climate policies and commitments are not yet consistent with the Paris Agreement's 1.5°C temperature limit but could be with moderate improvements.
- **Insufficient:** Indicates that a country's climate policies and commitments need substantial improvements to be consistent with the Paris Agreement's 1.5°C temperature limit.
- **Highly insufficient:** Indicates that a country's climate policies and commitments are not consistent with the Paris Agreement's 1.5°C temperature limit. For many countries in this category, policies and commitments lead to rising, rather than falling, emissions.

Figure 5-3 presents South Africa's policies and action, as well as the country's NDC targets, relative to CAT's rating categories. In summary, South Africa's "policies and action" are considered to be insufficient, while the "NDC targets" are considered to be almost sufficient.



[42] Climate Action Tracker (2022). *South Africa*. https://climateactiontracker.org [accessed on 09 October 2024].

Figure 5-3: South Africa's modelled domestic pathways[43]

While these calculations provide a useful indication of the scale of the contribution of the Project's GHG emissions to South Africa's domestic pathways, this approach does have some limitations:

- Firstly, the contribution of a single project to national GHG emissions inventory is unlikely to look significant, particularly if the project is located within a country, such as South Africa, with high emissions relative to most other countries.
- Secondly, there are no official benchmarks which could be used to determine the significance of the Project's contribution to the national GHG emissions.

The impact significance is therefore not formally rated.

5.2.4.3 Benchmarking Against Pre-Defined Thresholds

The third criterion for assessing the Project's GHG emissions is benchmarking again pre-defined thresholds developed by the European Bank of Reconstruction and Development (EBRD) - **Table 5-7**. The thresholds are used by the EBRD for initial screening to determine the order of magnitude of a Project's annual GHG emissions during the operational phase[44]. These thresholds are used by EBRD as an early indicator of a project's likely contribution to the Bank's GHG inventory and GHG intensity of the Bank's investment portfolio. In the absence of other commonly agreed thresholds they are used as a proxy to rate the significance of the Project's GHG emissions contribution to atmospheric GHGs.

Table 5-7: Thresholds for assessing the significance of a Project's GHG emissions.

Benchmark thresholds (tCO_2e/a)[45]	Significance rating
Negligible	Very low
< 20,000	Low
> 20,000 and < 100,000	Medium-low
> 100,000 and < 1 million	Medium-high
> 1 million	High

In addition, this assessment qualitatively assesses the impact of the Project on South Africa's national climate commitments in **Section 9**.

6. Description of the Affected Environment

To understand the vulnerability of the Project to climate-related risks, it is necessary to establish the occurrence of hazards (**Section 6.1**) and projected changes in climate in the

[43] *Ibid*.

[44] EBRD (2010). *EBRD Methodology for Assessment of Greenhouse Gas Emissions*. Version 7, 6 July 2010

[45] Projects in the Negligible Emission Category typically involve activities with negligible emissions. This includes for example, telecommunications, civil construction projects, industrial wastewater treatment, and small-size built environment projects (i.e., overall floor area < 1,000 m^2). For projects in this category, a CCRA in generally not warranted. Projects in the Low and Medium-Low categories typically involve activities with very low to low carbon emissions. This includes for example, property developments, light industrial facilities, agricultural processing facilities, road development projects, municipal solid waste landfill, and brick manufacturing. For projects in these categories, a CCRA in generally not warranted, but should be assessed on a project-by-project basis. Projects in the Medium-High and High Categories, typically involve activities with high carbon emissions. This includes for example, fuel production and processing, glass manufacturing, cement and lime works, metal manufacturing and processing plants, and power generating plants. For projects in this category, a CCRA in generally considered to be mandatory.

near- and medium-term under different climate scenarios (**Section 6.2**). The sections that follow cover each of these factors in more detail.

6.1 Hazards

The IPCC defines hazards as the potential occurrence of "*a physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources*"[46].

Several hazards are identified for the Central Karoo and Namakwa District Municipalities in which the Project would be located. These hazards could negatively impact the Project. Wildfire has been assigned a high hazard rating, while water scarcity and extreme heat have been assigned a medium hazard rating (**Table 6-1**)[47] [48]. River flood and urban flood have been assigned a low hazard rating, while cyclone has been assigned a very low hazard rating.

Note that only wildfire and extreme heat are considered further in this assessment. The other hazards are deemed to pose limited risk to the Project for the following reasons:

- River flood – The wind turbines are typically situated on plateaus and ridges, making them less vulnerable to adverse effects of flooding.
- Urban flood - The Project site is not situated within an urban area.
- Water scarcity - The Project activities are not, by their nature, water intensive.
- Cyclone - The Project site is located well inland and away from the ocean.
- Landslide – The wind turbines are typically situated on plateaus and ridges, making them less vulnerable to landslides.

Table 6-1: Overview of hazard risk for the Central Karoo and Namakwa District Municipalities[49]

Hazard type		Hazard rating	Description
	Wildfire	High	Presently, there is greater than a 50% chance of encountering weather that could support a significant wildfire that is likely to result in both life and property loss in any given year.
	Extreme heat	Medium	Presently, there is more than a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years.
	Water scarcity	Medium	Presently, there is a 1% chance drought will occur in the coming 10 years. (return period of c. 1 in 1000 years).

[46] IPCC (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, USA.

[47] ThinkHazard! *Central Karoo District Municipality*. URL: Think Hazard [Accessed on 06 June 2025].

[48] ThinkHazard! *Namakwa District Municipality*. URL: Think Hazard [Accessed on 06 June 2025].

[49] *Ibid*.

Hazard type		Hazard rating	Description
	Urban flood	Low	Presently, there is a chance of more than 1% that potentially damaging and life-threatening river floods occur in the coming 10 years (return period of c. 1 in 1000 years)
	Cyclone	Very low	Presently, there is less than a 1% chance of potentially-damaging cyclone-strength winds in the project area in the next 10 years.
	River flood	Very Low	Presently, there is a chance of more than 1% that potentially damaging and life-threatening river floods occur in the coming 10 years (return period of c. 1 in 1000 years).

6.2 Observed and Projected Changes in Climate

The following section presents a brief description of the projected changes in climate for the provinces in which the project would be located. It is important to understand these changes as these are often the drivers of the climate hazards that pose a potential risk to the Project, as well as Project-affected communities, priority ecosystem services, and sites of demonstrated importance to climate mitigation and adaptation. As noted in **Section 5.1**, this assessment considers two climate scenarios, specifically SSP2-4.5 ("Middle of the Road") and SSP5-8.5 ("Fossil-fuelled development").

*Wind speed projections were not considered in the assessment below as CRA's conducted for similar projects located in close proximity to the Project yielded an immaterial impact.

6.2.1 Western Cape Province

6.2.1.1 Average Mean Surface Air Temperature

Average mean surface air temperature refers to the air temperature at approximately 2 m above the surface of the earth. From 1995 to 2014 (historical baseline), average mean surface air temperature was modelled to be 17.07°C (**Figure 6-1)**[50]**.** In the near-term (2020 to 2039), mean surface temperature is projected to continue to increase, relative to the historical baseline, by 0.59°C (3.5%) to 17.66°C for the SSP2-4.5 scenario and 0.72°C (4.20%) to 17.79°C for the SSP5-8.5 scenario.

[50] World Bank Group (2021). South Africa: Climate Projections. URL: South Africa - Mean Projections Expert | Climate Change Knowledge Portal [accessed on 06 June 2025].

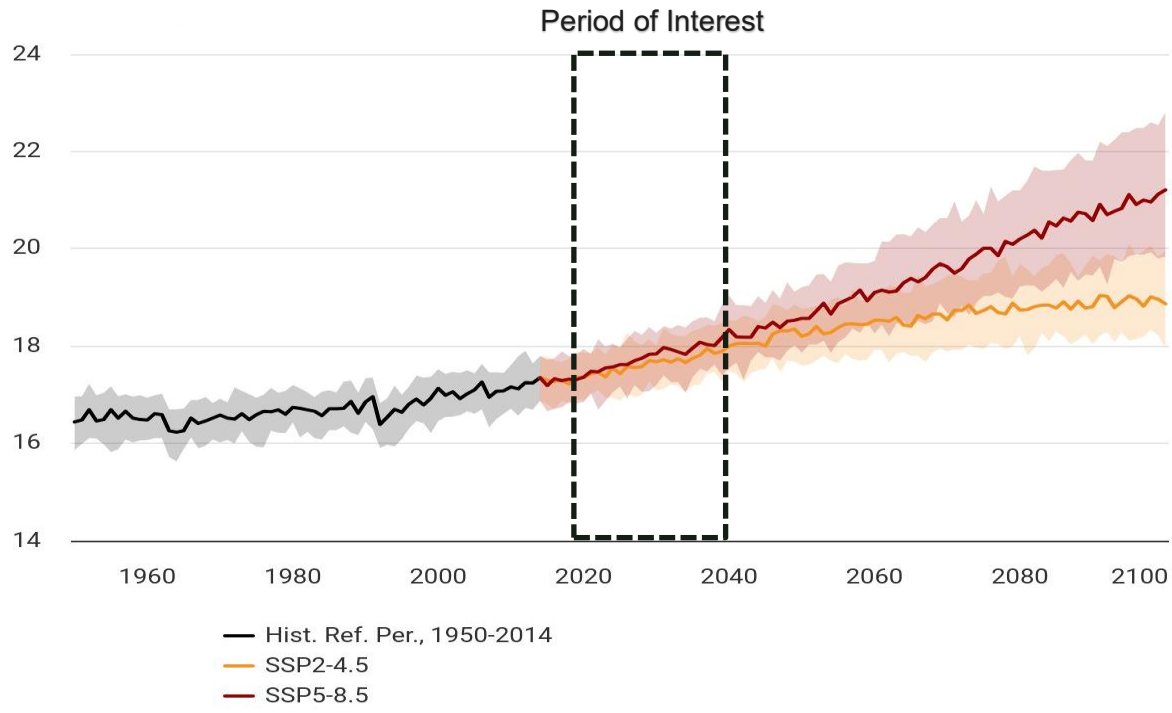


Figure 6-1: Projected change in mean surface temperature in the Western Cape province for the SSP2-4.5 and SSP5-8.5 scenarios[51].

6.2.1.2 Average Maximum Surface Air Temperature

The average maximum surface air temperature refers to the average maximum air temperature at approximately 2 m above the surface of the earth. From 1995 to 2014 (historical baseline), the average maximum surface temperature in the Western Cape was modelled to be 23.16°C (**Figure 6-2**)[52]. In the near-term (2020 to 2039), maximum surface temperature is projected to continue to increase, relative to the historical baseline, by 0.63°C (2.70%) to 23.79°C for the SSP2-4.5 scenario and 0.76°C (3.30%) to 23.92°C for the SSP5-8.5 scenario.

[51] Ibid

[52] World Bank Group (2021). South Africa: Climate Projections. URL: South Africa - Mean Projections Expert | Climate Change Knowledge Portal [accessed on 06 June 2025].

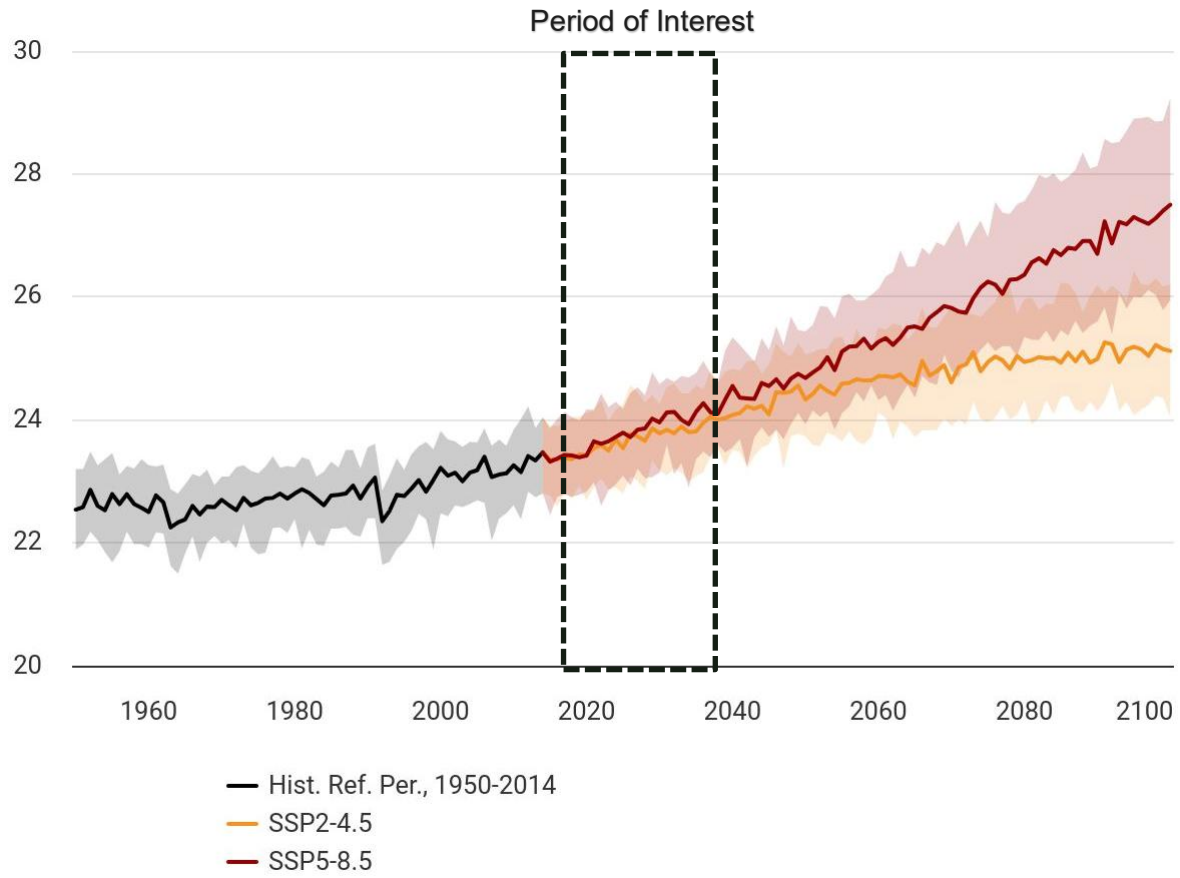


Figure 6-2: Projected change in the average maximum surface air temperature in the Western Cape province for the SSP2-4.5 and SSP5-8.5 scenarios[53]

6.2.1.3 Number of Very Hot Days

The average number of very hot days refers to the number of days in a given year a threshold temperature is exceeded. For this assessment, the threshold temperature of 35^{0}C was applied. From 1995 to 2014 (historical baseline), the average number of hot days in the Western Cape province was modelled to be 6.68 (**Figure 6-3**)[54]. In the near-term (2020 to 2039), the average number of hot days is projected to continue to increase, relative to the historical baseline, by 3.21 days (48.10%) to 9.89 days for the SSP2-4.5 scenario and 3.83 days (57.30%) to 10.51 days for the SSP5-8.5 scenario.

[53] *Ibid*
[54] *Ibid*

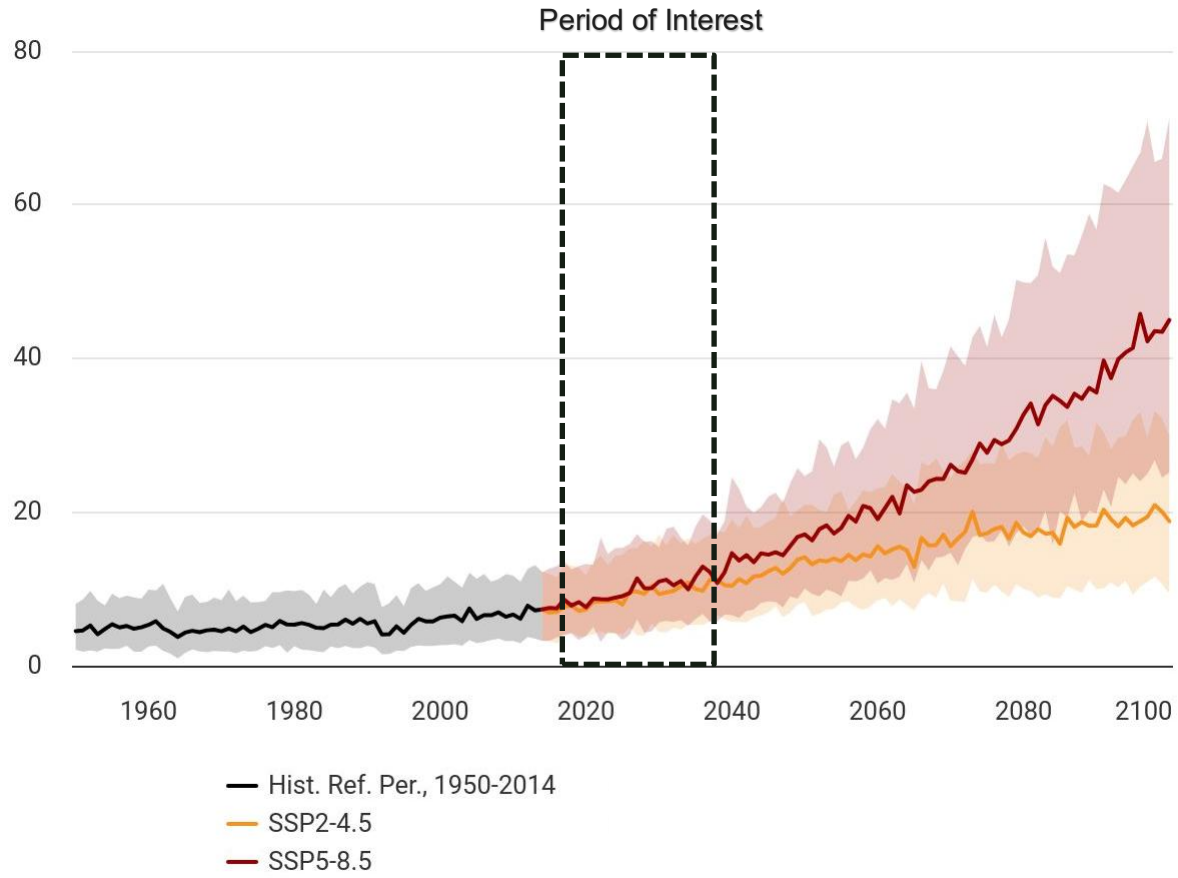


Figure 6-3: Projected change in the number of hot days in the Western Cape province for the SSP2-4.5 and SSP5-8.5 scenarios[55]

6.2.1.4 Precipitation

Precipitation refers to water released from clouds in the form of rain, freezing rain, sleet, snow, or hail. From 1995 to 2014 (historical baseline), mean annual precipitation in the Western Cape was modelled to be 361.24 mm (**Figure 6-4**)[56]. In the near-term (2020 to 2039), precipitation is projected to continue to decrease, relative to the historical baseline, by 10.85 mm (-3.00%) to 350.39 mm for the SSP2-4.5 scenario and decrease by 10.65 mm (-2.90%) to 350.59 mm for the SSP5-8.5 scenario.

[55] World Bank Group (2021). South Africa: Climate Projections. URL: South Africa - Mean Projections Expert | Climate Change Knowledge Portal [accessed on 06 June 2025].

[56] Ibid

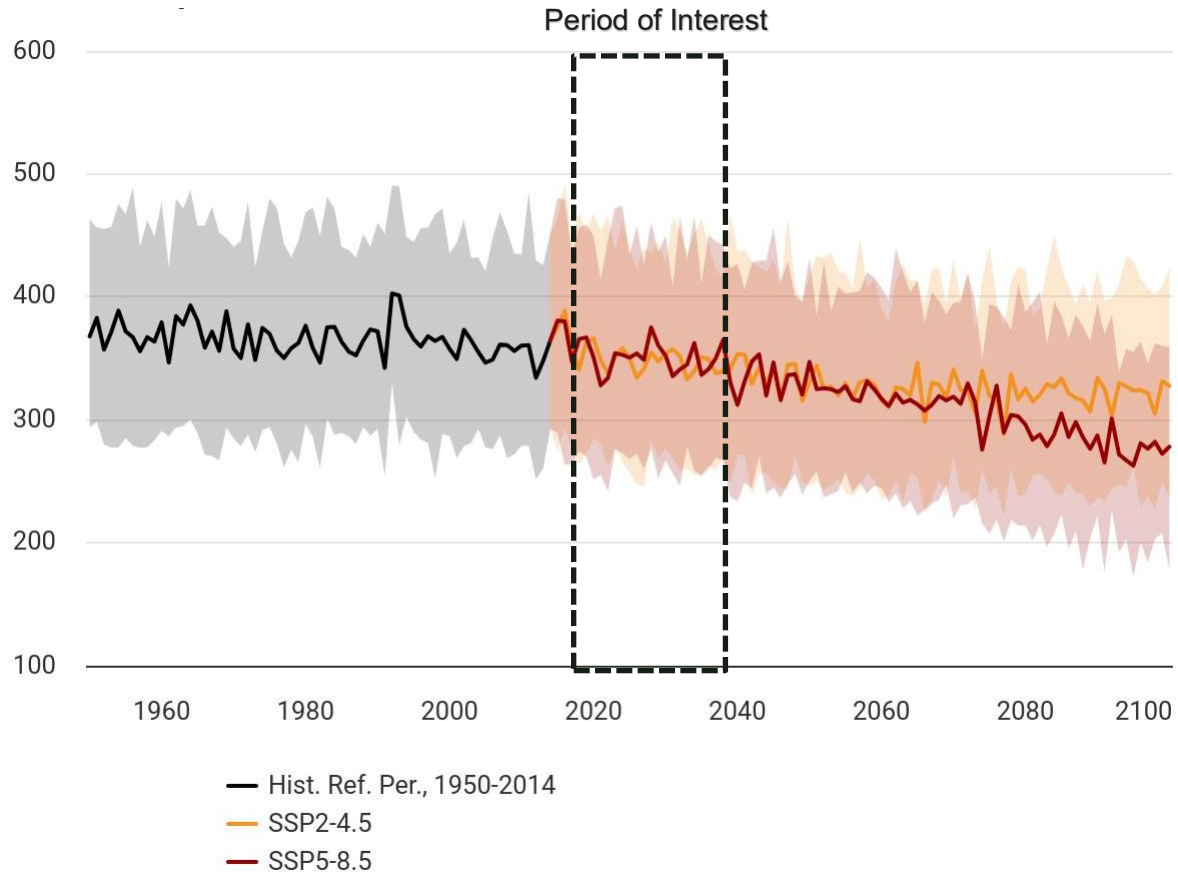


Figure 6-4: Projected change in precipitation in the Western Cape province for the SSP2-4.5 and SSP5-8.5 scenarios[57]

6.2.1.5 1-Day Cumulative Precipitation

1-day cumulative precipitation refers to the total precipitation accumulated over a consecutive 1-day period. From 1995 to 2014, 1-day cumulative precipitation was modelled to be 23.52 mm (**Figure 6-5**)[58]. In the near-term (2020 to 2039), the 1-day cumulative precipitation is projected to continue to increase, relative to the historical baseline, by 0.48 mm (+2.00%) to 24.00 mm for the SSP2-4.5 scenario and to decrease by 0.01 mm (-0.00%) to 23.51 mm for the SSP5-8.5 scenario.

[57] World Bank Group (2021). South Africa: Climate Projections. URL: South Africa - Mean Projections Expert | Climate Change Knowledge Portal [accessed on 06 June 2025].

[58] Ibid

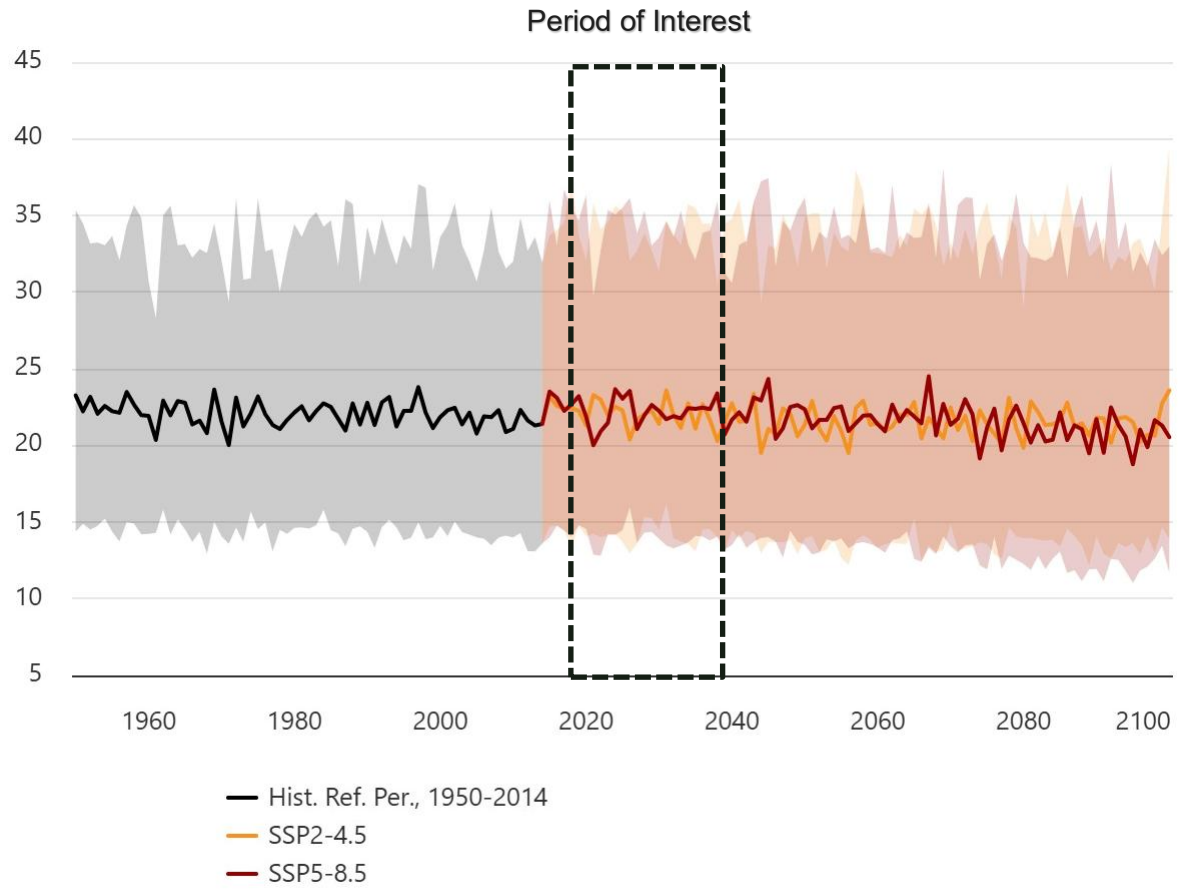


Figure 6-5: Projected change in the largest 1-day precipitation in the Western Cape province for the SSP2-4.5 and SSP5-8.5 scenarios[59]

6.2.2 Northern Cape Province

6.2.2.1 Average Mean Surface Air Temperature

Average mean surface air temperature refers to the air temperature at approximately 2 m above the surface of the earth. From 1995 to 2014 (historical baseline), average mean surface air temperature in Northern Cape was modelled to be 18.86°C (**Figure 6-6**)[60]. In the near-term (2020 to 2039), mean surface temperature is projected to continue to increase, relative to the historical baseline, by 0.78°C (4.10%) to 19.64°C for the SSP2-4.5 scenario and 0.93°C (4.9%) to 19.79°C for the SSP5-8.5 scenario.

[59] *Ibid*

[60] World Bank Group (2021). South Africa: Climate Projections. URL: South Africa - Mean Projections Expert | Climate Change Knowledge Portal [accessed on 06 June 2025].

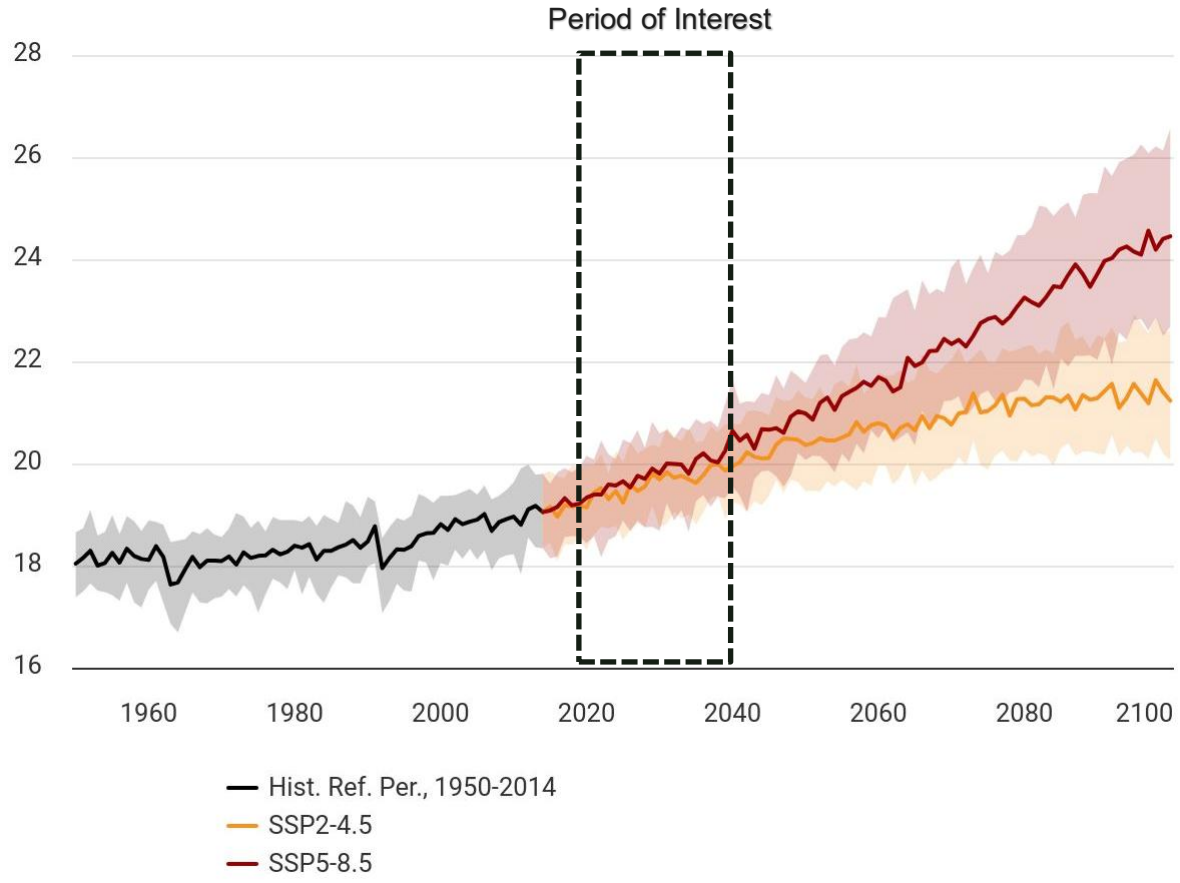


Figure 6-6: Projected change in mean surface temperature in the Northern Cape province for the SSP2-4.5 and SSP5-8.5 scenarios[61]

6.2.2.2 Average Maximum Surface Air Temperature

The average maximum surface air temperature refers to the average maximum air temperature at approximately 2 m above the surface of the earth. From 1995 to 2014 (historical baseline), the average maximum surface temperature in the Northern Cape was modelled to be 25.91°C (**Figure 6-7**)[62]. In the near-term (2020 to 2039), maximum surface temperature is projected to continue to increase, relative to the historical baseline, by 0.88°C (3.40%) to 26.79°C for the SSP2-4.5 scenario and decrease by 1.99°C (-7.70%) to 23.92°C for the SSP5-8.5 scenario.

[61] World Bank Group (2021). South Africa: Climate Projections. URL: South Africa - Mean Projections Expert | Climate Change Knowledge Portal [accessed on 06 June 2025].

[62] Ibid

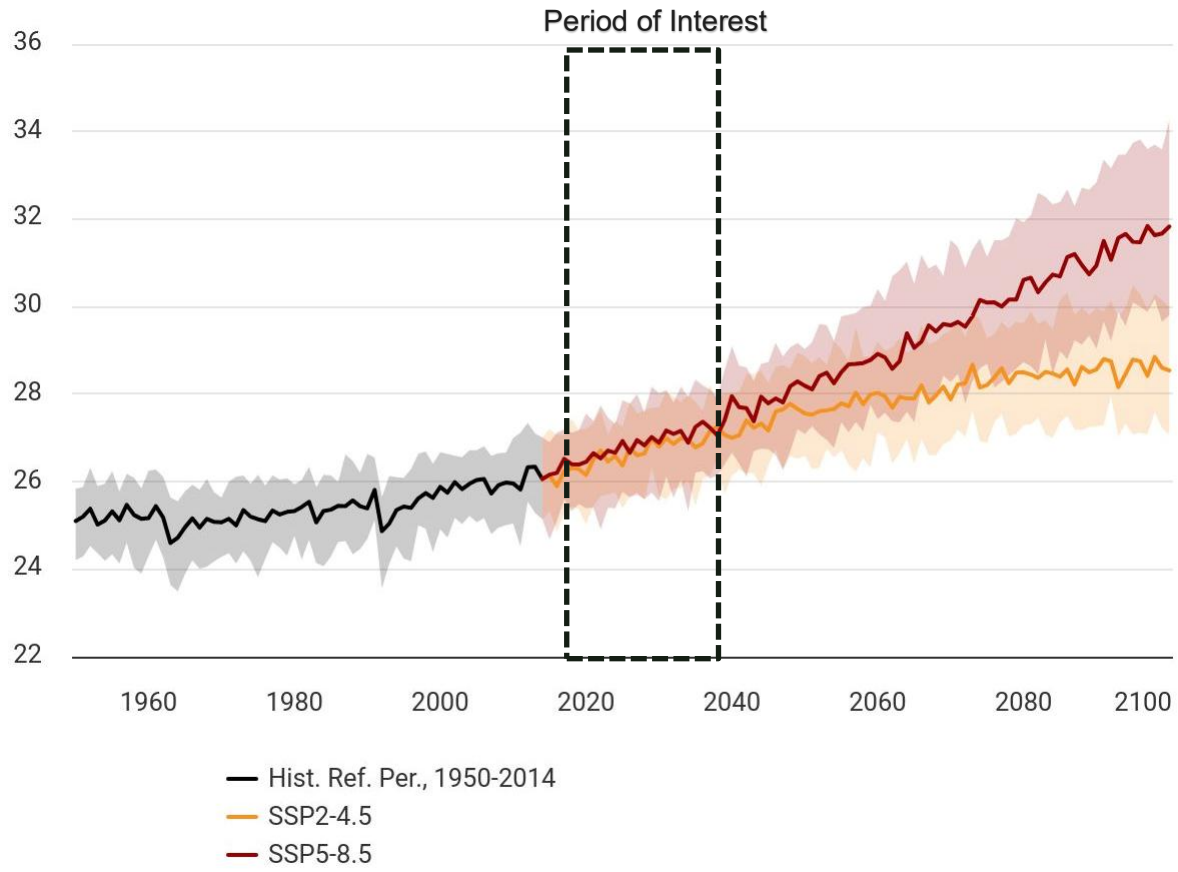


Figure 6-7: Projected change in the average maximum surface air temperature in the Northern Cape province for the SSP2-4.5 and SSP5-8.5 scenarios[63]

6.2.2.3 Number of Very Hot Days

The average number of very hot days refers to the number of days in a given year a threshold temperature is exceeded. For this assessment, the threshold temperature of 35^{0}C was applied. From 1995 to 2014 (historical baseline), the average number of hot days in the Northern Cape province was modelled to be 26.54 (**Figure 6-8**)[64]. In the near-term (2020 to 2039), the average number of hot days is projected to continue to increase, relative to the historical baseline, by 14.34 days (54.00%) to 40.88 days for the SSP2-4.5 scenario and 16.11 days (60.70%) to 42.65 days for the SSP5-8.5 scenario.

[63] World Bank Group (2021). South Africa: Climate Projections. URL: South Africa - Mean Projections Expert | Climate Change Knowledge Portal [accessed on 06 June 2025].

[64] *Ibid*

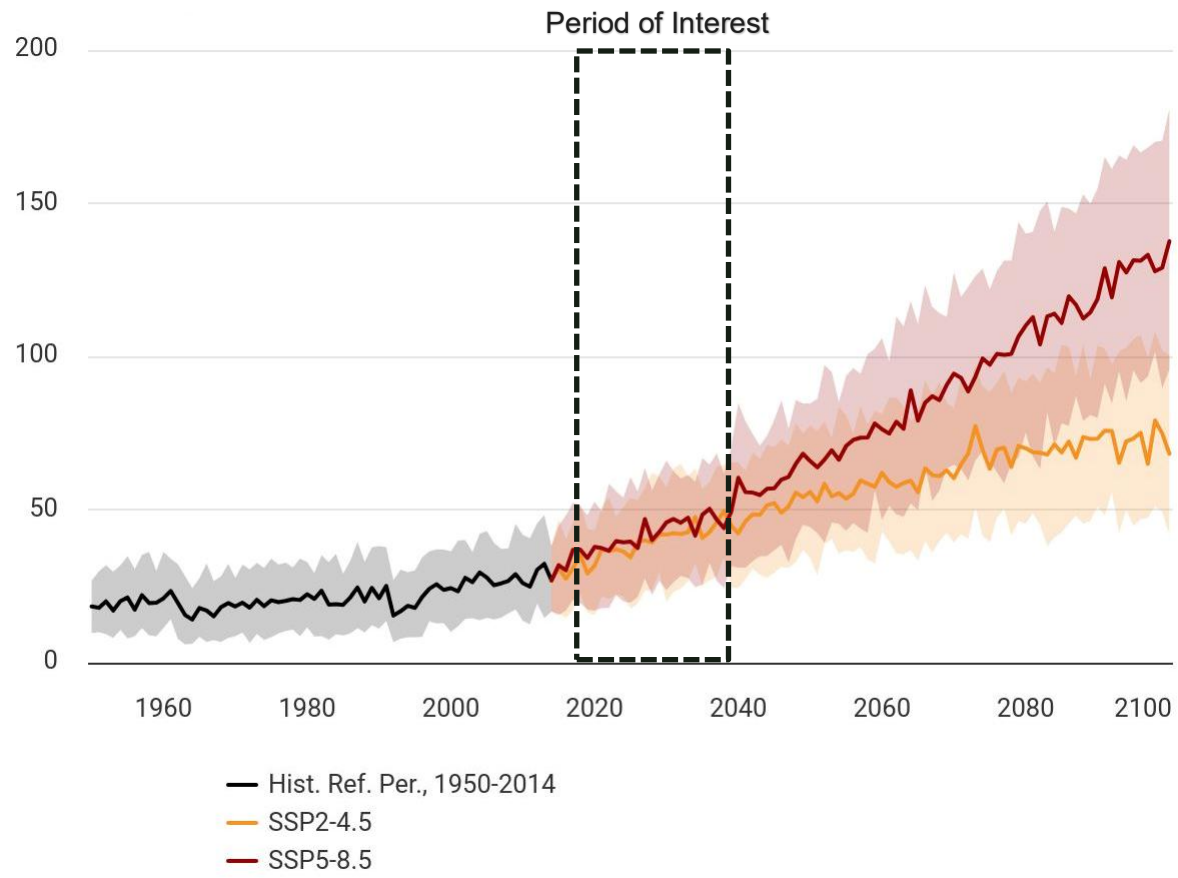


Figure 6-8: Projected change in the number of hot days in the Northern Cape province for the SSP2-4.5 and SSP5-8.5 scenarios[65]

6.2.2.4 Mean Monthly Precipitation

Precipitation refers to water released from clouds in the form of rain, freezing rain, sleet, snow, or hail. From 1995 to 2014 (historical baseline), mean annual precipitation in the Northern Cape province was modelled to be 275.20 mm (**Figure 6-9**)[66]. In the near-term (2020 to 2039), precipitation is projected to continue to decrease, relative to the historical baseline, by 11.82 mm (-4.30%) to 263.38 mm for the SSP2-4.5 scenario and decrease by 6.61 mm (-2.40%) to 268.59 mm for the SSP5-8.5 scenario.

[65] World Bank Group (2021). South Africa: Climate Projections. URL: South Africa - Mean Projections Expert | Climate Change Knowledge Portal [accessed on 06 June 2025].

[66] *Ibid*

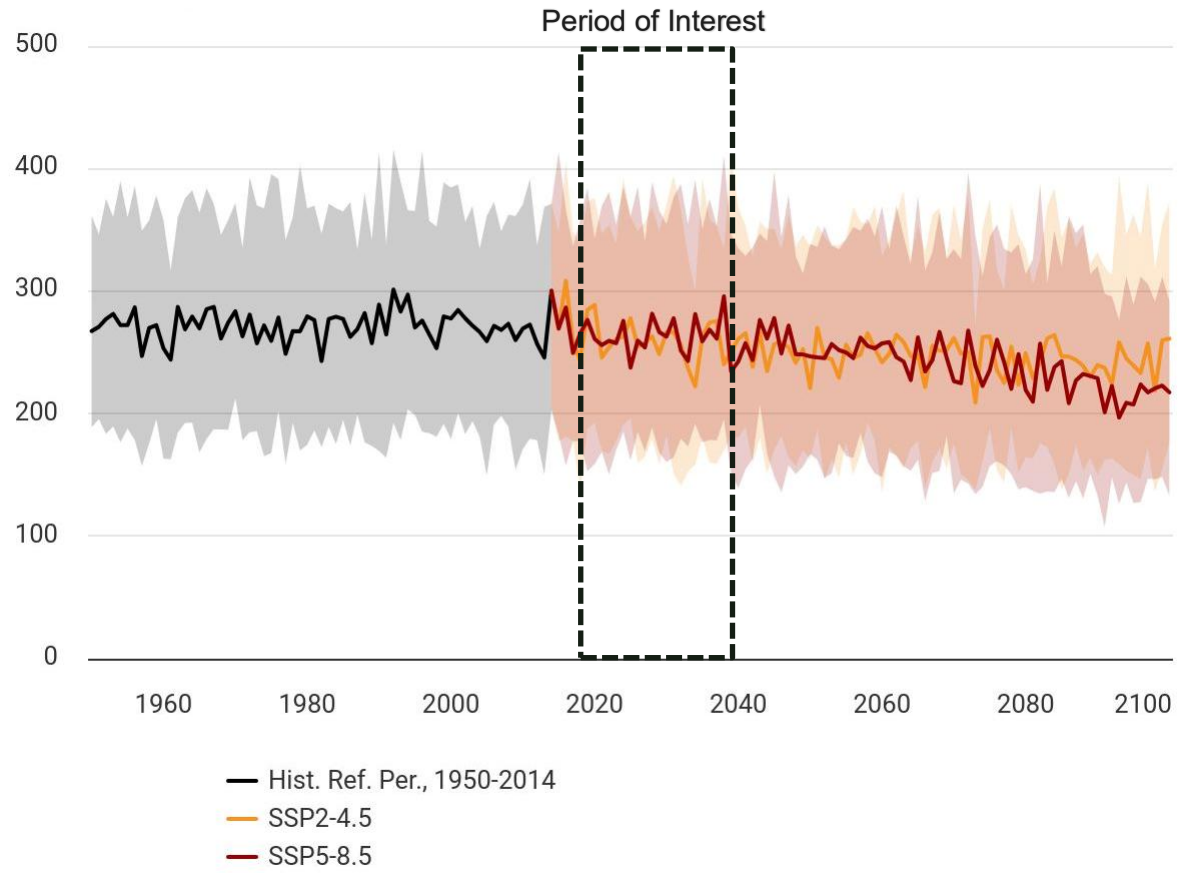


Figure 6-9: Projected change in precipitation in the Northern Cape province for the SSP2-4.5 and SSP5-8.5 scenarios[67]

6.2.2.5 1-Day Cumulative Precipitation

1-day cumulative precipitation refers to the total precipitation accumulated over a consecutive 1-day period. From 1995 to 2014 (historical baseline), the average 1-day cumulative precipitation event in the Northern Cape province was modelled to be 20.74 mm (**Figure 6-10**)[68]. In the near-term (2020 to 2039), the 1-day cumulative precipitation is projected to continue to decrease, relative to the historical baseline, by 0.04 mm (-0.20%) to 20.70 mm for the SSP2-4.5 scenario and decrease by 0.13 mm (-0.60%) to 20.61 mm for the SSP5-8.5 scenario.

[67] World Bank Group (2021). South Africa: Climate Projections. URL: South Africa - Mean Projections Expert | Climate Change Knowledge Portal [accessed on 06 June 2025].

[68] Ibid

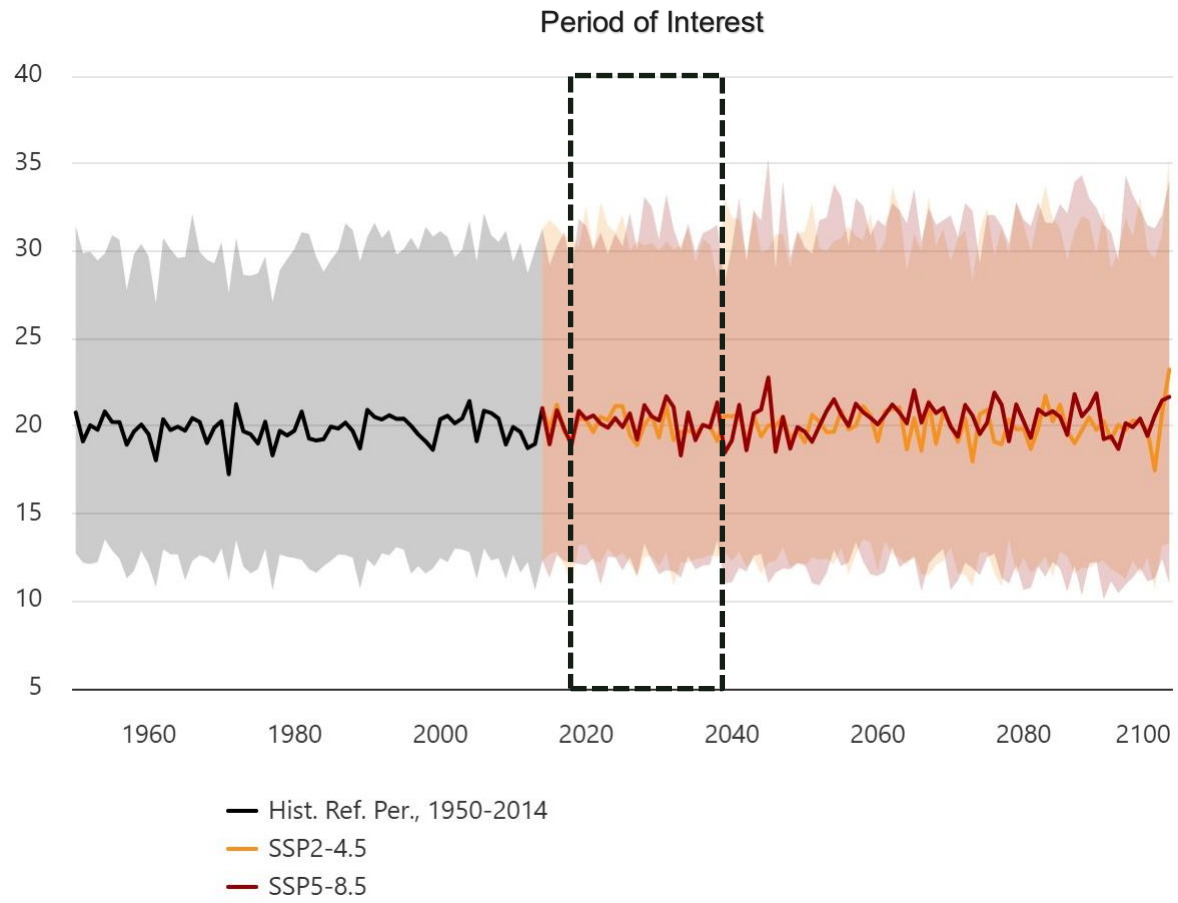


Figure 6-10: Projected change in the largest 1-day precipitation in the Northern Cape province for the SSP2-4.5 and SSP5-8.5 scenarios[69]

7. Project's Calculated GHG Emissions

7.1 Construction Phase

Using the methodology outlined in **Section 5.2.3**, it was calculated that the total direct (scope 1) GHG emissions for the construction phase are 2,810 tCO_2e (**Table 7-1**). As the construction phase would likely be 24 months in duration, it was assumed that the emissions would be split 50/50, yielding 1,405 tCO_2e in 2025, and 2026 respectively.

[69] World Bank Group (2021). South Africa: Climate Projections. URL: South Africa - Mean Projections Expert | Climate Change Knowledge Portal [accessed on 06 June 2025].

Table 7-1: Calculation of total GHG emissions for the construction phase

Emission source	Average monthly consumption	Emission factor[70]	Duration	Total GHG emissions
Freight transport	42,001 ℓ	2.662 ($kgCO_2e/ℓ$)	24 months	2,683 tCO_2e
Diesel generators	1,082 ℓ	2.662 ($kgCO_2e/ℓ$)	24 months	69 tCO_2e
Bus transport	1,564 km	0.454 ($kgCO_2e$/km)	24 months	17 tCO_2e
Taxi transport	8,200 km	0.208 ($kgCO_2e$/km)	24 months	41 tCO_2e
			Total GHG emissions	**2,810 tCO_2e**
			Duration of construction phase	2 years
			Average annual GHG emissions	**1,405 tCO_2e**

7.2 Operations Phase

Using the methodology outlined in **Section 5.2.3**, it was calculated that the total direct (scope 1) GHG emissions for the operations phase are 81,180 tCO_2e (**Table 7-2**). Over the 20-year life of the Project, the average annual GHG emissions are calculated to 4,059 tCO_2e.

Table 7-2: Calculation of total GHG emissions for the operations phase

Description	Value	Unit
Mean life cycle carbon emissions for wind energy facilities[71]	34.11	gCO_2e / kWh
Percentage of life carbon emissions[72]	23.9	%
Mean carbon emissions for construction phase	8.15	gCO_2e / kWh
Total yield over project lifespan	9,958,000,000	kWh
Total GHG emissions	**81,181**	**tCO_2e**
Total duration of operations phase	**20**	**years**
Average annual GHG emissions	**4,059**	**tCO_2e**

[70] Department for Energy Security and Net Zero (2024). *Greenhouse gas reporting: conversion factors 2024*. URL: https://www.gov.uk/ [accessed on 06 June 2025].

[71] Sovacool B. (2014). Assessing the Lifecycle Greenhouse Energy: A Critical Meta-Survey. *Energy Policy*. Vol. 65. pp. 229-244

[72] *Ibid*.

8. Assessment of the Project's GHG Emissions

8.1 Comparison to Alternative Technologies

Impact Description

The first criterion for assessing the Project's GHG emissions is a comparison of the lifecycle GHG emissions of the preferred technology (i.e., wind energy) and other technology alternatives (i.e., coal, natural gas, nuclear, solar PV, and CSP).

Lifecycle assessments indicate that the GHG emissions for renewable energy technologies are generally lower than that of fossil fuel technologies[73]. The median values for renewable energy technologies range from 1 to 12 grams carbon dioxide equivalent per kilowatt hour ("gCO_2e/kWh"), while those of fossil fuel technologies range from 460 to 1,020 gCO_2e/kWh[74].

Impact Assessment

Figure 8-1 presents a comparison of the lifecycle GHG emissions of other technology alternatives, namely solar PV, CSP, nuclear, natural gas, and coal, in comparison to onshore wind energy, the preferred technology alternative.

It was calculated that the lifecycle GHG emissions for producing the same quantity of energy (i.e. 497,900 MWh/year) using nuclear (5,477 tCO_2e), CSP (4,481 tCO_2e), solar PV (2,738 tCO_2e), gas (228,536 tCO_2e), and coal (507,360 tCO_2e), was greater than that of onshore wind energy, the preferred technology alternative (zeroed for comparison purposes). As the lifecycle GHG emissions of the preferred technology is lower than that of feasible technology alternatives, the impact of the Project's GHG emissions, from alternatives analysis perspective is deemed to be **Positive**.

[73] IPCC (2011). *Renewable Energy Sources and Climate Change Mitigation*. Cambridge University Press, Cambridge, United Kingdom and New York

[74] NREL (2021). Life Cycle Greenhouse Gas Emissions from Electricity Generation: Update. URL: https://www.nrel.gov [accessed on 06 June 2025].

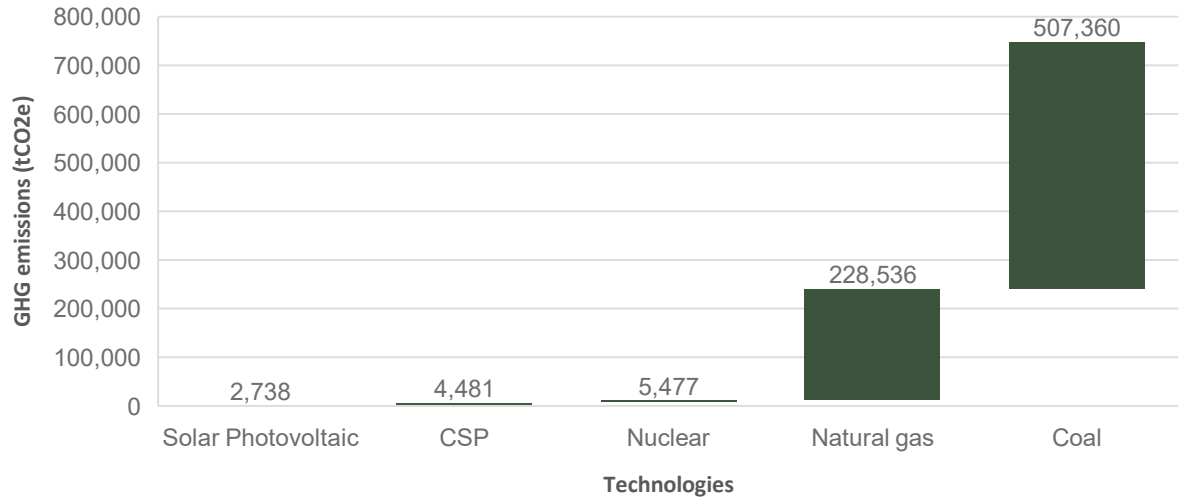


Figure 8-1: Comparison of the lifecycle GHG emissions of various technology alternatives relative to wind energy, the preferred option.

8.2 Contribution to South Africa's Modelled Domestic Pathways

Impact Description

The second criterion for assessing the Project's GHG emissions is the contribution of the Project's GHG emissions to South Africa's four modelled domestic pathways. As mentioned previously in **Section 5.2.4.2**, CAT has modelled four domestic pathways to evaluate whether South Africa's targets and policies are on track towards decarbonisation in line with 1.5°C temperature limit of the Paris Agreement. This includes:

- 1.5°C Paris Agreement Compatible.
- Almost Sufficient.
- Insufficient.
- Highly Insufficient.

The contribution of the Project's estimated GHG emissions to country's four modelled pathways was calculated for the period 2026 to 2050[75] **(Table 8-1**). The calculated contribution ranges between 0.0002% (Highly Insufficient pathway) and 0.0028% (1.5°C Paris Agreement Compatible pathway).

Table 8-1: Percentage contribution of the Project's GHG emissions to South Africa's four domestic modelled pathways

Year	Project's GHG emissions (MtCO2e)	1.5°C Paris Agreement Compatible Pathway	Almost Sufficient Pathway	Insufficient Pathway	Highly Insufficient Pathway
2025	0.001	0.0003%	0.0003%	0.0003%	0.0002%

[75] Although the life of the Project extends beyond 2050, CAT have only modelled the country's domestic pathways up until 2050.

Year	Project's GHG emissions (MtCO2e)	1.5°C Paris Agreement Compatible Pathway	Almost Sufficient Pathway	Insufficient Pathway	Highly Insufficient Pathway
2026	0.001	0.0003%	0.0003%	0.0003%	0.0002%
2027	0.004	0.0009%	0.0008%	0.0008%	0.0007%
2028	0.004	0.0009%	0.0009%	0.0008%	0.0006%
2029	0.004	0.0009%	0.0009%	0.0008%	0.0006%
2030	0.004	0.0009%	0.0009%	0.0008%	0.0006%
2031	0.004	0.0010%	0.0009%	0.0008%	0.0006%
2032	0.004	0.0010%	0.0009%	0.0008%	0.0006%
2033	0.004	0.0010%	0.0009%	0.0008%	0.0006%
2034	0.004	0.0010%	0.0009%	0.0008%	0.0006%
2035	0.004	0.0011%	0.0010%	0.0008%	0.0006%
2036	0.004	0.0011%	0.0010%	0.0008%	0.0006%
2037	0.004	0.0012%	0.0010%	0.0008%	0.0006%
2038	0.004	0.0013%	0.0010%	0.0008%	0.0006%
2039	0.004	0.0014%	0.0011%	0.0008%	0.0005%
2040	0.004	0.0015%	0.0011%	0.0008%	0.0005%
2041	0.004	0.0016%	0.0011%	0.0008%	0.0005%
2042	0.004	0.0018%	0.0012%	0.0008%	0.0005%
2043	0.004	0.0020%	0.0012%	0.0008%	0.0005%
2044	0.004	0.0023%	0.0012%	0.0008%	0.0005%
2045	0.004	0.0027%	0.0013%	0.0008%	0.0005%
2046	0.004	0.0028%	0.0013%	0.0008%	0.0005%
Min		**0.0003%**	**0.0003%**	**0.0003%**	**0.0002%**
Max		**0.0028%**	**0.0013%**	**0.0008%**	**0.0007%**

Impact Assessment

As mentioned previously, the significance of the contribution of the Project's GHG emissions to South Africa's domestic modelled pathways is not formally rated as there is no official benchmark which could be used.

8.3 Benchmarking Against Pre-Defined Thresholds

Impact Description

The third criterion for assessing the Project's GHG emissions is benchmarking Project-related GHG emissions against pre-defined thresholds. As mentioned previously in **Section 5.2.4**, the EBRD developed thresholds which are used for initial screening to determine the

order of magnitude of a Project's annual GHG emissions during the operational phase[76]. These thresholds are used in this CCRA as a proxy to assess the significance of the Project's GHG emissions.

The Project's average annual GHG emissions during the operations phase are estimated to be 4.059 tCO_2e. Based on the thresholds presented in **Table 5-7** (i.e., Negligible), the significance of the Project's annual GHG emissions is classed as **Low**.

Recommended Mitigation Measures

Required mitigation measures to further reduce the Project's GHG emissions are listed below:

- Diesel generators should be sized appropriately so that they run at their optimal workload (e.g., 70% to 100% of total load rating).
- Diesel generators should be regularly maintained in accordance with the manufacturers service schedule.
- Construction materials should be sourced as close to the work front as possible to reduce transport distances and carbon emissions.
- For the transport of materials and equipment, the vehicle load should be maximised to increase fuel efficiency and reduce emissions.
- Truck drivers should receive training on good driving practices to improve fuel economy and reduce carbon emissions.

9. Risk and Opportunities Assessment

The following section presents an assessment of the impact of a changing climate on the Project, as well as the opportunities that may arise for the Project with the transition to a lower carbon economy. The section also presents an assessment of the impact of the Project on communities, priority ecosystem services, and sites of demonstrated importance for climate change mitigation or adaptation, which are or likely to be adversely affected by climate change. The impacts are assessed using the methodology described in **Section 5.1.3.2**

9.1 Climate-Related Risks for the Project

9.1.1 Increased Risk of Wildfires

Risk	Increased risk of wildfires adversely affecting critical project infrastructure, potentially leading to increased capital costs, reduced generating capacity, and revenue losses.
TCFD Category	Physical - Acute
Risk description	The observed and projected increase in mean annual temperature and maximum daily temperature are likely to create hotter and drier conditions in the future, which can lead to an increase in the occurrence and spread of wildfires[77].

[76] EBRD (2010). *EBRD Methodology for Assessment of Greenhouse Gas Emissions*. Version 7, 6 July 2010

[77] Council for Scientific and Industrial Research (2019). *Green Book: The Impact of Climate Change on Wildfires in South Africa*. URL: https://pta-gis-2-web1.csir.co.za [accessed on 06 June 2025].

	Wildfire can result damage to critical project infrastructure. This may lead to increased capital costs from the replacement or repair of fire-damaged infrastructure. This may also lead to reduced generation capacity and revenue losses. The Project is relatively exposed and vulnerable to the adverse effects of wildfire as it surrounded by mostly undeveloped areas from which a wildfire can spread.	
Impact	Significant	Material financial impact as a wildfire could lead to significant capital costs with the need to replace or repair fire-damaged infrastructure (10%-50% monetary loss). The damage to critical project infrastructure could also lead to a reduction in production capacity and loss in revenue.
Likelihood	Unlikely	Although the conditions that can lead to an increase in the occurrence and spread of wildfires is projected to increase in the future, and the area currently experiences high natural wildfire frequencies, it is unlikely that a wildfire will adversely affect the Project with the implementation of the following mitigation measures already contained in the EMPr: • Ensure activities occurring on the Project site do not result in a fire. • Hold regular fire prevention talks with staff to create awareness regarding the risks of fire. • Appoint a fire officer, ensuring that the Project's response to a fire event is immediate and appropriate. • Construct a fire break around the footprint area prior to construction. The firebreak is to undergo regular maintenance. • Install "No-smoking" signs in areas used for the storage of oil and fuel. • Provide all construction camps with portable fire extinguishing equipment in accordance with all relevant legislation. • Service all fire extinguishers via an accredited service provider annually. • Ensure that the contractor has basic firefighting equipment on site at all times. • Ensure that the contractor has special measures in place regarding the spread of veld fires caused by activities at the campsites. • Ensure smoking only occurs in designated areas. • Install fire prevention facilities at all storage facilities. • Place emergency numbers for local police and fire department in prominent positions. • Prohibit fires in all localities on site apart from the designated cooking area. • Report any fires to the ESCO/ ECO immediately who will subsequently liaise with the local Fire Protection Agency.
Risk score	Low	

Adaptation/ mitigation measures	No additional mitigation measures are recommended.

9.1.2 Increased Risk of Extreme Heat

Risk	Increased risk of extreme heat adversely affecting the health of employees.	
TCFD Category	Physical - Acute	
Risk description	The projected increase in the frequency of hot days (> 35^0C) and warm spells, may lead to increased risk of employees suffering from heat stress. Heat stress can adversely affect an employees' health and productivity, and in extreme cases, result in loss of life. Heat stress may also lead to lower productivity and reduced revenue. Elderly employees or employees with pre-existing medical conditions, such as diabetes, are typically more vulnerable to the adverse effects of extreme heat.	
Impact	Major	In extreme cases, heat stress can be a life-threatening injury.
Likelihood	Rare	Although the conditions, which can lead to an increase in the occurrence and intensity of heat stress, is projected to increase in the future, it is highly unlikely that heat stress will adversely affect the health of employees. This is because many of the employees will be from the area and are likely to be relatively accustomed to extreme heat. The likelihood can be further reduced with the implementation of the adaptation measures listed below.
Risk score	Low	
Adaptation/ mitigation measures	A comprehensive employee health awareness program should be designed and implemented to inform both employees and contractors about the hazards associated with heat stroke and dehydration, as well as effective strategies for prevention and mitigation. Employees must be provided with appropriate personal protective equipment to reduce sun exposure and risk of heat stroke/ dehydration. On very hot days (i.e., >30°C), work should be rescheduled to cooler parts of the day, employees should be provided with more frequent rest breaks, and/or employees should be provided with shaded rest areas.	

9.1.3 Increased Risk of More Stringent Climate Policies and Legislation

Risk	Increased risk of more stringent climate policies and legislation which could lead to higher operational costs.
TCFD Category	Transition – Policy and legislation
Risk description	With the transition to a lower carbon economy, impacts may arise from legislation or policy actions that attempt to constrain activities which are incompatible with a country's national climate mitigation and/or adaptation commitments. Projects that are not aligned with national climate commitments may present higher transition risks due to the nature of the operations, which may adversely affect the commercial decisions of financial institutions.

	In determining the compatibility of a project with a country's national climate commitments, the first step is to determine if the project is included on the list of activity types that are universally considered to "not" be aligned with the goals of the Paris Agreement. It was found that the Project was not one of the activity types included on this list. The second step is to determine if the project is included on the list of activity types that are universally considered to be aligned with the goals of the Paris Agreement. It was found that the Project is one of the activity types included on this list and is therefore considered to be aligned, by default, with the goals of the Paris Agreement.	
Impact	Slight	A change in climate policies and legislation is likely to have little or no impact on operational uptime or revenue.
Likelihood	Rare	As the Project is, by default, aligned with the goals of the Paris Agreement, it is unlikely that a change in climate policies and legislation would adversely affect the Project.
Risk score	Low	
Adaptation/ mitigation measures	No additional mitigation measures are recommended.	

9.1.4 Increased Risk of More Stringent Waste Policies and Legislation

Risk	Increased risk of more stringent waste policies and legislation which could lead to higher operational costs.	
TCFD Category	Transition – Policy and legislation	
Risk description	With the transition to a lower carbon economy, there is growing global concern over the large number of end-of-life wind turbine blades and the lack of facilities for recycling and/or safe disposal of such blades. These blades are often made from composite materials like fiberglass or carbon fibre, which are difficult to recycle. Furthermore, these materials are designed for strength and durability, making them hard to break down and separate. There is an increased risk of more comprehensive regulations in the future governing the disposal and recycling of end-of-life wind turbine blades, may lead to increased operating costs for the recycling and/or safe disposal of such blades. While the EMPr outlines waste management measures applicable across all phases of the Project, it does not include specific provisions for the disposal or management of end-of-life turbine blades.	
Impact	Minor	A change in waste policies and legislation is likely to have minor impact on operations.
Likelihood	Possible	It is possible that more stringent waste policies and legislation could happen in the next ten years.
Risk score	Low	
Adaptation/ mitigation measures	Undertake an assessment of the best practicable environmental option for the end-of-life blades. This plan must be reviewed and updated at least every five years. During the review, it is essential to re-evaluate the 'best practicable	

	environmental option' by considering new and emerging waste technologies and processes.

9.2 Climate-Related Risks for Project-Affected Communities, Priority Ecosystem Services, and Sites of Demonstrated Importance to Climate Change Adaptation

In accordance with the requirements of IFC Performance Standards, this CCRA also considers the implications of climate change for:

- **Communities that are already impacted by climate change, which may experience an acceleration and/or intensification of impacts due to Project activities:** Deemed to be negligible as there are presently no communities living on or using the Project site. Furthermore, the current landowners have leased the portions of the farms to be developed to Karreebosch.
- **Impacts on priority ecosystem services which may be exacerbated by climate change:** Ten Type I ecosystem services (directly used or consumed by humans) were identified for the Project site, of which, three are considered to be priority ecosystem services[78]. This includes surface water (provisioning), water purification and groundwater recharge (regulating), and erosion prevention and maintenance of soil fertility (regulating). In addition, two Type II ecosystem services (indirectly support human well-being) were identified, both of which are considered to be priority ecosystem services. This includes water (provisioning) and vegetation cover for erosion prevention (regulating). The impact of the Project on the identified priority ecosystem services is deemed to be negligible as most of the Project infrastructure will be established on land which is classified as 'low agricultural sensitivity'[79]. Moreover, the impact will be further reduced through the implementation of the mitigation measures included in the existing EMPr.
- **Forest areas and marine and coastal habitats that are vulnerable to the effects of climate change or which contribute to climate change mitigation:** Deemed to be negligible as the Project site is located inland, about 160 km from the nearest coastline. Furthermore, there are no forests or dense woodlands within the boundaries of the Project site.
- **Sites of demonstrated importance to climate change adaptation for either species or ecosystems:** Deemed to be negligible for the following reasons:
    - The site layout is predominantly classified as land of 'low agricultural sensitivity', historically utilised for grazing with limited crops and pastures.
    - The final amendment of the site's layout avoids any land rated as more than a medium sensitivity. Additionally, the site layout results in the limited transformation and negligible cumulative loss of natural habitat.
    - Due to the limited development footprint, it is likely that any mammal species identified to be of conservation concern would be classified as transient visitors, which can easily be relocated to similar habitat nearby.

[78] Biodiversity Africa (2023). *Ecosystem Services Assessment Report for the Karreebosch Wind Energy Facility and Electricaql Gridline Infrastructure, Northern Cape and Western Cape, South Africa*.

[79] Karreebosch Wind Farm and Associated Infrastructure, Northern Cape & Western Cape Provinces. Final Environmental Management Programme). WSP. 2022. https://sahris.sahra.org.za/. [Accessed on 06 June 2025]

- The Project site is not located close to any recognised national Important Bird Areas. However, the Verreaux Eagle (VE) does, on occasion, nest within the site boundary. In this regard, the Site's bird monitoring process is conducted in accordance with South Africa's Birdlife Best Practice Manual and Specialist Recommendation. Moreover, nests located during initial site walkabouts have been afforded a buffer of 3 km. All 25 wind turbine blades will be painted with red and white stripes.
- The critical habitat assessment identified one endangered species (*Lotononis venosa*) and twenty-one restricted range and endemic plant species as triggers for critical habitat[80]. None of these species were, however, recorded within the development footprint.

As the climate-related risks for Project-affected communities, priority ecosystem services, and sites of demonstrated importance to climate change adaptation, are deemed to be negligible, no additional mitigation measures, other than those already included in the EMPr are recommended.

10. Supplementary Recommendations for the SLIP

Table 10-1 presents a summary of the recommendations in addition to those included in the existing EMPr. These recommendations are to be included in the supplementary lender information pack (SLIP). For the purposes of this assessment, "must" is used for recommendations which are deemed to be obligations, while "should" is used for recommendations which are strongly recommended.

[80] Biodiversity Africa (2023). *Critical Habitat Assessment of the Karreebosch Wind Energy Facility and Electricaql Gridline Infrastructure, Northern Cape and Western Cape, South Africa*.

Table 10-1: Summary of additional recommendations to be included in the SLIP.

No.	Project phase	Aspect	Management commitment	Action plan			
				Timeframe	Frequency	Performance indicator	Responsibility
1.	Construction, operational, and closure	Climate change	A comprehensive employee health awareness program should be designed and implemented to inform both employees and contractors about the hazards associated with heat stroke and dehydration, as well as effective strategies for prevention and mitigation. Employees must be provided with appropriate personal protective equipment to reduce sun exposure and risk of heat stroke/ dehydration. On very hot days (i.e., >30°C), work should be undertaken in accordance with the thermal requirements of the Occupation Health and Safety Act 85 of 1993 (as amended). Additional mitigation measures include: • Rescheduling hard manual labour to cooler parts of the day. • Providing more frequent rest breaks. • Providing shaded rest areas.	Duration of construction, operational, and closure phases	Ongoing	Implementation of Worker Health Awareness Program.	HSE Manager
4.	Operational and closure	Waste Management Plan	Undertake an assessment of the best practicable environmental option for the end-of-life blades. This plan must be reviewed and updated at least every five years. During the	Operational and closure	As required	Assessment of the best practicable environmental option for the end-of-life blades	Engineering

No.	Project phase	Aspect	Management commitment	Action plan			
				Timeframe	Frequency	Performance indicator	Responsibility
			review, it is essential to re-evaluate the 'best practicable environmental option' by considering new and emerging waste technologies and processes				
5.	Construction phase	GHG emissions	Diesel generators must be sized appropriately so that they run at their optimal workload (e.g., 70% to 100% of total load rating).	Construction and operational	Once-off	Diesel run at their optimal workload	Engineering Manager
6.	Construction phase	GHG emissions	Diesel generators must be regularly maintained in accordance with the manufacturers service schedule.	Construction and operational	Once-off	Diesel generators maintained in accordance with the manufacturers service schedule.	Engineering Manager
7.	Construction phase	GHG emissions	Construction materials should be sourced as close to the work front as possible to reduce transport distances and GHG emissions.	Construction	Once-off	Construction materials sourced, to the extent possible, as close to the work front as possible.	Engineering Manager
8.	Construction phase	GHG emissions	For the transport of materials and equipment, the vehicle load should be maximised to increase fuel efficiency and reduce emissions.	Construction	Once-off	Vehicle load maximised, to the extent possible, to increase fuel efficiency and reduce emissions.	Engineering Manager
9.	Construction phase and operational phases	GHG emissions	Truck drivers should receive training on good driving practices to improve fuel economy and reduce GHG emissions.	Construction and operational	Once-off	Truck drivers have received training on good driving practices to improve fuel economy and reduce GHG emissions.	HSE Manager

11. Conclusion

The observed and projected changes in climate in the near-and medium-term are unlikely to pose a significant risk to the Project. The climate-related risks to the Project, including both physical and transitional risks, were assessed to be **Low**.

The Project was found to be compatible with EBRD's list of activities that are aligned with the Paris Agreement, and therefore, deemed to be broadly compatible with South Africa's national climate commitments.

During the construction phase, the Project's GHG emissions are calculated to be 2,810 tCO_2e, with 1,405 tCO_2e per year of construction (two years in total – spanning 2025-2026). During the operations phase, the Project's GHG emission are calculated to be 81,180 tCO_2e, with an average 4,059 tCO_2e per annum over the 20-year life of the Project.

The potential contribution of the Project's GHG emissions to South Africa's four modelled domestic pathways was calculated to range between 0.0002% (Highly Insufficient pathway) and 0.0028% (1.5°C Paris Agreement Compatible pathway). Based on pre-defined thresholds, the impact of the contribution of the Project's GHG emissions would be classed as **Low** during the operations phase.

There are no additional mitigation management actions, other than those included in **Section 10**, to be included in the SLIP.

Based on the information presented in the report, and the interpretation and assessment thereof, it is the opinion of the specialist that no fatal flaws exist which would prevent the construction and operation of the Project.

12. Assumptions, Limitations, Uncertainties

In preparing this report, the following assumptions, uncertainties, and gaps in knowledge were noted:

- SLR has prepared this report in a manner that is consistent with the level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report.
- In developing this report, SLR has relied in good faith on information provided by the Applicant.
- The nature of the work undertaken is stochastic with substantial inherent uncertainly. However, these are uncertainties are highlighted, and environmental conservative assumptions are applied where applicable.
- The uncertainty associated with any projections or forecasts is increased with the duration of the projected period and is subject to future developments or intervening acts which may manifest in the interim period.
- This is considered an initial high-level assessment, and that detailed, downscaled climate modelling is required to more accurately determine the impact of climate change on the Project.
- No other warranty expressed or implied is made.

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Record of Report Distribution

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13. Details of the Specialist

Michael Van Niekerk is a climate change specialist with over 17 years consulting experience in South Africa and several other African countries, including Mozambique, Zambia, Kenya, Democratic Republic of Congo, Ethiopia, Ghana, Mali, and Uganda.

To date, Michael has worked on several climate change risk assessments, climate change strategies, and GHG inventories or carbon footprints. He has experience in a wide range of sectors, including mining, oil & gas, manufacturing, and industry. He has a strong working knowledge of local and international climate-related legislation, regulations, conventions, and agreements.

He also has specific experience in conducting energy audits and applying resource efficient and cleaner production methodologies. In the last 17 years, Michael has undertaken several ESIAs, and Basic Assessments. He also has experience in environmental auditing, solid and hazardous waste management, strategic environmental planning, and ecosystem services.

14. Specialist Declaration

I, Michael André Van Niekerk declare that:

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

Appendix A EP4 Requirements

Climate Change Risk Assessment for the Karreebosch Wind Energy Facility, Northern & Western Cape Provinces

DRAFT REPORT

Karreebosch Wind Farm (RF) (Pty) Ltd

SLR Project No.: 723.000133.00001

8 August 2025

Table A-1 presents a summary of the requirements for a CCRA which are set out in the EP4, as well as comments on whether the relevant requirements have been met in this CCRA[81].

Table A-1: Climate requirements for EP4

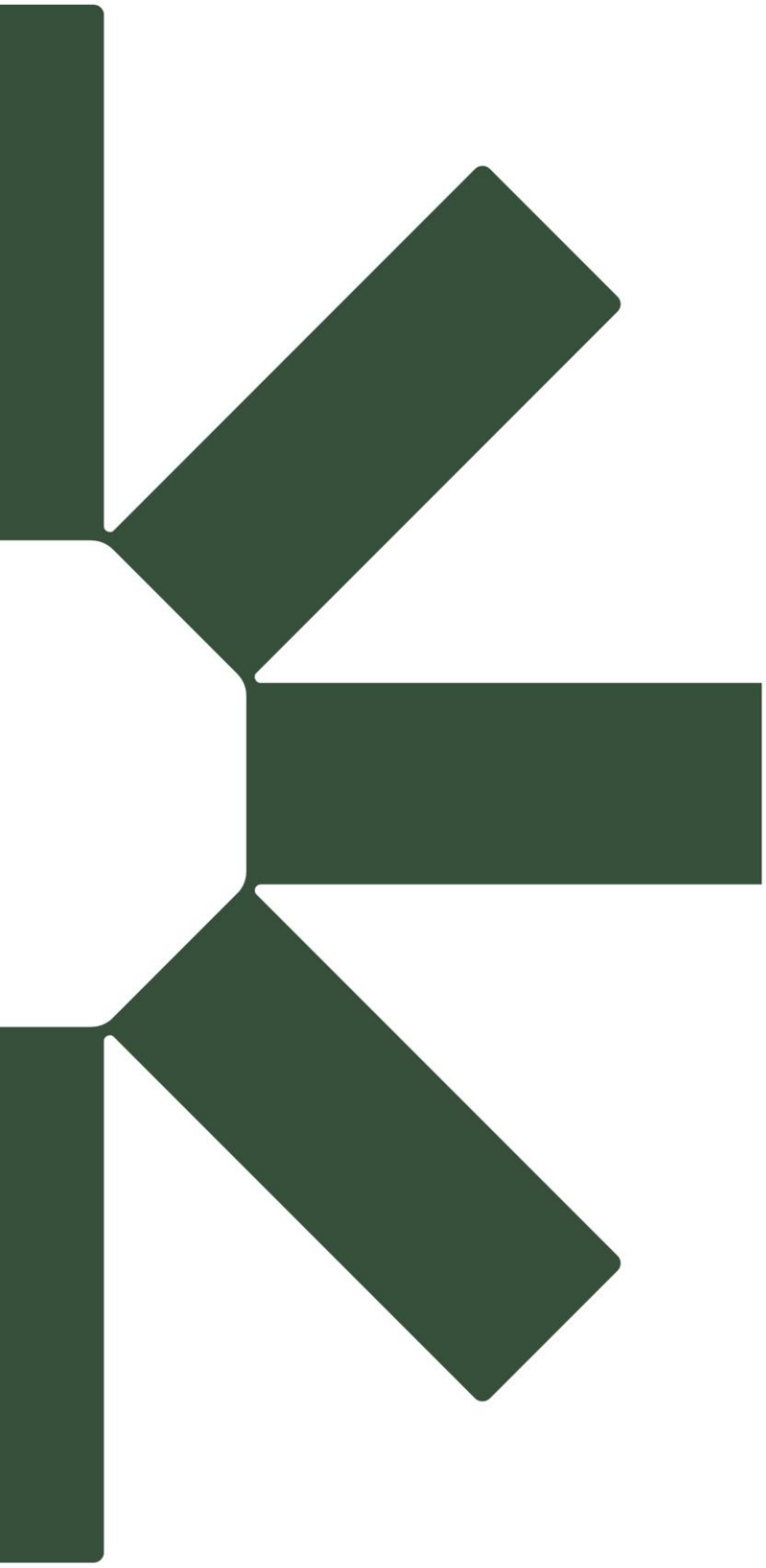
Section	Requirements	Comment on requirements
Principle 1: Review and Categorisation	Project will be categorised based on the magnitude of potential environmental and social risks and impacts, including those related to climate change.	Not applicable as this is the responsibility of the Equator Principles Financial Institutions.
Principle 2: Environmental and Social Assessment	Assessment Documentation is expected to include an assessment of potential climate change risks as part of the Environmental and Social Impact Assessment or other Assessment.	This CCRA is being submitted as part of the Project Due Diligence conducted by the Agent and will form part of the Environmental and Social Management System. Additionally, the CCRA is a Conditions Precedent of the loan agreement, required 6-months post financial close.
	Climate Change Risk Assessment should be aligned with Climate Physical Risk and Climate Transition Risk categories of the Task Force on Climate-related Financial Disclosures (TCFD).	This CCRA has aligned with the Physical Risk and Climate Transition Risk categories of the TCFD – see **Section 9**.
	A Climate Change Risk Assessment is required: • For all Category A and, as appropriate, Category B Projects, and will include consideration of relevant physical risks as defined by the TCFD. • For all Projects, in all locations, when combined Scope 1 and Scope 2 Emissions are expected to be more than 100,000 tonnes of CO_2 equivalent annually. Consideration must be given to relevant Climate Transition Risks (as defined by the TCFD) and an alternatives analysis completed which evaluates lower GHG intensive alternatives.	The combined scope 1 and scope 2 emissions of the proposed Project does not exceed the 100,000 tonnes carbon dioxide equivalent (tCO_2e) threshold. While this Project's GHG emissions do not exceed this threshold, a high-level alternative analysis was included in **Section 8**
	The depth and nature of the Climate Change Risk Assessment will depend on the type of Project as well as the nature of risks, including their materiality and severity	The depth and nature of the CCRA was tailored to the type of Project and nature of the risks.
Principle 10: Reporting and Transparency	For all Category A and, as appropriate, Category B Projects:	CCRA to be made accessible and available online together with the environmental impact assessment.

[81] Equator Principles Association (2020). *Equator Principles: EP4: July 2020*. URL: https://equator-principles.com [accessed on 06 June 2025]

Section	Requirements	Comment on requirements
	• The client will ensure that, at a minimum, a summary of the ESIA is accessible and available online and that it includes a summary of …. climate change risks and impacts when relevant	
	The client will report publicly, on an annual basis, GHG emission levels (combined Scope 1 and Scope 2 Emissions, and, if appropriate, the GHG efficiency ratio12) during the operational phase for Projects emitting over 100,000 tonnes of CO_2 equivalent annually. Refer to Annex A for detailed requirements on GHG emissions reporting.	As the Project's annual GHG emissions do not exceed the 100,000 tCO_2e threshold, there is no requirement to report publicly, on an annual basis, the combined scope 1 and scope 2 emissions.
Annex A: Climate Change: Alternatives Analysis, Quantification and Reporting of Greenhouse Gas Emissions	<u>Alternatives Analysis</u> The alternatives analysis requires the evaluation of technically and financially feasible and cost-effective options available to reduce Project-related GHG emissions during the design, construction and operation of the Project.	Not applicable as the Project's annual GHG emissions do not exceed the 100,000 tCO_2e threshold triggering an alternatives analysis. While this Project's GHG emissions do not exceed this threshold, a high-level alternative analysis was included in **Section 8**
	<u>Quantification and Reporting</u> GHG emissions should be calculated in line with the GHG Protocol to allow for aggregation and comparability across Projects, organisations and jurisdictions. Clients may use national reporting methodologies if they are consistent with the GHG Protocol. The client will quantify Scope 1 and Scope 2 Emissions.	The Project's GHG emissions were calculated in accordance with the GHG Protocol (see Section 5.2). The Project's scope 1 and Scope 2 emissions were calculated (see **Section 7**)[82].
	The EPFI will require the client to report publicly on an annual basis on GHG emission levels (combined Scope 1 and Scope 2 Emissions) and GHG efficiency ratio, as appropriate, during the operational phase for Projects emitting over 100,000 tonnes of CO_2 equivalent annually.	Not applicable as the Project's annual GHG emissions do not exceed the 100,000 tCO_2e threshold triggering annual public reporting.
	Clients will be encouraged to report publicly on Projects emitting over 25,000 tonnes.	Not applicable as the Project's annual GHG emissions do not exceed the 25,000 tCO_2e threshold triggering annual public reporting.

[82] Based on the assumption that the default values used in the calculation of the Project's GHG emissions included the material sources of Scope 1 and Scope 2 emissions. Furthermore, it is assumed that the Project's energy requirements for the operational phase will be met with self-generated energy.

Section	Requirements	Comment on requirements
	Where appropriate, EPFIs will encourage clients to publish a summary of the alternatives analysis as part of the ESIA. In some circumstances, public disclosure of the full alternatives analysis or Project-level emissions may not be appropriate.	Not applicable as the Project's annual GHG emissions do not exceed the 100,000 tCO_2e threshold triggering an alternatives analysis. While this Project's GHG emissions do not exceed this threshold, a high-level alternative analysis was included in **Section 8.**
	<u>Climate Change Risk Assessment</u> The Climate Change Risk Assessment should address the following questions at a high level: • What are the current and anticipated climate risks (transition and/or physical as defined by the TCFD) of the Project's operations? • Does the client have plans, processes, policies, and systems in place to manage these risks? i.e. to mitigate, transfer, accept or control. • This assessment should also consider the Project's compatibility with the host country's national climate commitments, as appropriate.	The CCRA identifies and assesses the current and anticipated climate risks (see **Section 9**). As part of the CCRA, the Project's existing Environmental Management Programme was reviewed, with additional measures recommended in **Section 10** to mitigate the identified risks. As part of the CCRA, the compatibility of the Project with South Africa's national climate commitments was considered (**Section 9).**



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