Specialist Climate Change Impact Assessment

Karpowership Gas to Power Project: Port of Richards Bay

Prepared by Promethium Carbon for:

triplo4 sustainable solutions

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PROMETHIUM CARBON

Executive Summary

This report presents the climate change impact assessment conducted by Promethium Carbon (appointed by Triplo4 Sustainable Solutions) for the Karpowerships Gas to Power Project at the Port of Richards Bay, KwaZulu-Natal. The assessment was conducted in accordance with the environmental authorisation process, and in the context of the Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others case[1] (Thabametsi) as well as other pertinent cases, such as the recent case of South Durban Community Environmental Alliance and Another v Minister of Forestry, Fisheries and The Environment and Others[2] (Eskom Gas-to-Power Project).

Promethium's assessment covered the impact of the proposed project on climate change and the project's resilience to climate change across both the construction and operational phases of the project.

The assessment of the project's impact on climate change was based on a life cycle assessment of the project's greenhouse gas (GHG) emissions, as calculated according to SANS 14064:2021 Part 1 and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations) and Technical Guidelines 2017, as amended, and published by the Department of Forestry, Fisheries, and the Environment (DFFE).

The assessment of the project's resilience to climate change was guided by the DFFE's Framework for Climate Change Vulnerability Assessments and the Equator Principles. The project's vulnerability was assessed across core operations, value chain (upstream and downstream), and the broader social and environmental context.

This report also addresses possible mitigation and adaptation measures that could be considered by the proposed project developer as recommendations to reduce GHG emissions and improve the project's resilience to climate change.

The impact of the project on climate change was assessed in the context of both the life cycle GHG emissions from the project, as well as the potential positive impact the project can have through the avoidance of emissions. The project will emit 1.5 million tCO_2e/year during the operational phase and 31 million tCO_2e over its lifetime.

Projected changes in several climate variables for Richards Bay under different potential scenarios were analysed against historic and current trends. Mean annual temperature is expected to increase

1 Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others (65662/16) [2017] ZAGPPHC 58; [2017] 2 All SA 519 (GP) (8 March 2017) (saflii.org).

2 South Durban Community Environmental Alliance and Another v Minister of Forestry, Fisheries and The Environment and Others (17554/2021) [2022] ZAGPPHC 741 (6 October 2022) http://www.saflii.org/za/cases/ZAGPPHC/2022/741.html

by at least 0.5°C over the next 30 years whilst very hot days is likely to increase by up to 18 days per year. Mean annual precipitation is also likely to increase by small amounts but there do not appear to be increases in extreme rainfall days (this is not to say rainfall amounts during storms will not increase). By 2050, despite higher precipitation, drought conditions are expected to increase significantly, whilst coastal flooding and fire risks are moderate.

There is evidence that Richards Bay could well become more exposed to tropical storms and cyclones in the future with data showing increasing intensity and westward movement of these low-pressure systems. In combination with sea level rise forecast, the risk of storm surges and intense wave action increases. This poses the biggest risk to the project in terms of weather.

Ocean pH levels have consistently declined since at least the middle of the 20th century and will continue to do so. However, this will not have a material impact on the project.

There is little information on changes in wind in under future climate scenarios, however, research suggests generally stronger winds but by small percentages over current speeds. Any increases in wind speeds will, however, amplify the impacts during storm events due to the interaction with waves and ocean currents.

Sea level has increased by ±4.2 cm since the late 1970s and is likely to rise by 10-40 cm by the middle of the 21st century. Again, this is not likely to have a material impact on the project but could act to amplify storm surges during storm events.

Mean sea surface temperature has increased by ±0.89˚C since 1900 and is currently around 24.3˚C. This could increase to up to 25˚C by 2030 and 25.3˚C by 2050. The warming of temperatures in the Richard's Bay region and further north into the Mozambique Channel may result in more favourable conditions necessary for the formation of tropical cyclones.

The assessment of the climate change impact of this project has been done on the impact of the project on climate change, the resilience of the project to climate change, as well as the options for mitigation of the impacts.

In accordance with the findings of this CCIA, we advise that the proposed Karpowership Project at Richards Bay should not be refused environmental authorisation based on climate change related issues.

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Key Terms and Definitions

Adaptive capacity[3] Adaptive capacity is a set of factors which determine the capacity of a system to generate and implement adaptation measures. These factors relate largely to available resources of human systems and their socio-economic, structural, institutional, and technological characteristics and capacities.

Climate change impacts[3] The consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. Impacts generally refer to effects on lives; livelihoods; health and well-being; ecosystems and species; economic, social and cultural assets; services (including ecosystem services); and infrastructure. Impacts may be referred to as consequences or outcomes and can be adverse or beneficial.

Climate change[3] The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as: '*a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes.

Climate exposure[3] The presence of people; livelihoods; species or ecosystems; environmental functions, services and resources; infrastructure; or economic, social or cultural assets in places and settings that could be adversely affected.

Climate resilience[3] The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation.

Climate variability[3] Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes

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[3] IPCC, 2022: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 37–118, doi:10.1017/9781009325844.002.

	within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability).
Climate Vulnerability[3]	The propensity or predisposition to be adversely affected and encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.
Direct emissions	GHG emissions that occur from sources that are controlled or owned by an organization
Extreme weather[4]	Is unexpected, unusual, or unforeseen weather and differs significantly to the usual weather pattern, such as droughts, floods, extreme rainfall, and storms.
Greenhouse Gas (GHG) [3]	Greenhouse gases (GHGs) are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself and by clouds. This property causes the greenhouse effect. The Kyoto Protocol deals with the following GHGs, carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), Sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).
Indirect emissions	GHG emissions that are a consequence of the activities of the reporting entity but occur at sources owned or controlled by another entity.
Resilience[5]	The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure.
Sensitivity[3]	Sensitivity determines the degree to which a system is adversely or beneficially affected by a given climate change exposure and is a function of the natural and socio-economic context of a particular site.
Shared Socioeconomic Pathway 1 (SSP1)[6]	*Taking the Green Road (Low challenges to mitigation and adaptation)*. A gradual but widespread shift to a more sustainable development pathway. This narrative emphasises inclusive development and respects environmental boundaries. The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects perceived environmental boundaries. Management of the global

4 GIZ. 2014. The vulnerability sourcebook. Gesellschaft für Internationale Zusammenarbeit, Bonn, Germany.
5 https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_AnnexVII.pdf
6 Riahi, K. *et al.* 2017. The Shared Socioeconomic Pathways and their energy, land use, and GHG emissions implications: An overview. Global Environmental Change 42: 153-168.

commons slowly improves, educational and health investments accelerate the demographic transition, and the emphasis on economic growth shifts toward a broader emphasis on human well-being. Driven by an increasing commitment to achieving development goals, inequality is reduced both across and within countries. Consumption is oriented toward low material growth and lower resource and energy intensity.

Shared Socioeconomic Pathway 2 (SSP2)[6]	*Middle of the Road (Medium challenges to mitigation and adaptation) or status quo.* The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns. Development and income growth proceeds unevenly, with some countries making relatively good progress while others fall short of expectations. Global and national institutions work toward but make slow progress in achieving sustainable development goals. Environmental systems experience degradation, although there are some improvements and overall, the intensity of resource and energy use declines. Global population growth is moderate and levels off in the second half of the century. Income inequality persists or improves only slowly and challenges to reducing vulnerability to societal and environmental changes remain.
Shared Socioeconomic Pathway 5 (SSP5)[6]	*Fossil-fuelled Development – Taking the Highway (High challenges to mitigation, low challenges to adaptation).* This world places increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. Global markets are increasingly integrated. There are also strong investments in health, education, and institutions to enhance human and social capital. At the same time, the push for economic and social development is coupled with the exploitation of abundant fossil fuel resources and the adoption of resource and energy intensive lifestyles around the world. All these factors lead to rapid growth of the global economy, while global population peaks and declines in the 21st century. Local environmental problems like air pollution are successfully managed. There is faith in the ability to effectively manage social and ecological systems, including by geo-engineering if necessary. There is faith in the ability to effectively manage social and ecological systems, including by geo-engineering if necessary.49 SSP5-8.5 is widely regarded as a worst-case, no policy scenario rather than 'business as usual' as it was originally framed as. This would result in a 5°C mean temperature rise by 2100 relative to pre-industrial levels. This scenario is gradually becoming more implausible as such a pathway would require a fivefold increase in coal use by the end of the century, for which most estimates believe could not be accounted for given the extent of recoverable coal reserves. SSP5-8.5 is further deemed unlikely given the declining costs in clean energy sources and thus the greater uptake of these.

Social vulnerability drivers[7]

Social vulnerability is defined as a dynamic state of societies comprising exposure, sensitivity and adaptive capacity. It is characterised by high levels of dependence on natural resources for livelihoods and economic development, combined with increasing environmental degradation, which can both increase exposure (e.g., wetland destruction) and reduce adaptive capacity (e.g., declining river flows constraining water provision). Examples of social vulnerability drivers include poverty, low awareness and inability to migrate.

Vulnerability[8]

Vulnerability is defined as the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.

7 Tucker, J., *et a*l. 2015. Social vulnerability in three high-poverty climate change hot spots: What does the climate change literature tell us? *Reg Environ Change* 15: 783. https://doi.org/10.1007/s10113-014-0741-6.

8 IPCC, 2022: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.

Declaration of Independence

The authors of this report do hereby declare their independence as consultants appointed by Triplo4 Sustainable Solutions (Pty) Ltd to undertake a Climate Change Impact Assessment as part of the Karpowerships Gas to Power Project at the Port of Richards Bay. Other than fair remuneration for the work performed the specialists have no personal, financial business or other interests in the project activity. The objectivity of the specialists is not compromised by any circumstances and the views expressed within this report are their own.

Robbie Louw

Kenneth Slabbert

Shannon Murray

Joshua Weiss

Indiana Mann

Details of the Specialist Team

Promethium Carbon is a South African climate change and carbon advisory company based in Johannesburg. The company has been active in the climate change and carbon management space since 2004.

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

Robbie Louw is the founder and director of Promethium Carbon. He has over 18 years of experience in the climate change industry. Robbie holds both a BCom Honours Degree in Economics as well as a BSc degree in Chemical Engineering. Robbie has significant experience with regards to climate change mitigation and adaptation. Robbie's chemical engineering background combined with his extensive experience in climate change has led to him leading several projects related to climate change risk and vulnerability, energy development and developing climate change mitigation and adaptation alternatives. His experience over a period of 35 years covers the chemical, mining, minerals process and energy fields, in which he was involved in R&D, project, operational and management levels. Robbie is currently a member of The Southern African Institute of Mining and Metallurgy and the Institute of Directors in South Africa (IoDSA). In addition, Robbie is also a member of the Technical Working Group of the Climate Disclosure Standards Board (CDSB). Robbie's experience in climate change includes, but is not limited to:

- Climate change risk and vulnerability assessments for large mining houses;
- Extensive experience in preparing carbon footprints. The team under his leadership has performed carbon footprint calculations for major international corporations operating complex businesses in multiple jurisdictions and continents;
- Carbon and climate strategy development for major international corporations;
- Climate change impact assessments for various companies and projects;
- Climate change scenario planning and analysis, particularly in terms of the recommendations of the Taskforce on Climate-related Financial Disclosure; and
- In depth understanding of South Africa's climate change regulations and carbon tax requirements.

Kenneth Slabbert is a Climate Change Advisor who holds a Masters in Mechanical Engineering specialising in energy management. He has four years of experience in climate change mitigation and energy management. Kenneth's experience includes carbon footprint calculations and reporting, carbon tax calculations, climate change impact assessments, energy management, CDP responses and carbon credit project documentation.

Shannon Murray is a climate change advisor who commenced her employment with Promethium Carbon in October 2021. She completed her BA Degree in Sign Language, as well as her LLB degree through the University of the Witwatersrand. Furthermore, Shannon obtained course certificates through the Wits Mandela Institute in Energy Law, Environmental and Sustainable Development Law, Land and Water Law and International Environmental Law. Shannon was admitted as an attorney in November 2019 and practised as such for a small commercial litigation firm until September 2021. In the short period of time that Shannon has been employed with Promethium Carbon, she has done extensive research in relation to the climate change field and has formed part of various teams within the company. She has gained experience in:

- The legal aspects of carbon credit purchase agreements;
- Developing a socio-economic development project list, with climate change project funding benefits, for a global mining company;
- Developing a climate change target for a listed pharmaceutical company; and

Performing an eligibility assessment for a carbon credit project, including the legal aspects of the carbon credit transaction.

Joshua Weiss is a Climate Change Advisor who holds an MSc in Conservation Biology and a BSc Hons in Ecology, Environment and Conservation. He has cumulatively over six years of experience using GIS to conduct ecological analyses, developing sensitivity maps and cartographic design; producing several other maps for various reports in suitable and meaningful ways. As part of his role as an environmental consultant combines his technical expertise in mapping and spatial analyses and his educational background in conservation and geography. Joshua has also previously been involved in avifaunal monitoring and reporting, particularly in the renewable energy space, as well as scoping and EIA reporting. Since working on the draft revision of the climate change adaptation plans for South Africa's biomes and biodiversity sector, he has increasingly been involved in accessing, analysing and interpreting historical and the latest projected climate data.

Camden Nauschutz is an intern climate change advisor at Promethium. He is currently completing his master's degree in environmental science with the Global Change Institute at the University of the Witwatersrand. His master's dissertation is focused on water research, specifically focusing on exploring the drivers of water vulnerability and water scarcity in the City of Johannesburg. Camden's tertiary education covered biogeography, climate change, environmental sustainability, and statistics. He is proficient in R-Studio and GIS. Camden recently completed his first carbon footprint calculation and report for a mining, safety instrumentation company. He also has experience in statistical data analysis of weather data for climate change impact assessments. He is currently assisting companies within the retail sector with calculating their carbon tax liability, as part of the South African Carbon Tax Act.

Indiana Mann is a Climate Change Advisor who holds an honours degree in Atmospheric Science. Her postgraduate studies focused on the impact meteorological conditions have on pollen distribution within Cape Town. With her background in Environmental and Geographical Science and Atmospheric Science, Indiana has knowledge in climate modelling, climate change risk and vulnerability assessments and climate change policies. The projects in which she has been active include:

- Climate Change Risk and Vulnerability Assessment;
- Climate Change Impact Assessments;
- The Task Force on Climate-Related Financial Disclosures reports;
- GHG Reporting;
- Carbon Footprints; and
- Handling of weather data for necessary reports.

Report structure and reference in terms of NEMA Regulations (2014), Appendix 6

NEMA Regulations (2014) (as amended) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report	Page xxi - xiv
The expertise of that person to compile a specialist report including a curriculum vitae	Page xxi - xiv
A declaration that the person is independent in a form as may be specified by the competent authority	Page xi
An indication of the scope of, and the purpose for which, the report was prepared	Section 2, sub-section 2.2
An indication of the quality and age of base data used for the specialist report	Sub-section 3.1.3 and 3.2.3
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
The duration date and season of the site investigation and the relevance of the season to the outcome of the assessment	No site investigation took place as this was a desktop study that relied on requested information
A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 3
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure inclusive of a site plan identifying site alternative	Sub-section 5.2
An identification of any areas to be avoided, including buffers	This is not relevant in terms of the climate change impact assessment.
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	This is not relevant in terms of the climate change impact study. However, this report does define the boundaries for which the project's impact on climate change, as well as the project's vulnerability to climate change was determined.
A description of any assumptions made and any uncertainties or gaps in knowledge	Sub-section 3.1.6 and 3.2.5
A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	Section 5
Any mitigation measures for inclusion in the EMPr	Section 5.1.5
Any conditions for inclusion in the environmental authorisation	N/A
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 7

NEMA Regulations (2014) (as amended) - Appendix 6	Relevant section in report
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and regarding the acceptability of the proposed activity or activities	Section 7
A description of any consultation process that was undertaken during preparing the specialist report	N/A
A summary and copies of any comments received during any consultation process and where applicable all responses thereto	N/A
Any other information requested by the competent authority	N/A

1 Introduction

Promethium Carbon has been appointed by Triplo4 Sustainable Solutions (Pty) Ltd (Triplo4) to undertake a Climate Change Impact Assessment (CCIA) specialist study as part of the Environmental Impact Assessment (EIA) for the proposed Karpowerships Gas to Power Projects (hereafter, referred to as Karpowership) located within three South African ports, namely: Port of Ngqura (Eastern Cape), Richards Bay (KwaZulu-Natal) and Saldanha Bay (Western Cape). *This report is for Richards Bay.*

The three gas-to-power projects introduced above are aimed to install a cumulative 1,220MW power facility off the South African coast. The projects forms part of the South African Government's request for proposals for independent power producers to supply up to 2,000MW of dispatchable electricity generation capacity under the Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP). Section 3.1 of the Overview of the RMIPPPP RFP states "*The Minister has issued a determination with the concurrence of NERSA to ensure energy security, and that approximately 2 000 megawatts is to be generated from a range of energy source technologies in accordance with the short-term risk mitigation capacity allocated under the heading 'Others', for the years 2019-2022 in the Table 5 of the Integrated Resource Plan for Electricity 2019-2030 (published as GN 1360 of 18 October 2019 in Government Gazette No. 42784 ('IRP 2019')."* The project therefore falls within the energy mix set out by the current IRP.

The objective of the RMIPPPP is to fill the current short-term supply gap, alleviate the current electricity supply constraints and reduce the extensive utilisation of diesel-based peaking electrical generators. The Determination for the RMIPPPP was gazetted on the 7th of July 2020[9].

The proposed project will utilise gas fuelled internal combustion engines in combined cycle with steam turbines to generate a contracted capacity of 450MW onboard floating power stations at Richards Bay port in KwaZulu Natal, South Africa. The stations are fully self-contained, integrated floating power stations that operate on re-gasified Liquified Natural Gas (LNG). The LNG is stored in liquid form then re-gasified and provided on demand to the Powerships via a specialized Floating Storage and Regasification Unit (FSRU) vessel moored in proximity. The powerships and FSRUs are immediately available for deployment.

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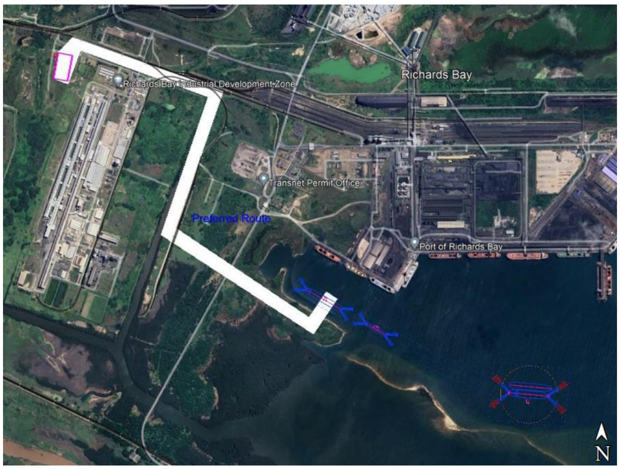
9 Department of Mineral Resources and Energy, 2020, Overview of the Request for Qualification and Proposals for New Generation Capacity under the Risk Mitigation IPP Procurement Programme, [Online] Available at: https://www.ipp-rm.co.za/ [Accessed 25/01/2021]

Locality	
	
Figure 1: Photograph showing the Port of Richards Bay, KwaZulu-Natal.	**Figure 2: Google image of the proposed Gas to Power Project**

The Project will include the following components:

- Two Powerships that generate electricity, which are fed with natural gas from a third ship – A Floating Storage and Regasification Unit (FSRU). The project design capacity is 540MW;
- The station will consist of 27 gas reciprocating engines comprising of an approximate heat input of over 10MW each (design capacity of 18.32MW each at full capacity);
- The three topping cycle steam turbines for heat recovery from the reciprocating engines will have a heat input of 15.45MW each;
- The on-board High Voltage substation will convert the power generated from the engines and turbines. The contracted capacity of 450MW, which cannot be exceeded under the terms of the RMIPPPP, will be evacuated via a 132kV transmission line over a total distance of approximately 3 km from the Richards Bay Port tie in point to the Eskom line, at connection point in proximity to the existing Bayside Substation, which supplies the national grid.

This climate change impact assessment specialists report covers four key aspects, namely:

- The project's potential contribution to climate change through the emission of GHGes (GHGs). These include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). These gasses are collectively referred to throughout this report as carbon dioxide equivalent (CO_2e);
- The GHG emissions of the project is assessed over the full lifecycle of the project;

- An assessment of the project's resilience to climate change impacts; and
- Mitigation or adaptation options that could be adopted to minimise the impact on/by climate change.

2 Background

This report will inform and assist Karpowership in developing a climate change strategy for the project, which is aligned to the company's environmental management goals. Therefore, and in this context, the impacts of the project on climate change and the climate change impacts on the project, must be considered.

2.1 The Legal Precedent, Basis and Development of Climate Change Impact Assessments in South Africa

2.1.1 Thabametsi Case

The *Thabametsi* case judgment sets the legal precedent for South African CCIAs. The environmental authorisation of the proposed *Thabametsi* coal-fired power station was appealed by Earthlife on the basis that the Chief Director of the Department of Environmental Affairs[10], who initially granted *Thabametsi* an environmental authorisation, and the Minister for Environment Forestry and Fisheries (now the Department of Forestry, Fisheries and the Environment "DFFE"), were obliged to consider the climate change impacts of the power station before granting an environmental authorisation, and that they failed to do so[11].

The court found that:

"[…] the legislative and policy scheme and framework overwhelming support the conclusion that an assessment of climate change impacts and mitigating measures will be relevant factors in the environmental authorisation process, and that consideration of such will best be accomplished by means of a professionally researched climate change impact report."[12]

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10 Following the announcement of the sixth administration in 2019, forestry and fisheries functions were amalgamated into the Department of Environmental Affairs, which became known as the Department of Environment, Forestry and Fisheries (DEFF). On 1 April 2021, the DEFF was renamed to the Department of Forestry, Fisheries and the Environment (DFFE).

11 Despite the court victory in March 2017, after reconsideration of the climate change impacts of the plant, the Minister again upheld Thabametsi's environmental authorisation, on the basis that the 2010 Integrated Resource Plan for Electricity (IRP) called for new coal-fired power capacity and had already assessed climate impacts. However, due to its large environmental footprint, funding for the project was pulled and on 19 November 2020, the court ordered that the environmental authorisation be set aside.

12 Ibid, See par 91 of the Judgement.

Before the legal precedent set by the *Thabametsi* case, there was no express provision stipulating that climate change is a relevant factor to be considered as part of an Environmental Impact Assessment (EIA) in South Africa. For this reason - and given the lack of domestic guidelines to assess the climate change impacts of a specific activity - it was necessary to not only consider the principles of NEMA, but to also consider international best practice and international laws which inform CCIAs.

2.1.2 Fuel Retailers Case

In 2007 the Constitutional Court[13] emphasised that a risk-averse and cautious approach is adopted in our environmental legislation, which entails taking into account the limitation on present knowledge about the consequences of an environmental decision. It was further held that the precautionary principle is applicable 'where, due to unavailable scientific knowledge, there is uncertainty as to the future impact of the proposed development.' It is, therefore, not enough to focus on the needs of the developer while the needs of the society are neglected.

While NEMA does not specifically refer to "need and desirability" of a proposed development, the Constitutional Court in this case confirmed that "need and desirability" is a relevant consideration. However, the Constitutional Court in this case equated the need and desirability assessment to the socio-economic considerations. Since the case's outcome, the EIA Regulations 2014[14], has specifically included the requirement that the "need for and desirability of a proposed activity" must be considered. These Regulations specifically require the consideration of how the "geographical, physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity" confirming and expanding on the fact that "need and desirability" relates to all of these considerations, and not only to socio-economic considerations.

2.1.3 Shell 3D Seismic Survey

In the case of Sustaining the Wild Coast NPC and Others v Minister of Mineral Resources and Energy and Others[15], Shell Exploration and Production South Africa BV (Shell) proposed a 3D seismic survey off the Wild Coast, in the Eastern Cape, aiming to explore potential hydrocarbon reserves beneath the seabed.

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13 Fuel Retailers Association of Southern Africa v Director-General: Environmental Management, Department of Agriculture, Conservation and Environment, Mpumalanga Province and Others (CCT67/06) [2007] ZACC 13; 2007 (10) BCLR 1059 (CC); 2007 (6) SA 4 (CC) (7 June 2007)

14 R. 982 National Environmental Management Act (107/1998): Environmental Impact Assessment Regulations, 2014: GG 3 38282, as amended.

15 Sustaining the Wild Coast NPC and Others v Minister of Mineral Resources and Energy and Others (3491/2021) [2022] ZAECMKHC 55 (1 September 2022) (saflii.org)

The seismic survey created an enormous amount of concern amongst environmental activists and coastal communities due to the possible negative impacts the survey will cause for both the marine environment, as well as the surrounding communities. During proceedings between Shell, Impact Africa and various environmental activists, it was held by Judge President Mbenenge in the Eastern Cape High Court that the granting of the exploration rights to Shell was set aside, preventing the exploration from proceeding. The judgment found that the coastal communities were not properly consulted before Shell was granted the exploration rights.

The EIA Regulations 2014 requires that both the need and the desirability of a development must be considered by the developer, the developer's independent environmental assessment practitioner (EAP), the various specialists, and the competent authority, during all the stages of an EIA process, being the screening, "scoping" and assessment stages. In this case, the Eastern Cape High Court held that had the competent authority considered a comprehensive assessment of the need and desirability of exploration for new oil and gas reserves, from a climate change and the right to food perspective, "*the decision-maker may very well have concluded that the proposed exploration is neither needed nor desirable*".

The court found that the decision-maker failed to take relevant considerations into account and failed to comply with the relevant legal prescripts and therefore, the granting of the exploration right requires review in terms of the Promotion of Administrative Justice Act of 2000, as amended and the principle of legality.

2.1.4 Eskom Gas-to-Power Project

Judgment in the South Durban Community Environmental Alliance and Another v Minister of Forestry, Fisheries and The Environment and Others[16] case was delivered on 6 October 2022 and similarly deals with a gas-to-power project. In December 2019, Eskom was granted environmental authorisation (EA) for the combined cycle gas power plant (CCGPP), which will supply up to 3,000MW of energy. Two environmental justice NGOs - the South Durban Community Environmental Alliance and Groundwork brought an application to have the environmental authorisation that was granted by the DFFE reviewed and set aside.

The grounds of Review brought by the NGOs were that (i) there was a failure to consider renewable alternatives to the proposed project, (ii) that a combined gas cycle power plant was neither necessary nor desirable, (iii) there had been a failure to adequately consider climate change impacts on the project, (iv) there had been inadequate public participation (v) there had been

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16 South Durban Community Environmental Alliance and Another v Minister of Forestry, Fisheries and The Environment and Others (17554/2021) [2022] ZAGPPHC 741 (6 October 2022) http://www.saflii.org/za/cases/ZAGPPHC/2022/741.html

inadequate water resources assessments, and (vi) the authorisation contains inappropriate wetland offset, primarily because it does not impose meaningful obligations upon ESKOM. It was held that six out of these seven grounds for review were without merit and could not succeed. The only ground that the court found to have merit was the inadequacy of the public participation process, as communication was only published in English and not isiZulu, which is the language spoken by most of the community that would be directly affected by the gas-to-power project. However, instead of setting aside the EA granted to ESKOM, the court ordered ESKOM to ensure the EA and its conditions are published in isiZulu, as well as all subsequent linked and ancillary applications for EA's pertaining to the CCGPP, to similarly be published in isiZulu.

With regards to the grounds for review that relate to this impact assessment, it was argued that there was a failure to consider renewable sources of power generation and that there was a failure to consider the climate change impacts of a CCGPP. The court found that both these grounds did not have merit and could not succeed. For the first ground, the court held that since the granting of an EA is not the exclusive domain for renewable energy projects, ESKOM had the discretion to submit its application for the project without considering an alternative, and furthermore, the specific requirements for the project were considered and conditions within the EA were imposed.

In terms of the second ground that is applicable to this impact assessment, the court determined that a CCIA should only consider the direct emissions from the project. All value chain (life cycle) emissions should be considered under the additional respective authorisations for that infrastructure. The judgement further ruled that emissions occurring outside of the boundary of the Republic of South Africa should be excluded, as our legal system does not have the requisite jurisdiction, and that the further applications for environmental authorisation, such as for the gas pipeline from the port terminal to the CCGPP, will also be subject to conditions - at the very least in respect of the assessment of both upstream and downstream GHG emissions Consideration of impacts from the Liquefied Natural Gas (LNG) terminal infrastructure at the port and the gas supply pipeline to the boundary fence of the Power Plant does not form part of the scope of this step in the assessment, nor does the power line connection to the grid, which considerations would need to be included within the separate EIA process to be undertaken for the gas supply infrastructure[17].

2.1.5 Needs and Desirability Assessment

When considering an application for an environmental authorisation, the competent authority must comply with section 24O of NEMA and must have regard for any guidelines published in

[17] South Durban Community Environmental Alliance and Another v Minister of Forestry, Fisheries and The Environment and Others (17554/2021) [2022] ZAGPPHC 741 (6 October 2022), pages 11, 12 and 31 http://www.saflii.org/za/cases/ZAGPPHC/2022/741.html

terms of section 24J, which includes the Guideline on the Need and Desirability published by the then Department of Environmental Affairs in 2017.

The Need and Desirability Assessment is based on the concept of sustainability, expressed in the Constitution and within NEMA. Addressing the needs and desirability of a development ensures that the principles of sustainable development are adhered to. In other words, ensuring that a development is ecologically sustainable and socially and economically justifiable – and ensuring the simultaneous achievement of the triple bottom-line (social, economic and environment). This is particularly relevant to the Karpowership Project, as such a project is expected to increase South Africa's electricity generation capacity and decrease the reality of the electricity shortages that South African communities are subjected to.

In general, the consideration of the "need and desirability" in the EIA decision-making process requires the consideration of both the strategic context of the development, as well as the broader societal needs and the public interest relating to the development's implementation.

Appendix 1, 2 and 3 of the EIA Regulations specify that the, scoping report and the environmental impact report respectively, must provide a motivation for the need for and desirability of the proposed development, including the need and desirability of the activity in the context of the preferred location. It requires that both the need and the desirability of the development must be considered by the developer, the developer's independent EAP, the various specialists, and the competent authority. Interested and affected parties must also be given an opportunity to provide their views in terms of the undertaken need and desirability considerations.

Furthermore, in the assessment of the need and desirability of a development, the EIA Regulations requires clarification of the development's effects on the "geographical, physical, biological, social, economic and cultural aspects of the environment". Therefore, the assessment of the "need and desirability" of a development entails a great deal more than just the socio-economic considerations of the development's impacts.

2.2 Scope of the Climate Change Impact Assessment

Considering the guidance from the *Thabametsi* judgement, this climate change impact assessment covers the following:

- The **impact of the project** on climate change:
  - A GHG inventory (carbon footprint) for the construction, operational and decommissioning phases of the project;
  - An analysis of the GHG inventory regarding the impact of the project on climate change;
  - An impact assessment of the project, which includes the cumulative impacts; and
  - Mitigation and adaptation measures to minimise the impacts of the proposed project on climate change.

- The **resilience of the project** to climate change:
  - A description of the existing climate and projected conditions of the local area;
  - Assessment of climate change related impacts in the region;
  - The processes and associated infrastructure of the proposed project that could be affected by climate change, and the potential magnitude of the impacts; Impacts of climate change on core operations;
  - Impacts of climate change on the upstream value chain; and
  - Assessment of potential climate change adaptation measures.
- **Mitigation and adaptation measures** to minimise the impacts of climate change on the proposed project.

2.3 Description of Project Activities and Associated Infrastructure

2.3.1 Projects proposed activities

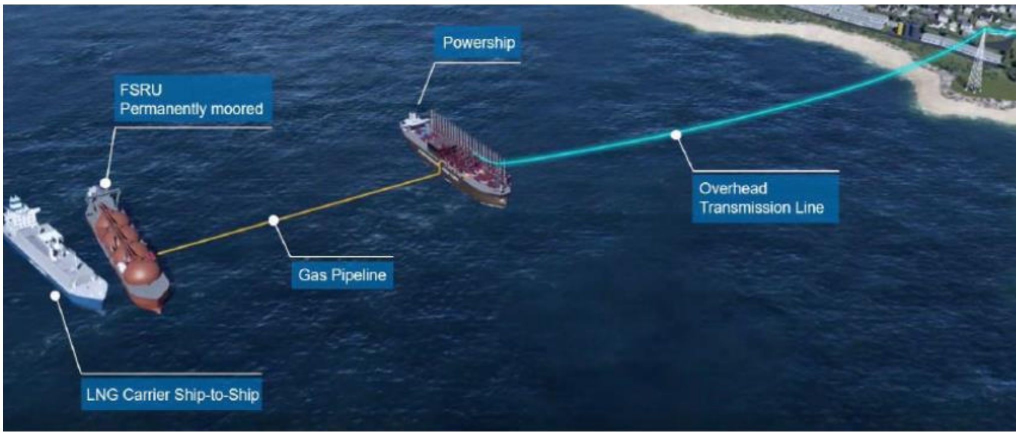
The proposed Richards Bay gas to power plant considered in this report, is aimed at enabling the generation of electricity from floating liquefied natural gas (LNG) fuelled power stations. From our understanding, such stations have the ability to navigate to and be stationed where the energy demand is required. By mooring in the relevant port and tying into the national grid, power is able to be generated immediately. In this regard, the proposed projects consist of the securing, deploying and operation of the floating power station at the Port of Richards Bay.

The design capacity for the Richard's Bay Powership project is 540MW of electricity, to supply a contracted capacity of 450 MW, using LNG as fuel. The project will consist of two Powerships which will be moored in the Port of Richards Bay and fed with natural gas from a third ship – a Floating Storage and Regasification Unit (FSRU). The ships are anticipated to be moored in the Port for a 20-year lifespan. The LNG will be supplied by an LNG carrier (LNGC) and offloaded to the FSRU approximately once every 20 to 30 days, depending on the power demand which is decided by the buyer, Eskom. The LNG will be transferred from the LNGC to the FSRU for storage and regasification along a submerged gas pipeline. When the LNG has been converted back to gas, it will be transferred to the Powership, also via a submerged gas pipeline. The electricity generated onboard the Powership will be conveyed along an overhead transmission line over a distance of 3km, from Port of Richards Bay tie-in point to the Eskom line, at a connection point, which will then feed into the national grid.

The scope of the carbon footprint calculation covers numerous sources of GHG emissions. These include:

1) Extraction of LNG by means of third parties;
2) Transportation of the LNG through the LNGC;
3) LNG regasification and storage activities via third parties; and
4) Combustion of LNG through to generate electricity.

The figures below provide a conceptual overview of the proposed activities:



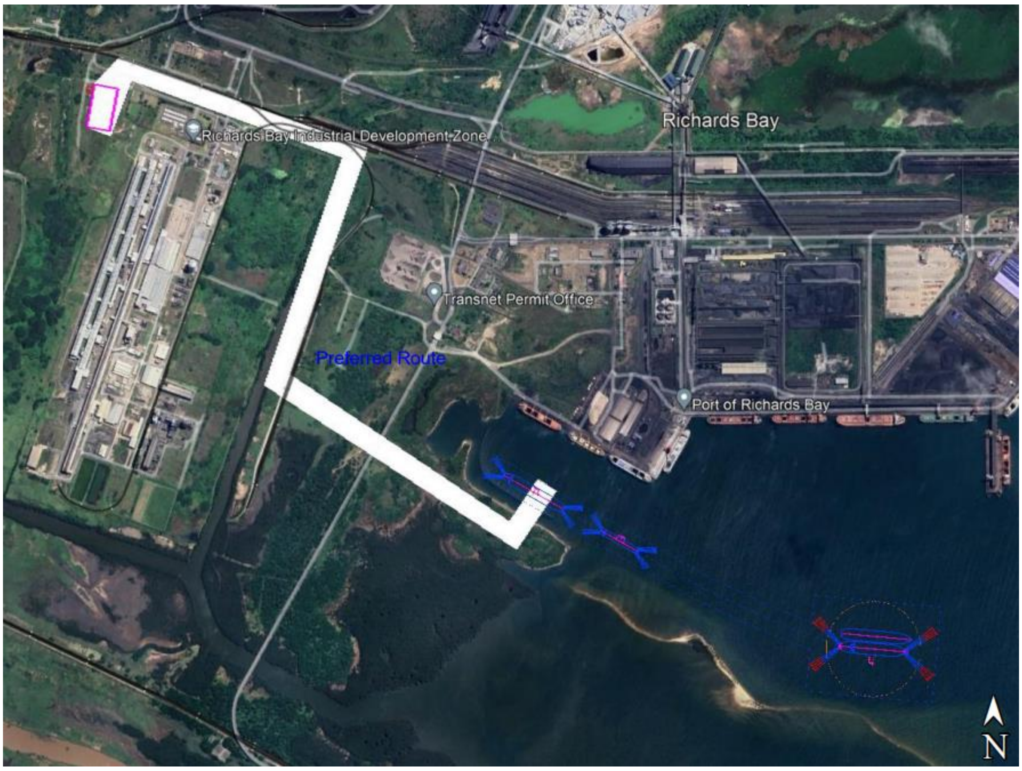


Figure 3: Conceptual overview and location of the proposed Port of Richard Bay Powership

2.3.2 Infrastructure of proposed site

The site for the proposed floating Powerships is in the Ports of Richards Bay, KwaZulu Natal, and in proximity of the Richards Bay Industrial Development Zone (IDZ). The IDZ falls within the uMhlathuze Local Municipality (Figure 4). The Richards Bay Port was deduced as an ideal location as it meets the technical requirements for the Project, port planning and operational requirements. In addition, the proposed site is within an area of the Port that does not require dredging.

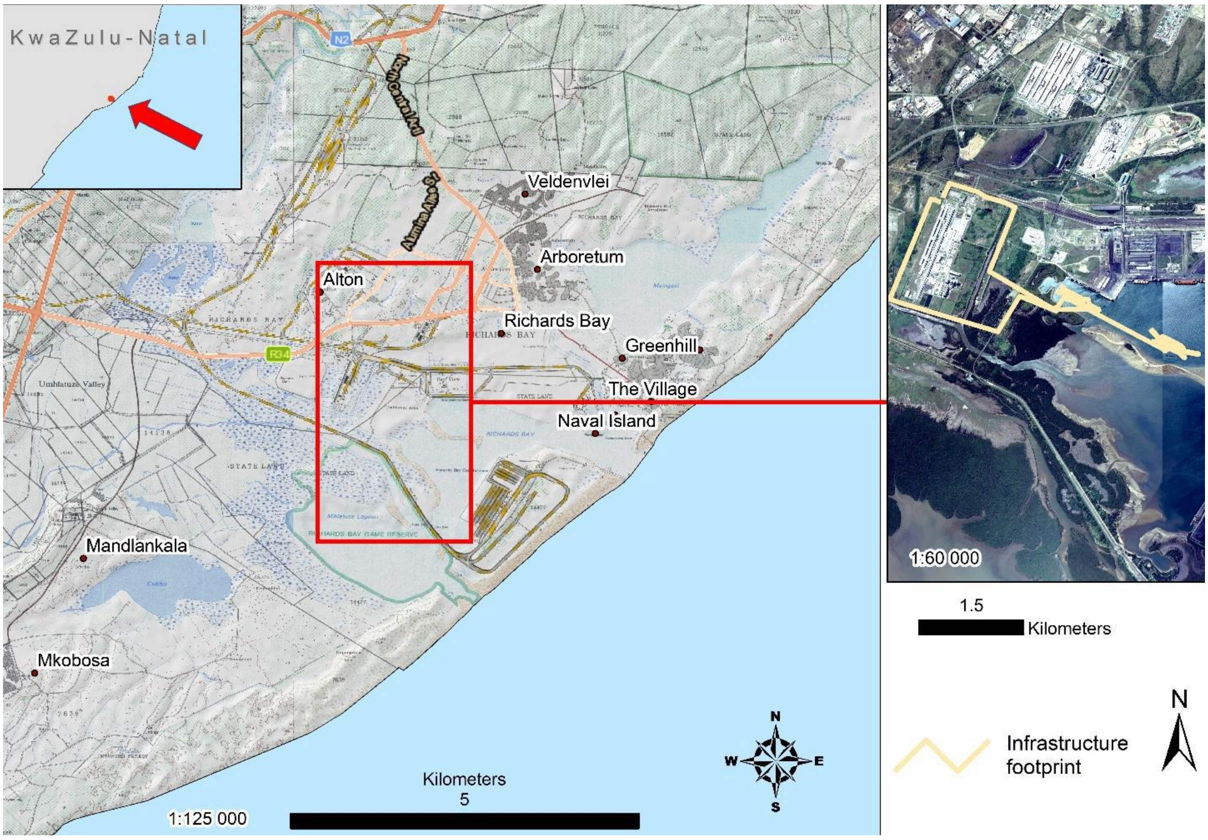


Figure 4: Locality and topography of Richards Bay

The port is situated within a complex, predominately natural estuary fed by the uMhlathuze River, the outflow of the Mzingazi Dam, and a variety of smaller wetland and riverine features. The port section of the estuarine area has been separated from the uMhlathuze by a causeway constructed by linking several islands which now includes a railway line for transport of goods (mainly coal) within the port area. As a result of the proposed development area resting over 4.5 km inland of the estuary mouth, coastal sedimentary process driven by wave actions are unlikely to exist.

2.4 Receiving Environment

Climate change is a global phenomenon. It is caused by an increase in the GHGs in the global atmosphere and cannot be addressed on a local level. This has been established at the Earth Summit in Rio in 1992, and lead to the formation of the United Nations Framework Convention on Climate Change (UNFCCC). It forms the basis of the 1997 Kyoto Protocol, and the 2015 Paris Agreement.

The relationship between the GHG emissions of any specific project, and local impacts of GHG emissions is shown in the Figure 5.

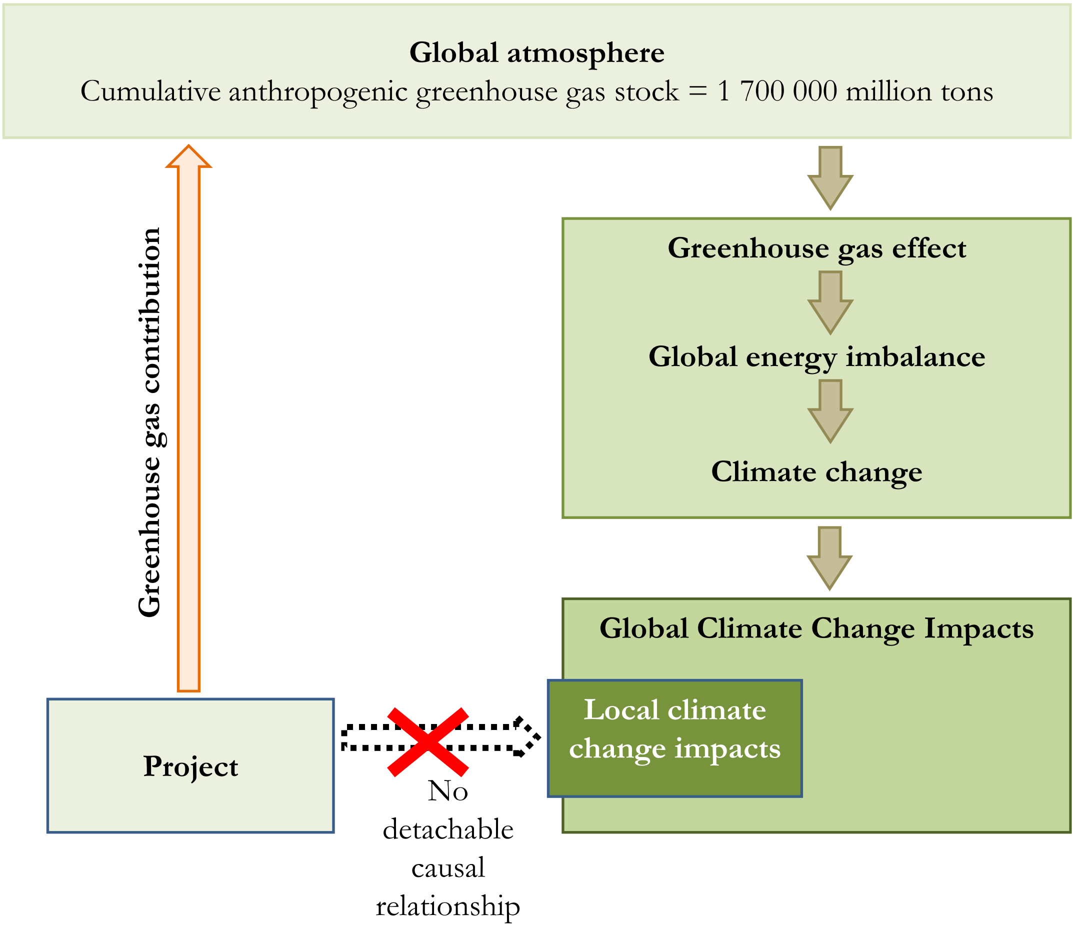


Figure 5: Relationship between a project's GHG emissions and local climate change impacts.

The principle that the emission of GHGs has no local impact and can therefore not be managed on a local level, is fundamental to the formation of the UNFCCC, the Kyoto Protocol, and the Paris Agreement.

It is in this context that the climate change specialist study did not consider the cumulative impacts of any of the additional power plants underway or planned within proximity of Richards Bay.

3 Approach and Methodology

The methodology used for this CCIA was informed by:

1. The nature of climate change;
2. The project development timeframes;
3. The long-term climate impacts anticipated for the project area; and
4. Available climate data for variables specifically relevant to the project.

The climate-related impacts and vulnerabilities relevant to the Project and surrounding areas will be considered throughout this CCIA.

3.1 Project Contribution to Climate Change

The Karpowership Project's contribution to global climate change will be determined by calculating the project GHG inventory (carbon footprint) over its lifetime. This process is described further below.

3.1.1 GHG Emissions Quantification

3.1.1.1 Standards used

At the time of writing this report, South African laws (most are considered under the umbrella of the NEMA), do not yet provide adequate guidelines for CCIAs[18]. Thus, this report makes use of the *National GHG Reporting Regulations No. 40762 of 2017 and its amendments,* and other globally accepted international best practice and is guided by the *Thabametsi* Judgement (as discussed in the background section above).

It is noted that the National GHG Reporting Regulations provides only for the calculation of direct emission. Various appeals to environmental authorisations have however referred to the "life cycle impacts" of the activities. This means that there is an expectation that the GHG emissions of a project is to be considered in terms of all of the emissions associated with the project including the upstream and downstream indirect emissions.

The GHG inventory, for the proposed Project at Richards Bay, has been guided by the following reference documents:

[18] South Africa's Department of Forestry Fisheries and the Environment is in the process of providing further guidelines for Climate Change Impact Assessments. However, these guidelines were not taken into consideration, as these guidelines are only a draft and have not yet been published.

- *SANS 14064:2021 Part 1: Specification with guidance at the organization level for quantification and reporting of GHG emissions and removals* [19];
- The GHG Protocol's *A Corporate Accounting and Reporting Standard (Revised Edition)*[20];
- The Department of Environmental Affairs' *Technical Guidelines for Monitoring, Reporting and Verification of GHG Emissions by Industry*[21];
- The Department of Forestry, Fisheries and the Environment's *Technical Guidelines for the Validation and Verification of GHG Emissions*[22];
- The 2006 Intergovernmental Panel on Climate Change (IPCC) *Guidelines for National GHG Inventories*[23]*;* and
- The Intergovernmental Panel on Climate Change (IPCC) *2019 Refinement to the 2006 IPCC Guidelines for National GHG Inventories, Volume 2, Chapter 4*[24].

The main guiding document used, in the calculation of the impact of the project on climate change, is the *SANS 14064:2021 Part 1*. This document sets out principles summarised in Table 1, that guide the GHG inventory development process. It requires that emissions be categorised into the following groups:

Category 1 – Direct GHG emissions and removals;
Category 2 – Indirect GHG emissions from imported energy;
Category 3 – Indirect GHG emissions from transportation;
Category 4 – Indirect GHG emissions from products used by an organization;
Category 5 – Indirect GHG emissions associated with the use of products from the organization;
Category 6 – Indirect GHG emissions from other sources.

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[19] Standards South Africa, 2021, *SANS 14064-1:2021 GHGes Part 1: Specification with guidance at the organisational level for the quantification and reporting of GHG emissions and removals*, Pretoria.

[20] GHG Protocol, 2015, *A Corporate Accounting and Reporting Standard: Revised Edition.*

[21] Department of Environmental Affairs, 2016, *Technical Guidelines for Monitoring, Reporting and Verification of GHG Emissions by Industry.*

[22] The Department of Forestry, Fisheries and the Environment ,2021, *Technical Guidelines for the Validation and Verification of GHG Emissions.*

[23] IPCC, 2006. *IPCC Guidelines for National GHG Inventories*, [Online] Available at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/ [Accessed on 05/04/2022].

[24] IPCC, 2019. *Refinement to the 2006 IPCC Guidelines for National GHG Inventories.*

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

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

The calculation of the GHG inventory for the proposed Project at Richards Bay, follows the general steps stipulated here:

1) Boundaries of the carbon footprint calculation are set;
2) GHG sources inside the boundary are identified;
3) The significance of each of the emission sources is determined;
4) Quantification method is established; and
5) GHG emissions inventory is calculated.

Note that traditionally, GHG reporting has been done in line with the 2006 version of SANS14064-1, which classified emissions in 3 emission scopes. The relationship between the traditional emission scopes and the latest version of the standard is shown in Table 2 below:

Table 2: GHG reporting for both standards ISO 14064-1:2021 and ISO 14064-1:2006.

SANS 14064-1:2021		ISO 14064-1:2006	
Category	**Description**	**Category**	**Description**
1	Direct GHG emissions and removals	Scope 1	Direct emissions
2	Indirect GHG emissions from imported energy	Scope 2	Energy indirect emissions
		Scope 3 Category 3	Fuel- And Energy-Related Activities
3	Indirect GHG emissions from transportation	Scope 3 Category 4	Upstream Transportation and Distribution
		Scope 3 Category 6	Business Travel
		Scope 3 Category 7	Employee Commuting
		Scope 3 Category 9	Downstream Transportation and Distribution
4	Indirect GHG emissions from products used by organization	Scope 3 Category 1	Purchased Goods and Services
		Scope 3 Category 2	Capital Goods
5	Indirect GHG emissions associated with the use of	Scope 3 Category 10	Processing of Sold Products

SANS 14064-1:2021		ISO 14064-1:2006	
Category	**Description**	**Category**	**Description**
	products from the organization	Scope 3 Category 11	Use of Sold Products
		Scope 3 Category 12	End-Of-Life Treatment of Sold Products
6	Indirect GHG emissions from other sources	Scope 3 Category 5	Waste Generated in Operations
		Scope 3 Category 8	Upstream Leased Assets
		Scope 3 Category 13	Downstream Leased Assets
		Scope 3 Category 14	Franchises
		Scope 3 Category 15	Investments

3.1.1.2 Significance Criteria for Inclusion of Indirect Emissions

The boundary of the GHG Inventory for the project is established in accordance with SANS 14064-1:2021 standard. The standard outlines the process as identifying emission sources at the operation and its value chain. All direct emission sources are included in the boundary, while indirect emission sources are identified through a significance assessment.

The direct emission sources included in the boundary for both construction and operation phases are the combustion of fuel in stationary and mobile mining equipment.

The indirect emission sources are assessed based on the following significance criteria.

Table 3: Karpowership Projects-defined and explained criteria.

Criteria	Description	Criteria applied to this project
Magnitude	The indirect emissions or removals that are assumed to be quantitatively substantial.	Include emission sources based on Magnitude when the value of the indirect emissions from a source is **more than 1%** of the total estimated GHG inventory of the project unless it is explicitly excluded by another criterion. Exclude all indirect emissions for specific sources when the value of the emissions from such sources are **less than 1%** of the total estimated GHG inventory of the project unless explicitly included by another criterion.

Criteria	Description	Criteria applied to this project
Level of influence	The extent to which the organization has the ability to monitor and reduce emissions and removals (e.g., energy efficiency, eco-design, customer engagement, terms of reference).	Include emissions from emission sources based on Influence when the level of influence of the project over such emission sources is considered to be **high.** Exclude emissions from emission sources based on Influence when the level of influence by the project over the emission sources is considered to be **zero.**
Risk or opportunity	The indirect emissions or removals that contribute to the organization's exposure to risk (e.g., climate-related risks such as financial, regulatory, supply chain, product and customer, litigation, reputational risks) or its opportunity for business (e.g., new market, new business model).	Include emissions from emission sources based on Risk or Opportunity when risk or opportunity to the project associated with such emission sources is considered **high.**
Sector-specific guidance	The GHG emissions deemed as significant by the business sector, as provided by sector-specific guidance.	Include emissions from emission sources based on Sector-specific guidance when such is **available.**
Outsourcing	The indirect emissions and removals resulting from outsourced activities that are typically core business activities.	Include emissions from emission sources based on Outsourcing when the value of the indirect emissions associated with the outsourcing is **more than 1%** of the total estimated GHG inventory of the company.
Employee engagement	The indirect emissions that could motivate employees to reduce energy use or that federate team spirit around climate change (e.g., energy conservation incentives, carpooling).	Include emissions from emission sources based on Employee Engagement when the impact on emissions of employee engagement is considered **high.** Exclude emissions from emission sources based on Employee Engagement when the impact of employee engagement on emissions is considered **zero.**

3.1.1.3 GHG Inventory Development

The direct, upstream, and downstream emissions for the construction and operational stages of the Project are calculated based on the procedures below considering the boundary above. The emissions for the decommissioning stage are considered insignificant in the context of the overall project and are therefore not calculated in this GHG Inventory. These emissions are insignificant due to the low infrastructure footprint of the project. The decommissioning phase will require have minimal energy requirements. Furthermore, the plants themselves are mobile and can be removed easily under their own power once the PPA lapses. The emissions from moving the Powership falls outside the boundary of the inventory assessment as they predominantly occur in international waters.

The GHG inventory developed in this assessment does not constitute a full Life Cycle Assessment. The inventory includes all significant value chain emissions in accordance with the SANS14064:2021 standard for calculating GHG emissions. Life Cycle Assessments are conducted in accordance with a separate standard (SANS 14040:2006 and SANS 14044:2006) with its own requirements outside of the scope of this report.

The LCA standards are not applicable to calculating a GHG inventory. As such, the SANS 14064:2021 standard is used. A full LCA consists of additional requirements not relevant to the calculation and assessment of the GHG emissions of a project. However, the emissions from all value chain stages are considered in this assessment without the additional requirements imposed by the LCA standards. The use of the SANS standard encompasses the life cycle emissions of the project.

Furthermore, in a recent judgement[25] the court determined that a CCIA should only consider the direct emissions from the project. All value chain (life cycle) emissions should be considered under the respective EIA's for that infrastructure. The judgement further ruled that emissions occurring outside of the boundary of the Republic of South Africa should be excluded as our legal system does not have jurisdiction over these plants.

To align with this judgement, the value chain emissions for the project will be calculated and assessed, however, in the assessment of the impact of the project on climate change only the direct operational emissions will be considered.

The direct emissions relate to onsite emissions during construction and operation (such as combustion of fuels). The upstream emissions relate to the sourcing of materials consumed during

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[25] South Durban Community Environmental Alliance and Another v Minister of Forestry, Fisheries and The Environment and Others (17554/2021) [2022] ZAGPPHC 741 (6 October 2022) http://www.saflii.org/za/cases/ZAGPPHC/2022/741.html. Pages 12 and 13.

construction and operation (such as material manufacture and transport emissions). The downstream emissions relate to the end of life of materials and the use of sold products (such as waste management activities and steel manufacture).

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

The construction- and operation-related emissions are calculated using the equation as described in the beginning of Section 3.1.1. The generic *Activity Data, Emission factor and Emission* terms are replaced with specific parameters to describe the emissions under consideration.

During operation, the Category 1 emissions are from the combustion of natural gas. These emissions can be calculated as followed:

$$Cat1_D = (Gas_x \times EF_{SD})$$

Where:

$Cat1_D$ represents the direct emissions during the construction and operation phase of the Project, measured in tCO_2e/year;

x represents the phase that is being accounted for. i.e., construction or operation phase;

Gas_{Dx} represents the total combustion of natural gas during the construction or operation phase of the Project, measured in litres/year;

EF_{SD} represents the emission factor of stationary combustion of natural gas, measured in tCO_2e/l;

The Category 2 emissions during the operation were calculated as:

$$Cat2_{Elec} = (\mathrm{Electricity}_x \times EF_{Elect})$$

Where:

$Cat2_{Elec}$ represents the Category 2 emissions during the operation phase of the Project, measured in tCO_2e/year;

Elect_x represents the electricity consumed in year *x* at the Project, measured in MWh/year; and

EF_{Elect} represents the grid emission factor for electricity, measured in tCO_2e/MWh.

The indirect emissions (Category 3 – 6) will account for the purchased goods and services, fuel and energy related activities, upstream and downstream transportation and distribution, use of sold products and waste generated. The main calculation that was used for these emissions is:

$$Scope3_{IDE} = (Act_x \times EF_{Act})$$

Where:

$Scope3_{IDE}$ represents the total indirect emissions during the construction and operation phase of the Project, measured in tCO_2e/year;

x represents the phase that is being accounted for. i.e., construction or operation phase;

Act_x represents the activity data occurring at the Project for a specific phase x, measured in Unit of Measurement/year. The Unit of Measurement depends on the activity, for example, tonnes of purchased material or distance transported; and

EF_{Act} represents the emission factor of that activity data, measured according to the activity measurement.

3.1.2 Boundaries

The indirect emission sources relevant to the Karpowership Projects were assessed, based on the table above, in Table 4 below:

Table 4: Significance criteria and related definition for Karpowership Project at Richards Bay indirect emissions.

Emission source	Significance criteria						Inclusion in the GHG inventory boundary
	Magnitude	Level of influence	Risk or opportunity	Sector-specific guidance	Outsourcing	Employee engagement	
Transport of natural gas to port	**Medium** - Forms about 3% of overall emissions	**High** – the source of the natural gas can be changed. If natural gas is sourced from close markets, then the transport emissions will be reduced.	**Medium** – minor risk of supply disruptions from climate change related events	N/A	N/A	**Low** – some change in these emissions could come from engaging with employees on responsible energy consumption	**Include**
	Include because magnitude is above 1%	Include because influence is high	Include because climate-related risk is high			Do not include or exclude because rating is low	
Production of natural gas	**Medium** - Forms about 6% of overall emissions	**Low** – the use of natural gas as fuel for the power plant cannot be changed	**Low** - the use of natural gas as fuel for the power plant cannot be changed	N/A	N/A	**Low** – the use of natural gas as fuel for the power plant cannot be changed	**Include**
	Include because magnitude is above 1%						
Production of purchased goods – cement used during the construction phase	**Low –** Forms less than 1% of overall emissions over the life cycle of the project	**Low** – there is minimal influence over the emissions associated with cement production due to the unmitigable emissions in the production process	**Low** – Cement can be sourced from a variety of sources	N/A	N/A	N/A	**Exclude.** All assessment criteria are low specifically magnitude.

Emission source	Significance criteria						Inclusion in the GHG inventory boundary
	Magnitude	Level of influence	Risk or opportunity	Sector-specific guidance	Outsourcing	Employee engagement	
	Exclude because magnitude is below 1%	Do not include or exclude because rating is low	Do not include or exclude because rating is low				
Production of purchased goods - steel used during the construction phase	**Low** - Forms less than 1% of overall emissions	**Low** – there is minimal influence over the emissions associated with cement production due to the unmitigable emissions in the production process	**Low** – Steel can be sourced from a variety of sources	N/A	N/A	N/A	**Exclude.** All assessment criteria are low specifically magnitude.
	Exclude because magnitude is below 1%	Do not include or exclude because rating is low	Do not include or exclude because rating is low				

3.1.3 Data used

3.1.3.1 Activity Data

The data used throughout this assessment was obtained from various sources. For the calculation of the GHG inventory for the CCIA, the main information was obtained from the data sheets sent by the client. The data provided is summarised in the table below.

Table 5: Activity data used in the GHG inventory.

Phase	Quantity	Data source
Construction Phase		
Steel required	231 tonnes/year	Provided by Triplo4
Cement required	373 m^3/year	Provided by Triplo4
Operation Phase		
Natural Gas consumption in the operation of the FSRU	298 TJ/year	Calculated from ship specifications provided by Triplo4
Natural Gas consumption by the power generation equipment	24 361 TJ/year	Calculated from engine heat rate provided by Triplo4
Gas generator for onboard electricity requirements*	0.8 MW	Provided by Triplo4
Lifetime	20 years	Provided by Triplo4
Electricity generated	2 669 473 MWh/year	Provided by Triplo4
Wartsila 18V50 heat rate	9 126 kJ/kWh	Provided by Triplo4

**The generator was assumed to run year round as a conservative estimate.*

3.1.3.2 Emission Factors

The emission and conversion factors applied in the calculation of the Project's GHG inventory, are aligned with the following principles:

- Derived from a recognised origin;
- Appropriate for the GHG source concerned;
- Current at the time of quantification;
- Take account of quantification uncertainty and are calculated in a manner intended to yield accurate and reproducible results; and
- Consistent with the intended use of the carbon footprint.

The main sources of the emissions and conversion factors used in this GHG inventory are the South African Technical Guidelines[26], the IPCC 2006 Guidelines[27] and the DEFRA 2021[28] emission factor sheet.

Specifically, the emission factors to calculate category 1 emissions were taken from the South African Technical Guidelines.

The emission factors (and other conversion factors) used in this CCIA are presented in Table 6 below.

Table 6: Emission and conversion factors used for the GHG inventory.

Emission factor	Value	Unit	Source
Direct Emission Factors			
Natural Gas Combustion	56 153	kg CO_2e/TJ	SA Technical Guidelines. Table A.1
Energy indirect Emission Factors			
South Africa - Grid	1.06	tCO_2e/MWh	Eskom FY21 IAR
Other Indirect Emission Factors			
LNG transport	0.0021	tCO_2e/GJ	Sasol information provided by Triplo4
Natural gas exploration	0.06	tCH_4/million m^3	IPCC 2019 refinement. Vol 2. Chapter 4
Natural gas production	4.09	tCH_4/million m^3	IPCC 2019 refinement. Vol 2. Chapter 4
Natural gas processing	1.83	tCH_4/million m^3	IPCC 2019 refinement. Vol 2. Chapter 4
Steel production	1.9	tCO_2e/tonne	World Steel Association
Cement production	1.13	tCO_2e/m^3	PPC Annual Report
Conversions and Assumptions			
Methane GWP	23	tCO_2e/tCH_4	SA Technical Guidelines*
Nitrous Oxide GWP	296	tCO_2e/tN_2O	SA Technical Guidelines*
Natural Gas NCV	34.3	MJ/m^3	SA Technical Guidelines converted from 0.048TJ/tonne

**The 100 year GWP is used to align with international standards on reporting GHG emissions as required by the IPCC 2006. The 20 year GWP for Methane is higher due to it having a shorter life in the atmosphere*

[26] Department of Environmental Affairs, 2017, *Technical Guidelines for Monitoring Reporting and Verification of GHG Emissions by Industry.*
[27] IPCC. 2006. Climate Change 2006 – The Physical Science Basis. Summary for Policy Makers. Intergovernmental Panel on Climate Change, Geneva, Switzerland.
[28] DEFRA, 2021, UK Government GHG Conversion Factors for Company Reporting.

In accordance with the selected standards and the internationally accepted best practice by the IPCC guidelines, the 100-year GWP was used in this inventory[29].

3.1.4 Environmental Impacts of GHG Emissions

The EIA reporting requirements[30] listed in Table 7 below, set out the criteria to describe and assess local environmental impact. However, climate change is a global phenomenon, thus, the criteria are only partially applicable as they are inadequate to fully quantify the impact. Despite this, these criteria are the only criteria currently available to measure the impact of the project on climate change.

Table 7: EIA Criteria.

Nature	A description of what causes the effect, what will be affected and how it will be affected. *In the case of climate change assessments, the nature of the impact is the contribution of the Project to global anthropogenic climate change.*
Intensity (I)	The intensity is the magnitude of the environmental impact under consideration. These impacts can be positive or negative and range from negligible change to severe irreversible change. The environmental impact assessment reporting requirements were developed to describe and assess environmental impacts, however GHG emissions that have a global impact has yet to be described. For this reason, a materiality threshold was defined to quantify the intensity of the impacts.
Extent (E)	An indication of whether the impact will be local (limited to the immediate area or site of development), regional, national, or international. Part of the site is considered very low, the whole property - low, affecting immediate neighbours - medium, local area - high and regional/national - very high. *In the case of climate change assessments, the extent is always global, and thus, very high is allocated to all projects that contribute to global anthropogenic climate change.*
Duration (D)	An indication of the lifetime of the impact. Impacts are quantified as follows: less than a year – very low, between 1 and 5 years – low, between 5 and 10 years – medium, between 10 and 20 years – high and longer than 20 years – very high. *In the case of this project, the impact will end at the end of the project life. Therefore, a high rating is allocated.*

29 The climate change impact resulting from fugitive emissions from natural gas production can be estimated using the 20-year GWP and results in approximately 270 ktCO2e per annum. However, when calculating a GHG inventory, the 100-year GWP is used to comply with the internationally accepted methodology resulting in approximately 100 ktCO2e. The use of the 20-year GWP cannot be justified in this context.

30 Environmental Impact Assessment Regulations, 2014, as amended. Section 3(j) Appendix 1 and Appendix 3 (Scope of assessment and content of Basic Assessment Report and Environmental Impact Assessment, respectively). https://cer.org.za/wp-content/uploads/1999/01/NEMA-EIA-Regulations-2014-as-amended.pdf

Probability (P)	An indication of the likelihood of the impact occurring. The scale of probability ranges from unlikely to definite. The IPCC has reported that it is 95 percent certain that man-made emissions are the main cause of current observed climate change[31]. *Thus, a definite probability is allocated to all projects that contribute to global anthropogenic climate change.*
Consequence (C)	The consequence of the impacts is a function of the intensity, extent and duration, and assesses the overall consequence of the impacts.
Significance (S)	The significance of the impacts is calculated as :S=C x P

3.1.5 Determining the Impact of the Project on Climate Change

The regulatory framework in South Africa does not provide guidance on the impact of GHG emissions. Promethium Carbon has thus developed an approach to determining the impact of projects based on GHG emissions. This approach is summarised in the table below:

Table 8: Impact Rating of Project on Climate Change

Impact rating	Approach to quantification
Low	The draft document - *National Guideline for the Consideration of Climate Change Implications in Applications for Environmental Authorisations, Atmospheric emissions Licenses and Waste Management Licenses* gives guidance for when a specialist climate change impact assessment is necessary. The lower limit is when the activity breaches one of the thresholds stipulated in the *National GHG Reporting Regulations*. Thus, the upper limit of the ***low impact category*** was taken as installation with GHG emissions equivalent to the combustion of coal at a capacity of 10 $MW_{thermal}$ at a 100% utilisation.
Medium	The impact of projects in the ***medium impact category*** was taken as the project falling between the upper limit of the low impact category and an order of magnitude below the upper limit of the high impact category.
High	The impact of projects in the ***high impact category*** was taken as project falling between the upper limit of the medium impact category and the lower limit of the very high impact category.

[31] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Impact rating	Approach to quantification
Very high	The lower limit for the ***very high impact category*** was calculated to be the equivalent of the annual emissions of a new coal fired power station. The size of the hypothetical power station was equivalent to the average capacity of the Eskom coal-fired fleet, namely 2 900 MW. The annual emissions were calculated using an efficiency taken from the 2017 EPRI Report for new coal-fired power stations and the current availability of the Eskom fleet.

Table 9 combines the above calculations into one impact table. This is used to assess the magnitude of the impact of a project on climate change. It also compares the thresholds to the low emission Nationally Determined Contribution (NDC) carbon budget of 7 758 Mt CO_2e.

This assessment only considers emissions in the GHG inventory that occur within the boundary of South Africa. This ensures consistency in the impact assessment, as the climate change impact assessment is a South African legal requirement. There is therefore no jurisdiction over emissions from international sources within this process. This also allows the emissions to be compared to the NDC, which only considers the South African national GHG inventory.

Table 9: Impact category thresholds used to determine the magnitude of the impact of the project on climate change.

GHG impact rating as a % of SA's carbon budget	Amount of GHG emissions		Relative to Low Emission NDC Carbon Budget	
	Lower limit (tCO_2e)	Upper limit (tCO_2e)	Lower limit (tCO_2e)	Upper limit (tCO_2e)
Low	-	30 000	0.000000%	0.00039%
Medium	30 001	1 500 000	0.00039%	0.019%
High	1 500 001	15 000 000	0.019%	0.193%
Very High	15 000 001	+		> 0.193%

3.1.6 Limitations and Assumptions

This CCIA makes use of data obtained during a desktop review for the development of this GHG inventory and associated impact assessment. Certain assumptions were made to ensure the development of the most accurate and extensive GHG inventory and the associated impact assessment. These assumptions were made considering the significant boundary set out by the GHG reporting requirements, as per SANS14064 (2021). The assumptions are the following:

- It was assumed that the energy requirements during construction of the project will be immaterial when compared to the operational phase of the plant. The operational phase of the project results in 1.1 million tCO_2e. the energy associated emissions in the construction phase would form less than 0.2% of this total.

- It was assumed that the decommissioning of the plant will contribute immaterially towards the GHG inventory when compared to the operational phase.

3.2 Project Resilience to Climate Change

Although the project lifetime is 20 years or less, the project can still be subject to climate change impacts. Climate change management should, therefore, not be limited to emission reductions (mitigation) but should also take into consideration measures for increasing the resilience of the project (adaptation) in the face of climate change impacts. Identifying impacts of climate change on the project will be considered in this assessment.

3.2.1 International Best Practice

Due to the current lack of local regulations regarding CCIAs in South Africa, specifically with regards to unpacking and quantifying vulnerability to climate change, international best practice is used in this assessment. In this regard, this report makes use of globally accepted international best practice, including:

- Framework for Climate Change Vulnerability Assessments[32];
- International Finance Corporation (IFC) performance standards[33];
- International Council on Mining and Minerals (ICMM): Adapting to climate change[34];
- European Bank for Reconstruction and Development (EBRD) principles; and
- The Equator Principles[35].

The abovementioned documents were used to develop a rating system (indicated in Section 3.1.5 of this report), to which the current project is benchmarked. This enables us to adequately assess climate change impacts considering available baselines and relevant information.

3.2.2 Key Areas of Impact

Climate change could potentially pose threats to the key processes of the development and implementation of the Karpowership Project at Richards Bay. Climate change could disrupt several main areas, such as the core operations, the natural environment, the value chain, and the

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32 GIZ. 2014. The vulnerability sourcebook. Gesellschaft für Internationale Zusammenarbeit, Bonn, Germany.

33 International Finance Corporation, 2012, *Performance Standards*, [Online] Available at: https://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/Sustainability-At-IFC/Policies-Standards/Performance-Standards [Accessed on 30/03/2022].

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

35 The Equator Principles Association, 2020, *Equator Principles EP4*, [Online] Available at: https://equator-principles.com/about/ [Accessed on 30/03/2022].

social context of the area surrounding the Project. Consequently, climate change impacts within these areas are focused on the following four areas:

1. **Core operations** - The core operations relate to the activities taking place on site, which are essential to the operations of the facility. These are operations that are performed by the project and that its management has complete control over. These activities are centred on processes related to the receipt, storage and re-gasification of the natural gas fuel, as well as the generation and dispatch of electricity;
2. **Value chain (upstream and downstream)**- The value chain relates to the fuel supply, goods and services the Karpowership Project requires to operate. These are operations that are related to the project but falls outside of the control of the project. These include activities of suppliers, customers, government, and the greater economic market;
3. **Social environment (surrounding/impacted communities)** - This includes the people that are both directly and indirectly affected by the project, such as employees, surrounding industry and local communities. The social context of this assessment refers to the communities/settlements (both urban and rural) that would be impacted, both directly and indirectly, by climate change. The impacts should be integrated into a more detailed socio-economic assessment, and;
4. **Broader environmental risks** - This is related to risks to the natural environment directly surrounding the operations of the project. The natural environment relates to natural capital in ecosystems that deliver valuable services to people, such as water supply, climate regulation, soil formation and disaster risk reduction.

3.2.3 Data used

This vulnerability assessment refers to various data sources in the process of determining the critical vulnerability factors faced by the project. Data sources are limited to those that are publicly available and where possible using the most up-to-date data from reputable international or local data repositories. These include but are not limited to the World Bank Climate Change Knowledge Portal (CCKP), the Copernicus Climate Data Store (CCDS) and the National Oceanic and Atmospheric Administration (NOAA). The relevant data sources are referenced where applicable. Where processing was relevant, the data were processed in either Google Earth Engine, R (v4.2.0) and/or using GIS software (Esri ArcGIS Pro or QGIS).

These data were used in conjunction with the information sheet received from the client and considering the specialist's background and understanding of climate-related impacts posed on the Karpowership Project at Richards Bay.

3.2.4 Determining project vulnerability and resilience

The overall vulnerability of the Karpowership Project at Richards Bay, and its surrounds to climate change impacts, can be determined by identifying the exposure, vulnerability, and adaptive capacity of the region in which the Project lies. The IPCC Sixth Assessment Report (2021)[36] defines vulnerability as: "*the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt*"[37]. This definition aligns with the method for determining the Project's climate-related vulnerability, proposed in Figure 6.

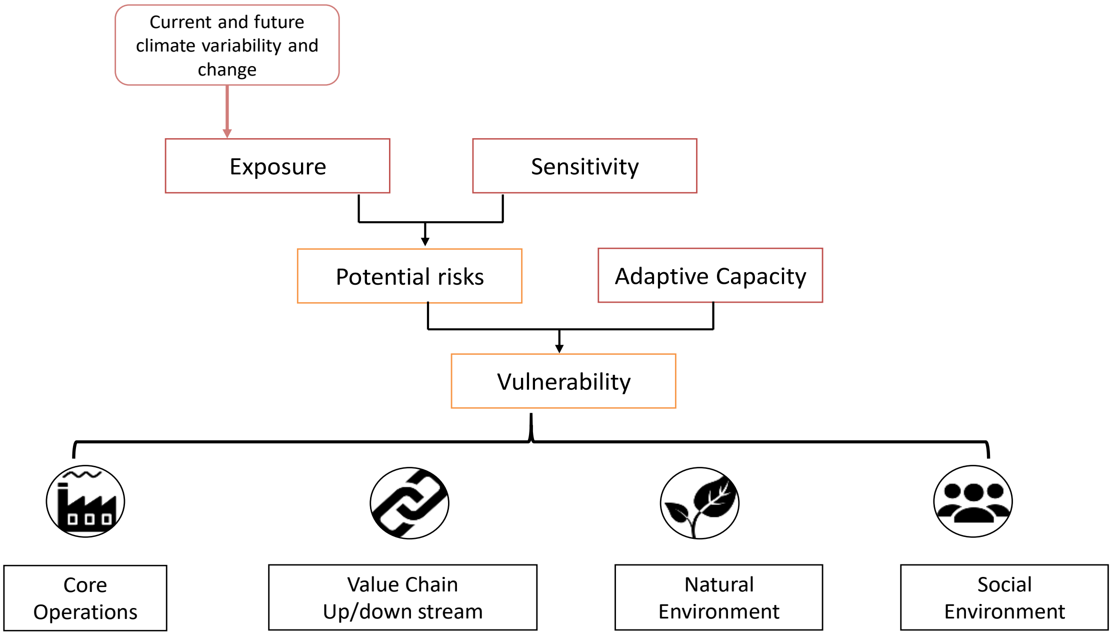

Figure 6: Interrelations of Exposure, Sensitivity and Adaptive Capacity, which makes up the basis of the vulnerability assessment.

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

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[36] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[37] IPCC, 2021, *Data Distribution Centre Glossary: Vulnerability*, IPCC [Website] Available at: https://www.ipcc-data.org/guidelines/pages/glossary/glossary_uv.html [Accessed on 16/03/2022].

3.2.5 Limitations and Assumptions

The Project's vulnerability to climate change is assessed within this CCIA through an analysis of available[38] datasets. It should be noted that climate data was extracted and analysed at the finest scale possible. Modelling climate variables is challenging and thus most datasets for future climate are at a coarser resolution than observed or reanalysed climate data. Whilst every effort was made to use data from the relevant location, some data may represent an aggregation of a larger area. This introduces a level of uncertainty and higher variance than projections at regional or continental scales, however, the overall trend remains similar, and the interpretation is likely to remain the same. Where necessary, non-statistical adjustments have been made based on the historical trend.

Furthermore, while confidence is growing in global climate models, there is a much greater appreciation of uncertainties involved in downscaling global models to illustrate climate projections at a local scale[39]. This is particularly relevant for precipitation-related projections in southern Africa.

This uncertainty should be noted by the project developers since the impacts of climate change may result in decreased investment value over time and possible increases in costs of maintenance.

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

- Only impacts on the core operations and direct value chain were assessed and;
- Consideration focused on impacts occurring *during the lifetime* of the project.

3.3 Polycentric Integrative Approach

A polycentric approach to the proposed project requires the holistic consideration of all relevant factors, inclusive of potential impacts that the proposed Project could have on the local as well as the broader community. Section 2(4)(b) of NEMA states that Environmental management must be integrated, acknowledging that all elements of the environment are linked and interrelated, and it must consider the effects of decisions on all aspects of the environment and all people in the environment by pursuing the selection of the best practicable environmental option. Sustainable development as per NEMA requires the integration of social, economic, and environmental factors

38 This includes both spatial and temporal availability.

39 Bourne, A, P. deAbreu, C. Donatti, S. Scorgie, and S. Holness. 2015. A Climate Change Vulnerability Assessment for the Namakwa District, South Africa: The 2015 revision. Conservation South Africa, Cape Town.

in the planning, implementation, and evaluation of proposed projects, to ensure that development serves the needs of present and future generations.

This specialist assessment considered both the positive and negative impacts of actual and potential impacts on the geographical, physical, biological, social, economic, and cultural aspects of the environment in a polycentric and holistic approach:

- To ensure that all aspects are weighed up against each other;
- To identify the risks and consequences of alternatives and options for mitigation of activities, with a view to minimising negative impacts, maximising benefits, and promoting compliance with the principles of environmental management as set out in section 2 of NEMA.

A specialist integrative workshop and weekly meetings were held during the EIA process where specialists raised matters to be considered by the specialist team and verified technical information to prevent any discrepancies and where relevant, to co-ordinate approaches.

This approach ensured that there are no gaps contained between the various specialist reports and provides a holistic picture of the project and allows a polycentric assessment of environmental and socio-economic impacts and the identification of appropriate mitigations and recommendations for potential negative impacts and the maximisation of positive impacts and the value of the project to society.

4 Projected Climate Changes

Understanding potential future climate change impacts and risks on the project relies on analysis of both near-historical and future projected/modelled climate data. Appropriate data sources were used for historical and near-future (ca. 1980-2021). Climate projections are primarily drawn out of datasets that form part of the Coupled Model Intercomparison Project Phase 6 (CMIP6).[40] We acknowledge the World Climate Research Programme, which, through its Working Group on Coupled Modelling, coordinated and promoted CMIP6.[41]

Future projections are based on Shared Socio-economic Pathways (SSPs, see Key Terms and Definitions above).[42] Here, SSP1-2.6 (SSP1), SSP2-4.5 (SSP2) and SSP 5-8.5 (SSP5) are presented. SSP2 is seen as one of the most likely future scenarios given that the indicate modest mitigation,[43] SSP1 aligns to a 1.5 °C world, and SSP5 represents a pessimistic (and increasingly unlikely) scenario based on minimal mitigation and adaptation. These scenarios assist in understanding a range of futures and risks that could occur, and accounts for the inherent uncertainty of modelled future climate.

The main weather-related risks relevant to the project are those that relate to marine and coastal weather: **sea surface temperature, ocean pH (acidification), coastal storm activity and impacts, wind, and sea level**. Air temperature and precipitation are also relevant but to a lesser degree on the core operations and more on the value chain and surrounding environment. For example, temperature changes and extreme temperature occurrences could affect operations and labour productivity. Although all sites are in regions with relatively high temperatures, uncomfortable heat levels impact labour productivity and have a direct bearing the health and safety of personnel. Heat stress and discomfort felt could lead to unforeseen incidents that could cause damage to equipment/or human injury. This could lead to higher mortality rates, heat-related illnesses, increased injuries, more absenteeism, slow work pace, loss of productive capacity, and

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[40] Eyring, V., Bony, S., Meehl, G. A., Senior, C. A., Stevens, B., Stouffer, R. J., and Taylor, K. E. 2016: Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, *Geosci. Model Dev.*, 9, 1937-1958, DOI: https://doi.org/10.5194/gmd-9-1937-2016.

[41] We thank the climate modelling groups for producing and making available their model output, the Earth System Grid Federation (ESGF) for archiving the data and providing access, and the multiple funding agencies who support CMIP6 and ESGF.

[42] The SSPs have been introduced into the latest assessment report (AR6) currently being compiled by the IPCC. They describe five narratives each describing different governance scenarios, application of climate policies and levels of climate change mitigation. The SSPs are useful in that they provide for different trends in economic and human development and the links between different regions in light of these. These are then combined with Representative Concentration Pathways (RCPs) which set pathways for GHG concentrations and the potential warming (radiative forcing) that could occur by 2100. The use of numerous SSPs can be seen as using a number of future scenarios.

[43] Hausfather, Z. & Peters, G.P. 2020. Emissions – the 'business as usual' story is misleading. *Nature* 577: 618–620.

poor social well-being. Unlike land-based projects, ocean-based projects have limited impacts from flooding. However, given that infrastructure associated with the project is land-based, precipitation and flooding are considered to a degree.

4.1 General Regional Climate Change Considerations

The climate change projections for the Project indicate that the median annual mean ambient temperatures are likely to increase by 0.4-0.8˚C by 2030 and 0.8-1.4˚C by 2050 (with significant annual variability) under different climate scenarios (Figure 7).

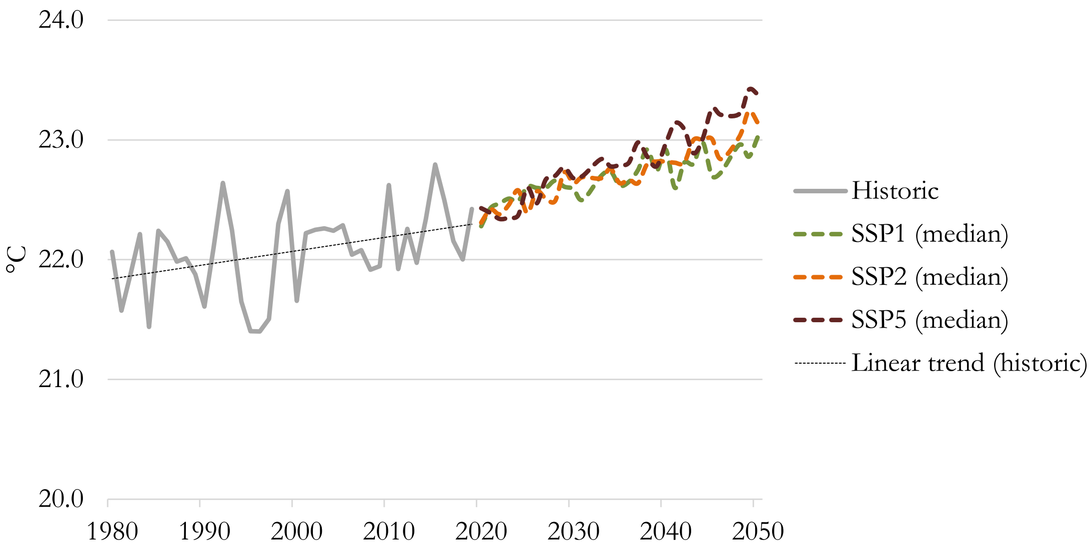

Figure 7: Historical and projected mean annual temperature at Richards Bay. Data sources: Copernicus Climate Change Service (C3S)[44] and CMIP6[45]

Mean annual precipitation is likely to decrease slightly (<5% change) in the short-term and then stabilises somewhat by 2050. (Table 10). Such climatic changes could impact on the Project in terms of its core operations, value chain and broader socio-economic and natural environment. Extreme rainfall events do not appear to increase under different scenarios but are challenging to model and should be prepared for.

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44 Copernicus Climate Change Service (C3S). 2017. ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate. Copernicus Climate Change Service Climate Data Store (CDS), 15 September 2022, https://cds.climate.copernicus.eu/cdsapp#!/home.

45 Eyring, V., Bony, S., Meehl, G. A., Senior, C. A., Stevens, B., Stouffer, R. J., and Taylor, K. E. 2016: Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, *Geosci. Model Dev.*, 9, 1937-1958, DOI: https://doi.org/10.5194/gmd-9-1937-2016.

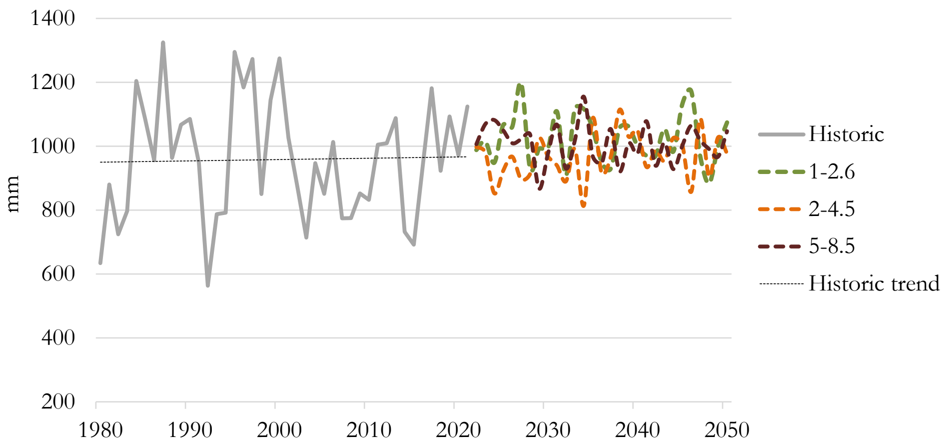

Figure 8: Historical and projected mean annual precipitation at Richards Bay. Data sources: Copernicus Climate Change Service (C3S)[46] and CMIP6.[47]

The current and future changes in weather for the Karpowership Project at the Port of Richards Bay, are summarised in the table below.

[46] Copernicus Climate Change Service (C3S). 2017. ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate. Copernicus Climate Change Service Climate Data Store (CDS), 15 September 2022, https://cds.climate.copernicus.eu/cdsapp#!/home.

[47] Eyring, V., Bony, S., Meehl, G. A., Senior, C. A., Stevens, B., Stouffer, R. J., and Taylor, K. E. 2016: Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, *Geosci. Model Dev.*, 9, 1937-1958, DOI: https://doi.org/10.5194/gmd-9-1937-2016

Table 10: Current and future climate projections for temperature and precipitation-related variables for the Karpowership Project at Richards Bay within the uMhlathuze Local Municipality. Data sources: Copernicus Climate Change Service (C3S)[48,49] and Green Book Risk Profile Tool.[50]

		Projected change by 2040-2059 (median year 2050) relative to baseline		
Climate change impact	Current/Near historical	SSP1	SSP2	SSP5
Mean annual temperature	22.1˚C (19.6-24.6˚C); increasing trend	Increase of 0.5-0.8°C	Increase of 0.8-1.2°C	Increase of 1.0-1.4°C
Very Hot Days[51]	6.9-9.7 days/year	Not available	Increase by 0-12 days/year (mean increase of 1.7 days per year)	Increase by 0-18 days per year (mean increase of 10.5 days per year)
Mean annual precipitation	958 ±187 mm/year; negligible trend	Mean decrease of ±30 mm/year	Mean decrease of ±35 mm/year	Mean decrease of ±90 mm/year
Extreme Rainfall Days[52]	19.7-21.3 days/year	Not available	Decrease of up to 3 days/year	Negligible change (<0.5 days)
Drought Risk	Moderate to high	Not available		Extreme risk of increase in drought conditions per decade compared to baseline
Coastal flooding risk	Not available	Not available		Medium risk
Fire Risk	Possible	Not available		Medium risk
Damaging wind risk	Not available			

4.2 Storms and storm-related weather impacts

Coastal storms and related impacts such as storm surges are likely to be the foremost impact on the project. There is wide agreement in the climate science community that an increase in global average temperature be commensurate with an increase in weather extremes.[53] Of particular relevance for the Port of Richards Bay is the trend in tropical storms and low-pressure systems such as cut-off lows[54] that bring widespread rain.

4.2.1 Tropical storms and cyclones

Owing to its latitude, South Africa is impacted by tropical storms over the south-western Indian Ocean. However, it has been impacted less than Mozambique and Madagascar over which many spring and summer tropical storms pass directly over (the latter of which buffers the southern Africa mainland from many of these storms). That said, many tropical storms are occurring further west and south over the Indian Ocean and Mozambique Channel. There is evidence to suggest that these tropical storms are becoming more frequent within the vicinity or impacting South Africa's coastline despite rarely making landfall (Box 1, Figure 12).[55]

Box 1: Recent cyclone activity impacting South Africa

The first cyclone to have a major impact in South Africa was Tropical Storm Domoina which struck the Mozambique coastline in January 1984. Several major rivers in then Natal flooded beyond their 100-year flood lines. Over 60 people were left dead and over 500 000 people suffered damage to property. The overall cost at the time was estimated to be around US$70 million. Four people were killed just a month later when Tropical Storm Imboa struck South Africa's coastline. In September 1987, an exceptionally strong cut-off low pressure system resulted in torrential rain, killing over 500 people.

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[48] Eyring, V., Bony, S., Meehl, G. A., Senior, C. A., Stevens, B., Stouffer, R. J., and Taylor, K. E. 2016: Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, *Geosci. Model Dev.*, 9, 1937-1958, DOI: https://doi.org/10.5194/gmd-9-1937-2016.

[49] Copernicus Climate Change Service (C3S). 2021. CMIP6 climate projections. Copernicus Climate Change Service Climate Data Store (CDS), 15 September 2022, https://cds.climate.copernicus.eu/cdsapp#!/dataset/10.24381/cds.c866074c?tab=overview. DOI: 10.24381/cds.c866074c.

[50] Le Roux, A., van Niekerk, W., Arnold, K., Pieterse, A., Ludick, C., Forsyth, G., Le Maitre, D., Lötter, D., du Plessis, P. & Mans, G. 2019. Green Book Risk Profile Tool. Pretoria: CSIR. Available at: riskprofiles.greenbook.co.za. Accessed: 23 September 2022.

[51] A day when the maximum temperature exceeds 35 °C.

[52] More than 20 mm of rain falling within 24 hrs over an area of 64 km^2.

[53] Arias, P.A. *et al.* 2021. Technical Summary. 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 [Masson-Delmotte, V., P. *et al.* (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 33−144. doi:10.1017/9781009157896.002.

[54] Anti-cyclonic depression that results when air in the mid-atmosphere moving in an easterly direction is disturbed and through the development of a trough. This trough generally intensifies to form a low pressure system that 'cuts off' from the westerly often resulting in heavy rainfall for several days. They are most common in spring and autumn.

[55] Fitchett J. 2018. Recent emergence of CAT5 tropical cyclones in the South Indian Ocean. *South African Journal of Science* 114(11/12), doi.org/10.17159/sajs.2018/4426.

In February 2000, category 4 Cyclone Eline struck Mozambique's coastline and resulted in one of the worst natural disasters in a century. In South Africa, 21 people were killed and damage was estimated to be around US$300 million.

Two storms in early 2012 (Subtropical Depression Dando in January and Tropical Storm Irina in March) caused several deaths and resulted in damage exceeding US$65 million.

In 2019, category 4 storm Cyclone Idai struck the southern Africa's east coast. The death toll in Mozambique made is the second-deadliest tropical cyclone in the Southern Hemisphere in recorded history, and the deadliest since 1973. Although heavy rainfall occurred, damage and loss of property in South Africa was not recorded. In Mozambique, the cyclone resulted in damage to the power supply infrastructure linked to Cahora Bassa Hydropower Station resulting in a power shortage across the country.

Since 2020, three major tropical storms have impacted South Africa significantly. In December 2020, Tropical Storm Chalane resulted in exceptionally heavy rainfall across South Africa's northern provinces. A month later, Cyclone Eloise resulted in 10 deaths in South Africa. Perhaps the most pertinent impacts in recent memory, however, are those linked to Subtropical Depression Issa which struck the coastline of KwaZulu-Natal on 12 April 2022. Despite being a relatively weak storm, the low-pressure system resulted in torrential rainfall in KwaZulu-Natal resulting in severe flooding and coastal erosion, damaging several thousand properties, displacing tens of thousands and killing at least 461 people. The floods were described by insurer Santam, as the worst natural disaster to hit South Africa on their records.[56]

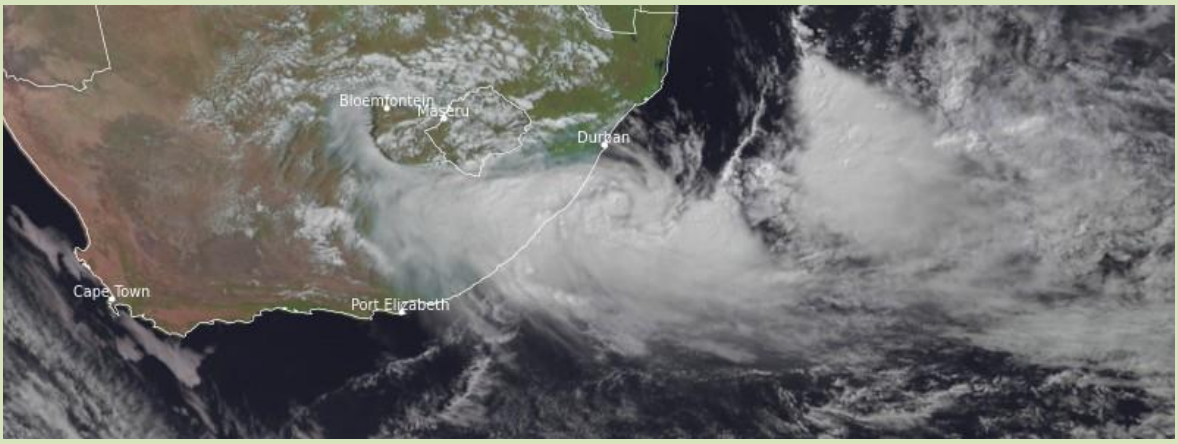

Figure 9: A still from a satellite image showing subtropical depression Issa on 12 April 2022. Source: Cooperative Institute for Research in the Atmosphere (CIRA).

56 Buthelezi, L. 2022. Recent KZN floods are 'by far' the largest natural catastrophe in Santam's history. *Fin24*. 1 June 2022. Accessed 14 September 2022.

Records for tropical cyclones date back to the mid-19th century and the tracking of these systems has improved dramatically since then. Whilst the effects of tropical depressions have always had an impact on the weather along South Africa's east coast and eastern interior, it is only since the 1980s that major tropical cyclones have had a significant impact on society, the environment and infrastructure.

Using tropical cyclone data from the International Best Track Archive for Climate Stewardship (IBTrACS) version 4.0 dataset,[57] we extracted all the available (since 1848) cyclone and storm tracks for the area covered by a bounding box including all of South Africa, Mozambique and Madagascar (Figure 10). For each storm, the minimum latitude and minimum longitude (i.e., the furthest south-west, hence closest to the southern African coastline) midpoint for each storm track was plotted against time with a particular focus on storms per decade (Figure 11). The 2000s was and remains the decade with the highest number of tropical storms since records began, followed by the 2010s.

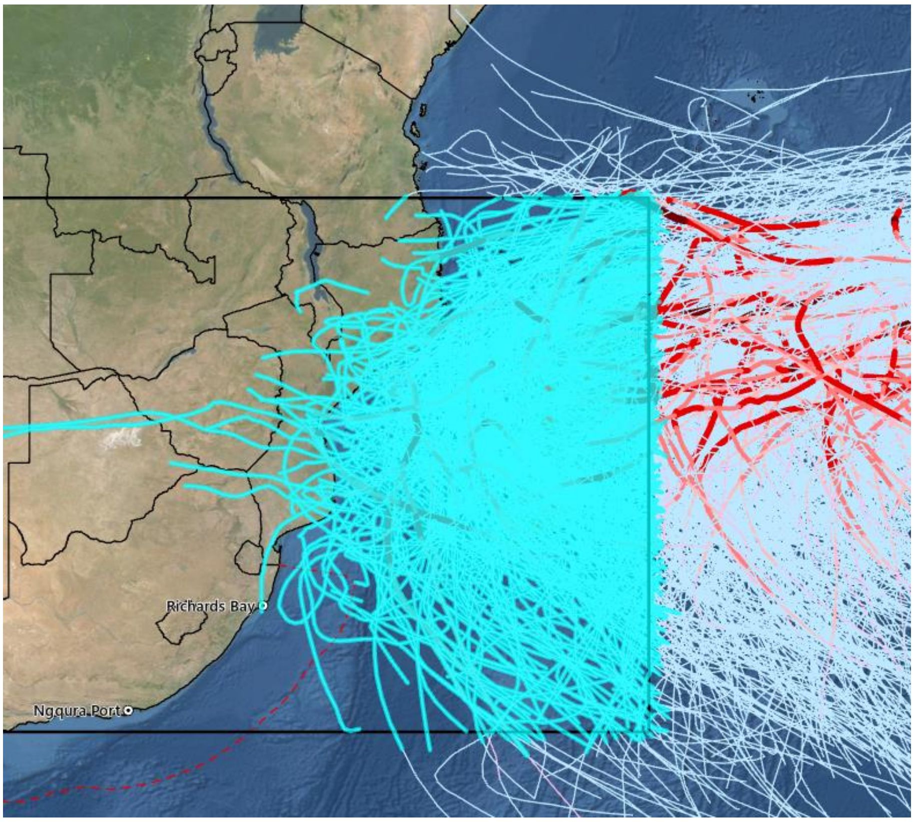

Figure 10: Selected storm and cyclone tracks from the IBTrACS dataset for analysis.

[57] Knapp, K. R., Kruk, M.C., Levinson, D.H., Diamond, H.J. and Neumann, C.J. 2010. The International Best Track Archive for Climate Stewardship (IBTrACS): Unifying tropical cyclone best track data. *Bulletin of the American Meteorological Society* 91: 363-376. doi:10.1175/2009BAMS2755.1.

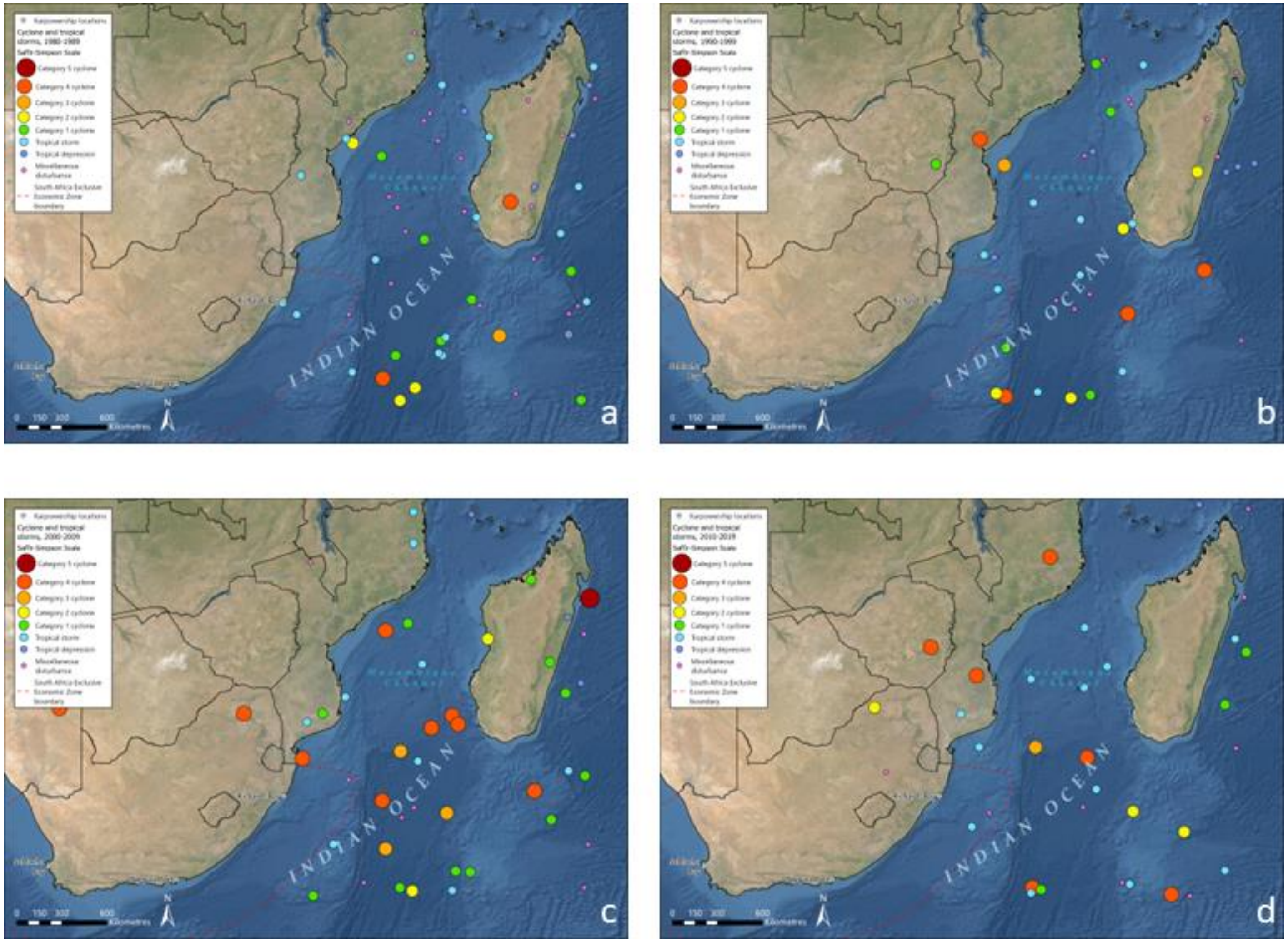

Figure 11: Cyclone and tropical storm locations (minimum latitude and minimum longitude) in the south-western Indian Ocean in the (a) 1980s; (b) 1990s; (c) 2000s and; (d) 2010s.

The maximum longitude of the midpoints of all recorded tropical storm track segments were plotted against time. There is a clear trend over the last 180 years of storms moving further west, closer to the east coast of southern Africa (Figure 12). It is also clear that tropical storms have become more frequent within South Africa's Exclusive Economic Zone (EEZ)[58] with the first ca. 1940 and moving beyond the latitude of Richards Bay with three major storms since 2002.

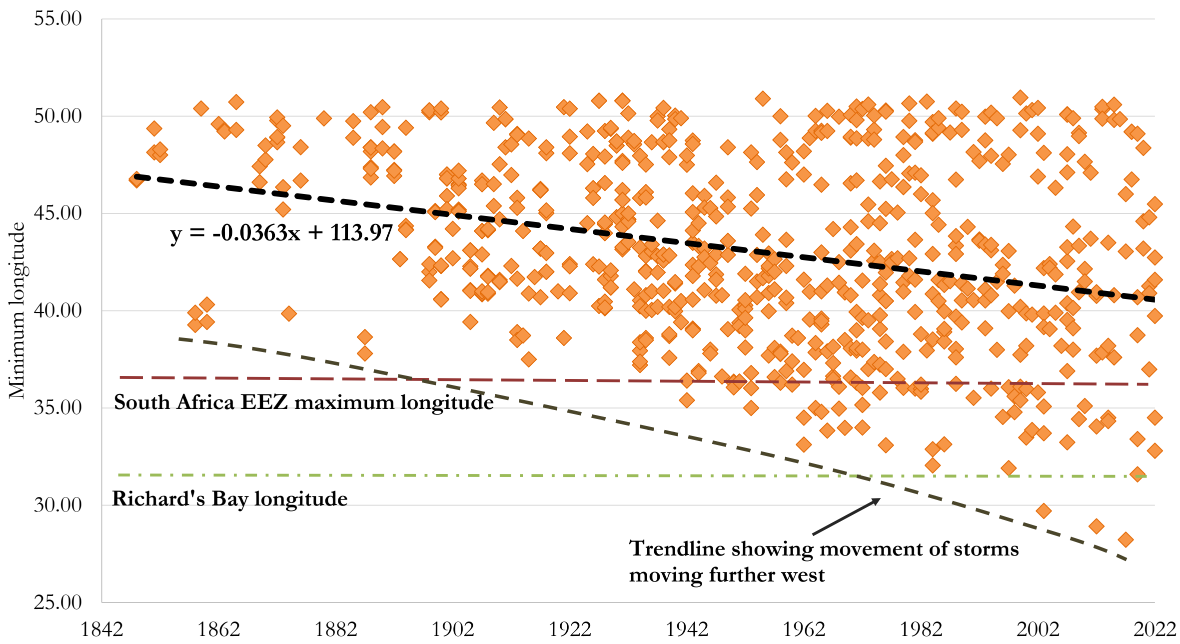

Figure 12: Plot of all recorded tropical storms in the IBTrACS record over time against the minimum longitude each storm reached.

High intensity tropical storms have become more frequent in the South Indian Ocean since the first record of a category 5 storm in 1994.[55] Category 4 and 5 cyclone tracks are plotted per decade in Figure 13. It is difficult to pick out a trend and there is no clear pattern, it is clear that cyclones moving over the subcontinent into the interior of the region are all since 2000. It is also important to bear in mind that these tracks represent the centre of these systems which are themselves much larger and result in weather conditions over large areas well away from the storm centres.

58 An area of the ocean, generally extending 200 nautical miles (370 km) beyond a nation's territorial coastline, within which a sovereign state has jurisdiction over both living and non-living resources.

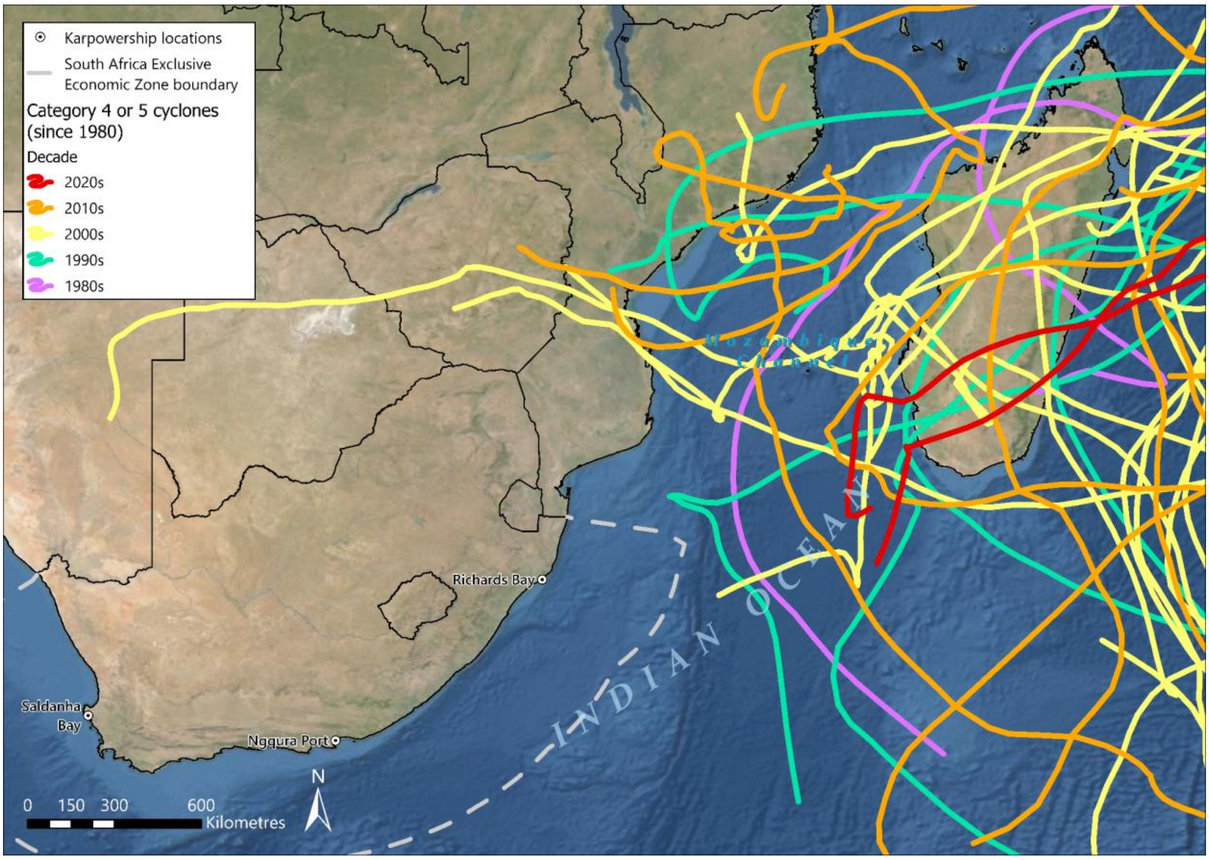

Figure 13: Category 4 and 5 cyclones tracks in the south-western Indian Ocean per decade.

Whilst poor planning, a paucity of suitable adaptation plans and lack of oversight over coastal and riparian are certainly to blame for the damage and loss of life in previous storms, there is increasing evidence to suggest that climate change has had a role to play in the recent and increasing frequency of these events.[59] A paper[60] being prepared indicates that the 2022 storm and foods were indeed exacerbated to some degree by climate change. The intensity of the storm could have increased by 4-8% as a result of climate change. Such events, the researchers conclude, are likely to continue to become more frequent and intense as the global mean temperature rises and alters global circulation patterns.[61]

59 Engelbrecht, F. *et al.* 2022. Is climate change to blame for KwaZulu-Natal's flood damage? *Institute of Security Studies*. Accessed: 14 September 2022.

60 Pinto, I. et al. In press. Climate change exacerbated rainfall causing devastating flooding in Eastern South Africa. Available at: https://www.worldweatherattribution.org/wp-content/uploads/WWA-KZN-floods-scientific-report.pdf.

61 Ibid

Whilst there have been an insufficient number of high intensity cyclones to determine a statistically significant trend going forward, there is published evidence that there has been a southward shift in high intensity storms[62, 55] and an analysis of storm track data suggests a slight trend of a westward shift of all tropical storms in region off the southern African east coast (Figure 12). Both of these trends indicate potentially greater frequency of tropical storms that could fall within South Africa's EEZ and indeed make landfall along the KwaZulu-Natal coastline. Sea surface temperature of at least 26.5°C is required for the formation of tropical cyclones. The historical rise in sea surface temperature (and poleward shift in warmer water)[62] and projected increases going forward (see section 4.6) could further provide conditions for increased tropical storms in the future leading to storm surges. This is the most material climate-related risk for the proposed Karpowership at Richards Bay but there is inherent uncertainty in the likelihood of these large-scale occurrences that rely on several interacting physical atmospheric and oceanic dynamics.

4.2.2 Sea surges and wave action resulting from storm activity

One of the key impacts of coastal and tropical storms are the associated storm surges that result from the high-wind speeds interacting with the ocean surface. In the region, the veering away of cyclones away from the continent in a south-easterly direction, or those that become semi-stationary result in the largest swells experienced. A combination of high sustained onshore winds and the storm area are the two primary variables that influence wave impact.[63] Storm surges are among the leading causes of damage and loss of life from tropical storms.

Waves that impact maritime activities and infrastructure are primarily linked to ocean currents, frontal patterns, cut-off low systems and tropical depressions and cyclones. Wave climate is highly seasonal and varies in intensity and wave period. The east coast of South Africa is among the least impacted overall in terms of wave height and return period. There is no consensus on the impact climate change will have on the strength of the Agulhas current which itself has a major impact on waves.[64] A slight increase in mean wave height was found by researchers but there is little evidence of increasing severity in the region (as opposed to that of much of the globe where confidence is high in such impacts[65]) Peak wave height during storms appears have increased and with an

[62] Fitchett J. 2018. Recent emergence of CAT5 tropical cyclones in the South Indian Ocean. *South African Journal of Science* 114(11/12), doi.org/10.17159/sajs.2018/4426.
[63] Mather, A.A., & Stretch, D.D. 2012. A Perspective on Sea Level Rise and Coastal Storm Surge from Southern and Eastern Africa: A Case Study Near Durban, South Africa. *Water* 4: 237-259.
[64] Rossouw, M. & Theron, A.K. Investigating the potential climate change impacts on Maritime operations around the southern African coast. CSIR.
[65] Dasgupta, S., Laplante, B., Murray, S. and Wheeler, D. 2009. Climate Change and the Future Impacts of Storm-Surge Disasters in Developing Countries. Working Paper 182. Center for Global Development.

increase in storm activity in the future, there is a possibility if increased storm surges in the future but substantially more data and research are needed to confirm this.

Although less vulnerable than sandy coastlines and coastal plains, harbours and ports such as those in which the Karpowership Projects are located remain at risk. Near-shore offshore infrastructure and coastal developments are particularly vulnerable to storm surges. This risk increases with a rise in mean sea level. At the Port of Richards Bay, the area surrounding the port (particularly around the uMhlathuze River mouth) and Qhubu Lake shoreline are most likely to be affected by a combination of sea level rise (see section 4.5), tides and storm surges (Figure 14). Coastal infrastructure including those associated with harbours and port will require increased maintenance to withstand increased storm surges.[64] The coastal flooding risk for Richards Bay is classified as medium risk in the medium-term with maximum regional wave heights likely to be around 9 m.

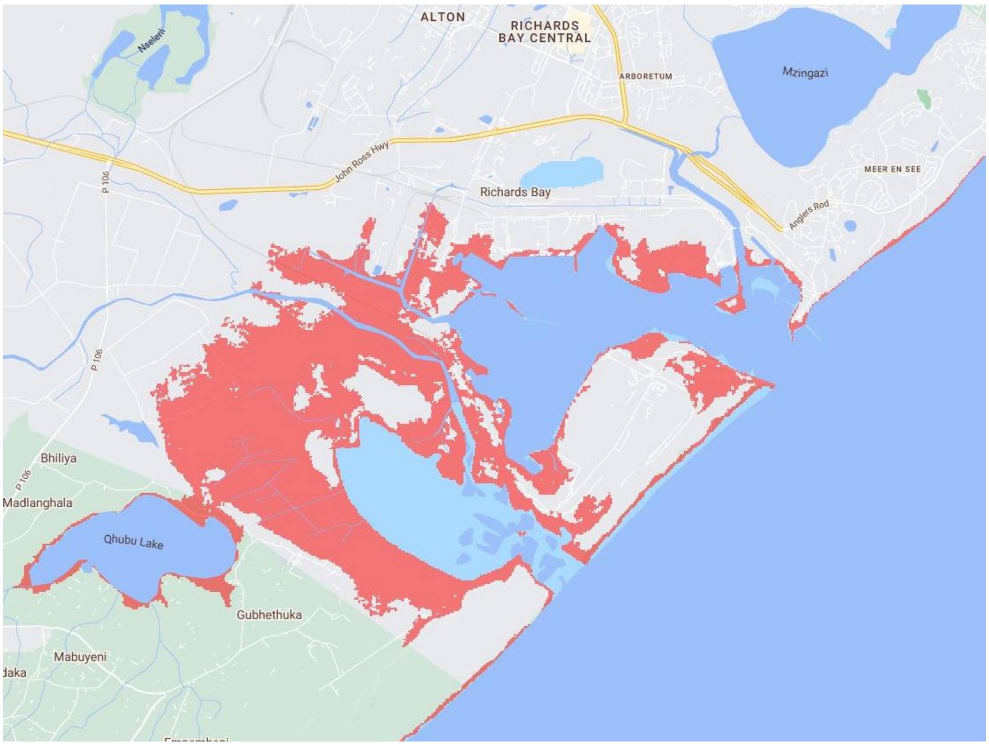

Figure 14: Area impacted (in pink) at and around the Port of Richards Bay by a 1 m rise in water level through combinations of sea level rise, tides, and storm surge. Source: https://coastal.climatecentral.org/.

4.3 Ocean pH

Ocean acidification due to increased deposition and dissolution of higher concentrations of atmospheric CO_2. The problem is particularly widespread in the open ocean (away from coastlines). There is very high confidence (virtually certain) according to the IPCC's sixth assessment report (AR6) that ocean pH has declined since ca. 1985.[66] At a global level this has been from roughly 8.11 to just above 8.05 by 2020 (Figure 15), and around the South African coast at between 0.0018 and 0.0015 per year (around the global mean).[67] At Richards Bay, surface sea water pH has declined from roughly 8.12 to 8.07 (Figure 16).

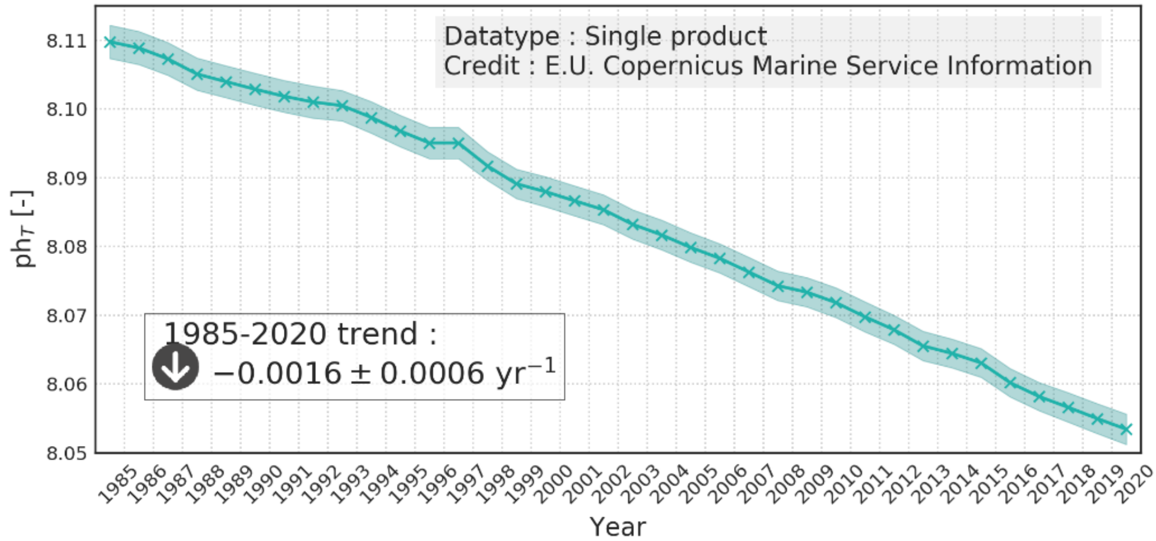

Figure 15: Annual mean surface sea water pH reported on total scale between 1985 and 2020. Source: E.U. Copernicus Marine Service Information.

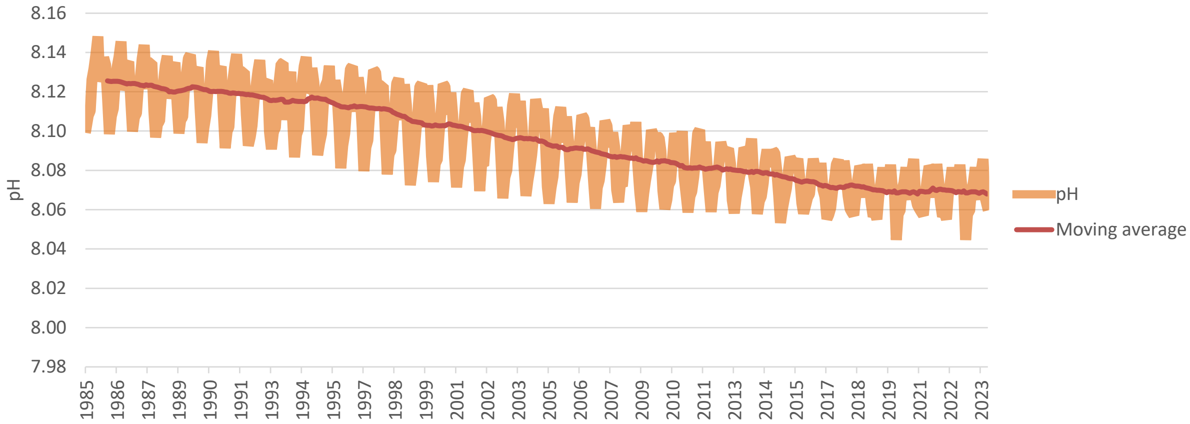

Figure 16: Surface sea water pH at Richards Bay between 1985 and 2023. Data source: Global Ocean Biogeochemistry Hindcast.[68]

[66] Arias, P.A., *et al.* 2021: Technical Summary. 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 [Masson-Delmotte *et al.* (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 33−144. doi:10.1017/9781009157896.002.

[67] E.U. Copernicus Marine Service Information.

[68] Copernicus Marine Environment Monitoring-Service.

By 2050, pH is predicted to be ~0.2 lower than a baseline of 1950 along the east coast of southern Africa under SSP5.[69] Change of this magnitude and based on a trend of historical data poses a low risk the project and associated infrastructure. However, it may well pose a risk to marine and coastal biota, particularly corals (Anthozoa, if present), molluscs and crustacea, and this risk should be detailed by a marine fauna or biota specialist.

4.4 Wind

Winds at Richards Bay are predominantly from the south and north onshore from the north-east, south, east and south-east. Wind velocity is expected to increase across all seasons in South Africa but to a very small degree (maximum 6% increase).[70] On occasions where a 10% increase in wind speed is experienced, there is a 26% increase in wave height. This compounds the impacts during storm surges and can result in significant increases in sediment transport into harbours and ports. Other than during storm events, the risk posed to the project from wind speed under climate change is low. Wind direction is also not likely to shift significantly along the KwaZulu-Natal coast.[70] compounds

4.5 Sea level

Local and regional sea level varies in space and time due a number of factors such as tides, wind, waves and atmospheric conditions.[71] Anthropogenic activity has exacerbated this. Global mean sea level (GMSL) increased by 15-25 cm between 1901 and 2018 with a particularly elevated increase since 2006 of 3.7mm yr^{-1} (Figure 17). According to the AR6, it is considered to be virtually certain that GMSL will continue to risk over the 21st century.[72] Mitigation efforts are unlikely to change the trajectory of sea level rise. GMSL is predicted to rise by between 28 and 55 cm under SSP 1-1.9 and 63-101 cm under SSP5-8.5, relative to the average between 1995 and 2014 (Figure 18).[53]

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69 IPCC pH at surface (pH) – Change (pH).

70 Herbst, L. & Rautenbach, H. 2016. Climate change impacts on mean wind speeds in South Africa. *Clean Air Journal* 25: http://dx.doi.org/10.17159/2410-972X/2015/v25n2a2.

71 In South Africa, sea level generally increases from west to east and measurements are made relative to their level.

72 Arias, P.A., *et al.* 2021: Technical Summary. 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 [Masson-Delmotte *et al.* (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 33−144. doi:10.1017/9781009157896.002.

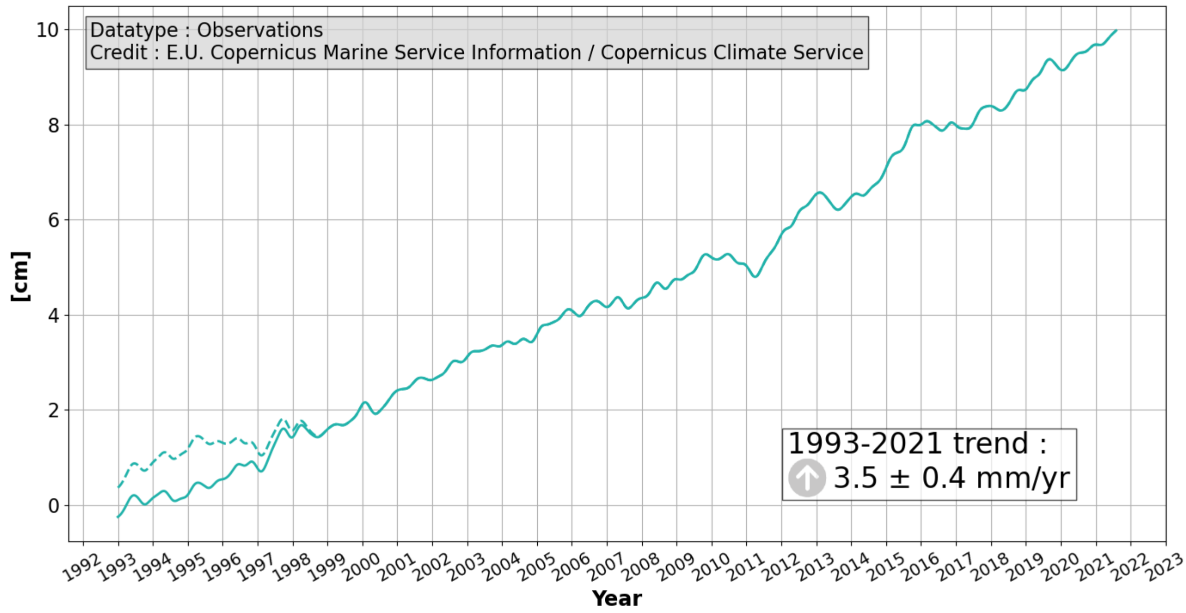

Figure 17: Global mean sea level. Source: E.U. Copernicus Marine Service Information.

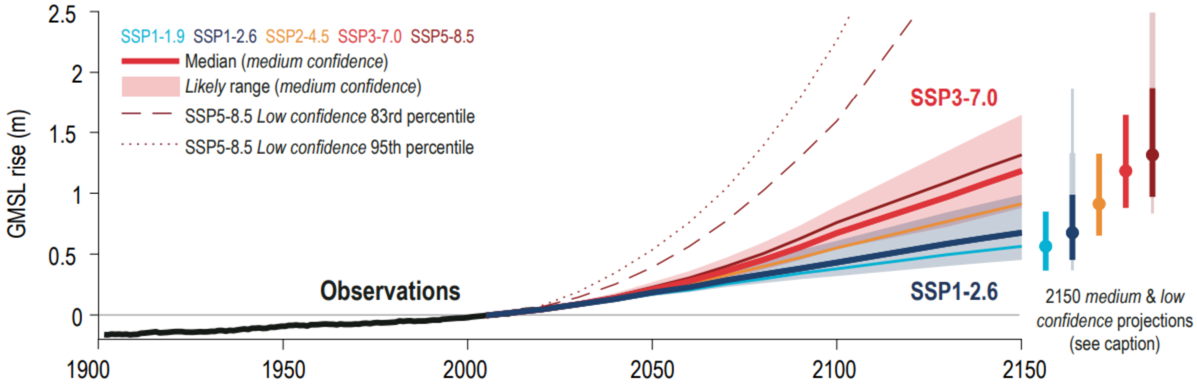

Figure 18: Global mean sea level rise from 1900–2150. Source: Arias, P.A. *et al.* 2021.[73]

Sea level has increased by varying degrees along the South African coastline.[74] Data from the [South African] Hydrographic Office shows that sea level at Richards Bay has increased by ±4.2 cm (1.06 mm y^{-1}) between 1978 and 2018 based on a linear trend (Figure 19). According to

73 Arias, P.A., *et al.* 2021: Technical Summary. 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 [Masson-Delmotte *et al.* (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 33−144. doi:10.1017/9781009157896.002.

74 Mather, A.A., Garland, G.G. and Stretch, D.D. 2009. Southern African sea levels: corrections, influences and trends. *African Journal of Marine Science* 31: 145-156.

IPCC AR6 projections (medium confidence), sea level around Richards Bay is expected rise by 10-40 cm (from a 1995-2014 mean) by 2050 under different SSPs (Figure 19) with the *earliest* expected 1 m rise (from a 1995-2015 mean) by ca. 2095 under SSP5-8.5.

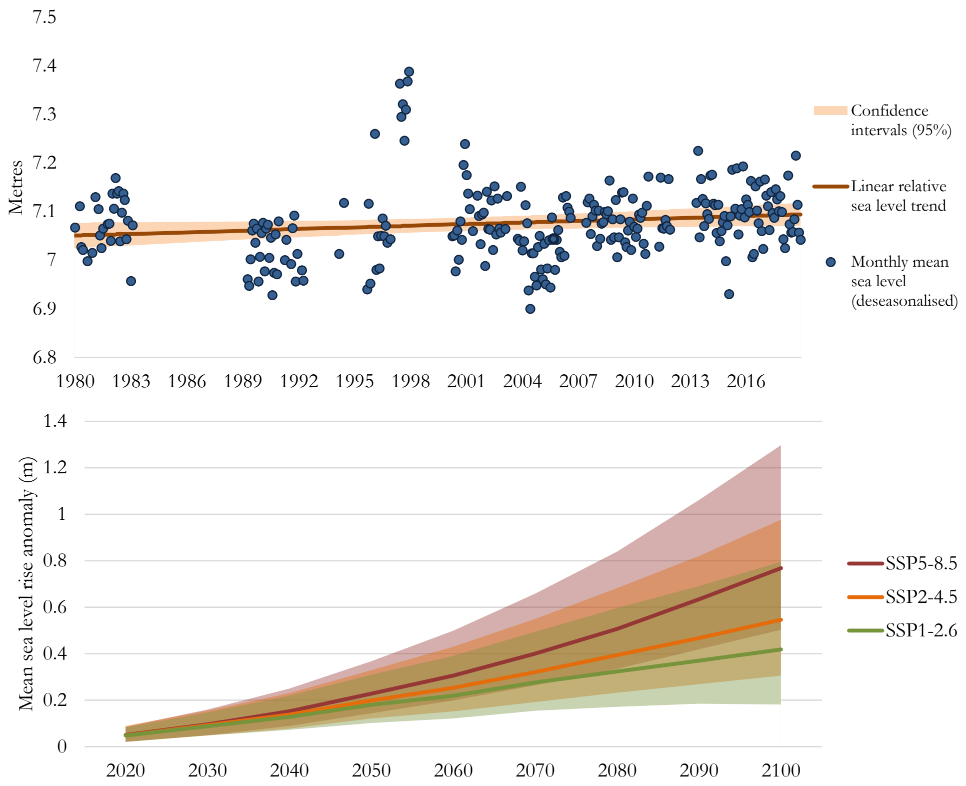

Figure 19: Measured monthly sea level at Richards Bay from 1978 to 2018. Data source: SAN Hydrographic Office[75] (top) and sea level rise projections under SSPs 1, 2 and 5. Data source: IPCC AR6.[76,77,78] (bottom).

The rise in sea level is not likely to have a material impact on the project during its lifetime. Increases in sea level amplify storm surges during extreme weather events. Increased sea level will result in greater water depth which positively influences wave energy, thus increasing the potential impacts on wave damage during storms and periods of sustained high winds. Higher wave energy

[75] Hydrographic Office Maritime Headquarters. Extracted from the Permanent Service for Mean Sea Level (psmsl.org).

[76] Fox-Kemper, B., H. T. *et al.* 2021, Ocean, Cryosphere and Sea Level Change. 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 [Masson-Delmotte, V., P. *et al.* (eds.)]. Cambridge University Press. In press.

[77] Garner, G. G., *et al.*, in prep. Framework for Assessing Changes To Sea-level (FACTS). Geoscientific Model Development.

[78] Garner, G. G. *et al.* 2021. IPCC AR6 Sea-Level Rise Projections. Version 20210809. PO.DAAC, CA, USA. Dataset accessed 9 September 2022.

will reduce the stability of vessels. The impact on stationary ships is difficult to determine in this regard and is best determined by a hazard specialist.

4.6 Sea surface temperature

Sea surface temperature (SST) is a fundamental component of climate science given that 71% of earth's surface is covered by oceans and that oceans absorb significant amounts of extra heat arising from GHGs. SST is strongly influenced on a seasonal and annual basis by global circulation patterns and is highly variable along the South African coastline[79] (see Figure 20) and are useful in identifying El Niño and La Niña cycles that are part of the El Niño–Southern Oscillation (ENSO). These cycles strongly influence seasonal weather patterns. For example, La Niña conditions (colder SST in the equatorial Pacific area) generally lead to higher rainfall and warmer summer temperatures over eastern South Africa and vice versa.

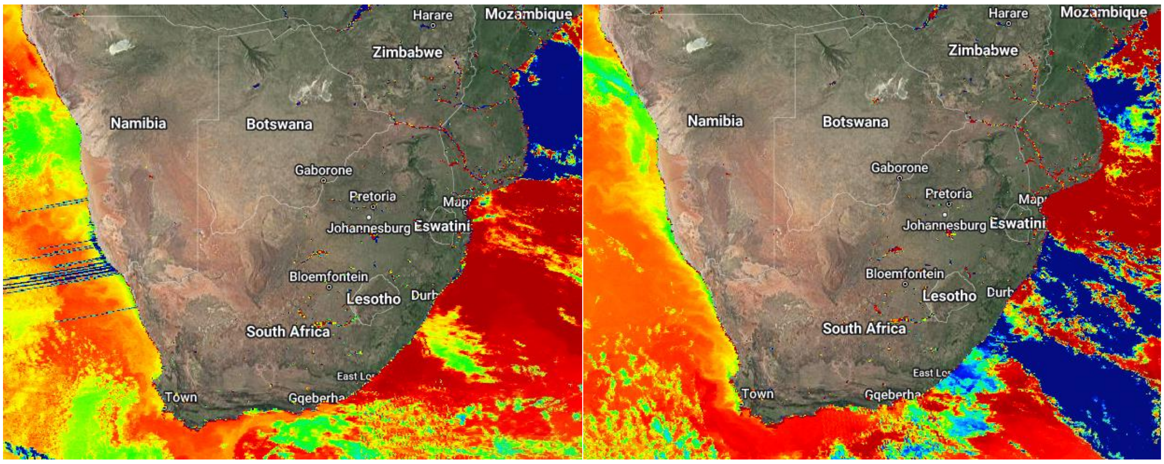

Figure 20: Example of seasonal and annual variation in sea surface temperature around South Africa's coast: mean sea surface temperature for 1985 (left) vs. mean sea surface temperature in 2011 (right). Data source: Baker-Yeboah *et al.* (2016).[80]

Like terrestrial air temperature has increased over the last century, so too has sea surface temperature. The IPCC AR6 indicates global SST increase of between 0.68-1.01˚C across the globe's oceans since the period 1850-1900 to the last decade, most of which has occurred since 1980.[76] Since 1993 the global mean SST has increased by ±0.016˚C per annum,[67] with the greater levels of warming being in the Arctic and northern Pacific Oceans. SST at Richards Bay has increased by ±0.89˚C since 1900, with a

79 Schumann, E.J., Cohen, A.L., and Jury, M.R. 2022. Coastal sea surface temperature variability along the south coast of South Africa and the relationship to regional and global climate. *Journal of Marine Research* 53:231-248.

80 Baker-Yeboah, S. *et al.* 2016. *Pathfinder Version 5.3 AVHRR Sea Surface Temperature Climate Data Record*, Fall AGU 2016 Poster (manuscript in progress).

decadal mean of 24.33˚C at present. By 2030 the mean SST could reach 24.4˚C (24.27-24.9˚C depending on SSP) and 25.3˚C by the late 2040s (Figure 21).

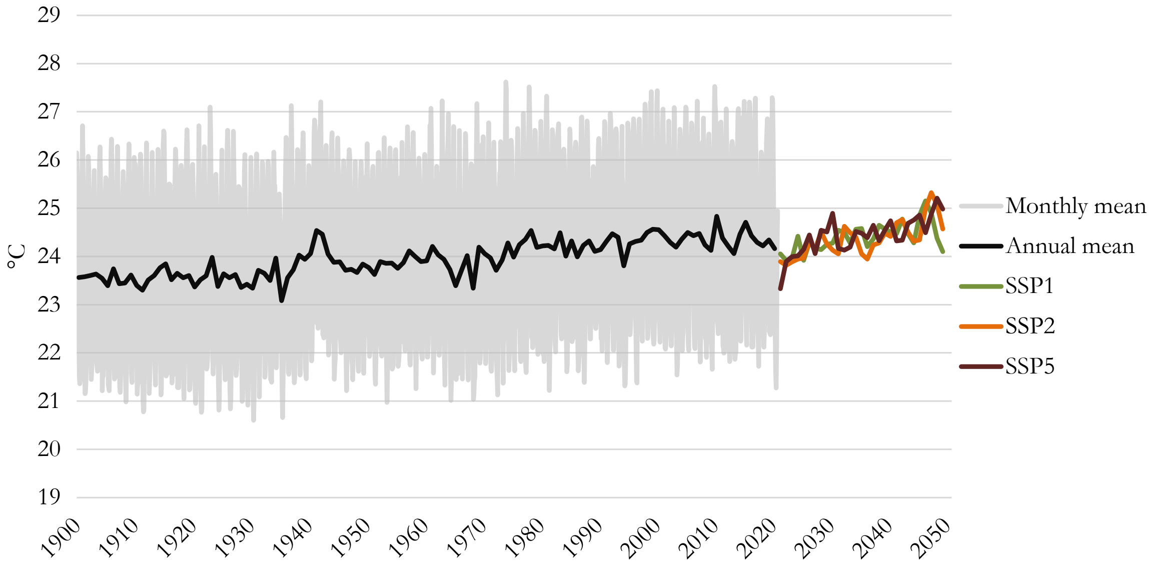

Figure 21: Historical mean sea surface temperature for Richards Bay since 1900 and projected sea surface temperature up until 2050 under SSPs 1,2 and 5. Data sources: HadISST (historical),[81] CMIP6 (future).[82]

SST increases up to 2050 are unlikely to have a material impact on the operations of the project and the associated risk to the project is thus deemed to be very low. The primary impacts of SST changes are on marine biota, with widespread coral (Anthozoa) bleaching being the most well-known impacts of increased sea temperatures. Migration patterns and timing, fish spawning and plankton blooms have also been affected by changes to sea temperatures. This poses an increasing risk to aquaculture and fisheries going forward. The key impacts of SST change should be informed by these results and determined by the relevant specialists (marine fauna and socio-economic).

It should be noted that the increase in mean SST in the region and particularly further north into the Mozambique Channel may result in more favourable conditions necessary for the formation of tropical cyclones.

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81 Rayner, N. A., *et al.* 2003. Global analyses of sea surface temperature, sea ice, and night marine air temperature since the late nineteenth century *J. Geophys. Res.*108: 10.1029/2002JD002670

82 Copernicus Climate Change Service (C3S). 2021. CMIP6 climate projections. Copernicus Climate Change Service Climate Data Store (CDS), 15 September 2022, https://cds.climate.copernicus.eu/cdsapp#!/dataset/10.24381/cds.c866074c?tab=overview. DOI: 10.24381/cds.c866074c.

5 Results

5.1 Project Contribution to Climate Change

This section outlines the Karpowership Project's contribution to climate change. The GHG inventory was assessed in accordance with the methodology described in section 2.4. The boundary of this assessment includes the construction and operation of the powership at Richards Bay, as well as the upstream production and transport of the gas. The emissions from the construction and decomissioning phase are deemed immaterial in the context of the overall inventory and have therefore been excluded from the calculations. The emissions from these phases form less than 0.5% of the overall emissions from the project. There is minimal infrastructure required for the project at the port resulting in low energy and material requirements in both the construction and decommisioning phase. The bulk of the plant are mobile on the powerships. These ships will travel to and from ports outside of the Republic of South Africa and the emissions from this fall outside of the boundary of this assessment.

5.1.1 Project GHG Inventory

The GHG inventory for the project was developed in accordance with the SANS 14064-1 (2021) standard, as well as the GHG Protocol Corporate Standard, as described in Section 3.1.1 above. For the purposes of this assessment, the GHG inventory according to SANS14064 will be used. The boundaries of the analysis were set, as indicated above. This analysis took into consideration the relevant emissions from core operations, as well as upstream and downstream emissions.

Table 12 summarises the calculated emissions for the project for the direct emissions and significant indirect emissions. The key GHG emission sources are the production, transport. and combustion of natural gas.

We note that the Request for Proposal (RfP) for the RMIPPPP projects is for dispatchable power, as specified by section 3.2.2 of the overview of the RFP[83]. As such, the Project will only generate, and therefore emit GHG emissions, when ordered by the System Operator to dispatch power. The emissions shown in this section assume that the plant runs for 16.5 hours per day. This can be seen as the worst-case scenario within the constraints given by the overview of the RFP. The implication is that, if/when the Eskom generation crisis is solved, and the use for power from this project is decreased due to the addition of more generation capacity to the grid, this project may be requested to dispatch less power, and the emission from the project will be reduced. The

[83] Overview of the Request for Qualification and Proposals for New Generation Capacity Under the Risk Mitigation IPP Procurement Programme, Tender No: DMRE001/2020/21, Department of Mineral Resources and Energy

dispatchable nature of the power also makes this project available to serve as grid stabilisation for the introduction of intermittent renewable energy to the grid.

Section 3.2.2 of the overview pf the RfP sets out the following Performance Requirements for the RMIPPPP projects. These requirements inform the scenarios presented below.

- Dispatchable and flexible generation;
- Be able to provide energy, capacity and ancillary services;
- Be able to operate between 05h00 and 21h30;
- Operate at a minimum load factor of 50% per year;
- Include a minimum Stable Load electricity generation capacity of at most 25% of Project Contracted Capacity;
- Must be able to reach Project Contracted Capacity and shut down in at most 15 minutes from cold start;
- Must be able to be synchronised to the electricity grid in under 5 minutes from trigger;
- Have minimum starts and stops of 365 times per year and maximum starts and stops of 800 times per year;
- Provide Instantaneous Reserves of 3% of Project Contracted Capacity in 10 seconds; and
- Deliver Regulating Reserves of 10% of MCC at a ramp rate of at least 1.67% of Project Contracted Capacity per minute;

These requirements indicate that one of the main objectives of the RMIPPPP is for grid stabilisation. It is clear that the intent is not to operate the planned power plant as baseload, as such baseload plant would not have the requirements for stable operation at low power output and stringent requirements for ramp-up and grid synchronisation.

Several scenarios are assessed in terms of the generation and resulting emissions from the Project. The emissions are calculated for three scenarios where the Project is run at 100%, 50% and 25% of the full 16.5hrs/day at the contract capacity. The results are shown in Table 11 below. The scenarios indicate that the impact intensity of the project falls into the medium threshold when the Project is not operated at 100% of the contracted capacity.

Table 11 Emissions by generation scenario

Scenario	Operating hours/day	Annual emissions	Lifetime emissions	Impact Intensity
100%	16.5 hrs/day	1 536 078 tCO_2e	30 721 561 tCO_2e	High
50%	8.25 hrs/day	768 039 tCO_2e	15 360 781 tCO_2e	Medium
25%	4.125 hrs/day	384 020 tCO_2e	7 680 390 tCO_2e	Medium

Table 12: Operation emissions (100% scenario)

Emission category	Emission source	Operation phase – Annual emissions	Total over life of project (20 years)
Category 1: Direct GHG emissions and removals	Natural gas combustion	1 388 200 tCO_2e	27 763 994 tCO_2e
Total Direct emissions		**1.4 million tCO_2e**	**27.8 million tCO_2e**
Category 3: Indirect GHG emissions from transportation	Natural gas transport	49 082 tCO_2e	981 642 tCO_2e
Category 4: Indirect GHG emissions from products used by organization	Purchased steel	Not significant	Not significant
	Purchased cement	Not significant	Not significant
	Natural gas production	99 174 tCO_2e	1 983 480 tCO_2e
	Total Category 4 emissions	**99 174 tCO_2e**	**1 983 480 tCO_2e**
Total indirect emissions		**148 $ktCO_2e$**	**3.0 million tCO_2e**
Total emissions		**1.5 million tCO_2e**	**30.7 million tCO_2e**

5.1.2 Impact Assessment

The proposed Karpowership Project would result in total emissions of approximately 1.5 million tCO_2e/annum and 31 million tCO_2e over the PPA duration, assuming that the project operates 16.5hours per day per year. This falls within the high intensity as assessed against the thresholds in section 3.1.5. The emissions from the Project would have a negative climate change impact. This could reduce to a medium intensity should the Project not generate at 100% capacity as discussed in the previous section.

The Project can offer load following capability required to stabilise additional renewable energy capacity until sufficient battery storage is added to the grid. The additional renewable energy that this enables would result in avoided emissions that exceed the operational emissions of the project. These avoided emissions that could result from this are in addition to those calculated in section 5.1.4.2 which indicate the emissions from switching from the coal fleet in the national grid. This would be a positive impact from the Project on climate change.

Natural gas power plants offer a transitional option to switch from a predominantly coal based grid system to a lower emission option. This enables electricity generation to allow economic growth while sufficient renewable generation with battery storage is brought online. Operating the natural gas power plant would allow for less emissions than generating the same electricity from a coal fired power station. The natural gas power plant further offers dispatchable power as required unlike renewables without battery storage.

The lifetime operational emissions of the Project, 31 million tCO_2e, can be compared to the thresholds in section 3.1.5 as well for a cumulative impact analysis. The emissions over the 20-year lifetime of the project are comparable to 2 years of running a new coal fired power station, which the upper threshold is based on. This supports the paragraph above that natural gas can be used as a transitional technology to move away from reliance on coal. If the operational emissions of the project are analysed for just a 5-year period, the emissions total 8 million tCO_2e which remains in the high category but below the emissions from operating a coal fired power station for a year. This can be considered a positive impact allowing for economic growth while reducing the reliance on coal fired power stations.

When considering all impacts related to the Project, it can be considered to have a low positive impact. Despite having a high intensity impact from operational emissions, the project enables significant reductions through avoided emissions and enabled renewables. Furthermore, it allows for economic development to occur by providing dispatchable power onto the grid which is critical for the economy.

5.1.3 Carbon lock-in[84]

The lifetime operational emissions from the project could result in emissions lock in, also known as carbon lock-in. However, the emissions lock-in is considered a low risk from the project due to both the emissions avoided from using more carbon-intensive technologies such as coal as well as the enabling of additional renewable energy capacity on the grid. Furthermore, as discussed below, the actual lifetime emissions may be much lower further reducing the carbon lock-in.

The lifetime emissions in this report assume that the project operates for a full 16.5 hours a day for the full lifetime duration. This represents a worst-case scenario for the lifetime emissions. However, the actual emissions are directly proportional to the dispatch instructions received from the System Operator. The overview of the RFP for the RMIPPPP states in 3.2.2.1 "*dispatchable and flexible generation*" as a performance requirement. This means that the project will only export electricity, thus combusting natural gas for its generation, upon receipt of a dispatch instruction. As a result, the actual emissions from the project may be much lower depending on these instructions.

[84] Carbon lock-in occurs when fossil fuel-intensive systems perpetuate, delay or prevent the transition to low-carbon alternatives.

5.1.4 Comparing LNG to alternative generation

The majority of the generation fleet in South Africa is made up of coal-fired power stations operated by Eskom. The use of the Powerships to generate power should therefore be compared to the generation of power using coal. In the short term, the use of the gas generation would potentially offset the operation of Eskom's open-cycle gas turbines run on diesel. However, this would not be applicable for the entire PPA duration. A comparison with coal generation is therefore more applicable in this scenario.

In South Africa, a large portion of the current electricity demand is met by coal-fired power stations. South Africa is a signatory member of the Paris Agreement and has voluntarily committed to decarbonising its economy. An essential part of this is moving away from carbon-intensive power plants, such as coal-fired plants, and moving towards greener energy technologies.

The Integrated Resource Plan (IRP) accounts for the introduction of gas-powered electricity generation onto the South African National Electricity Grid, to meet the projected national energy demands.

The IRP makes provision for 3000 MW of gas-generated electricity onto the grid[85] by 2030 while ensuring the South Africa electricity generation capacity expansion plan meets national climate change policies. The impact of the Karpowership projects on climate change should be considered in context of the IRP requirements.

5.1.4.1 Comparison with alternatives

The use of natural gas as an energy source in electricity generation is less emissions intensive than coal-based power. Natural gas combustion releases approximately half the emission of that of coal[86] (if coal is not used as a feed product in the production of the natural gas and that the fugitive emissions during extraction are well managed). Thus, the use of natural gas for electricity generation could reduce the amount of GHG emissions and pollutants produced in the generation of electricity in South Africa.

The combustion of natural gas also results in lower emissions than the combustion of diesel. This is a relevant comparison as Eskom operates its peaking plants on diesel. The combustion of diesel results in approximately 74.1 tCO_2e/TJ in comparison to natural gas which emits approximately 56.1 tCO_2e/TJ.

The combustion of natural gas is also cleaner than that of diesel and coal in terms of air quality and pollution prevention. Natural gas combustion does not release particulate matter, nor does it

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85 Department of Energy, 2019, *Integrated Resources Plan (IRP2019)*, Government Gazette, [Online] Available at: http://www.energy.gov.za/IRP/2019/IRP-2019.pdf [Accessed on 14/01/2021].

86 Based on the emission factors provided in the South African Technical Guidelines used for the calculation of the project GHG inventory

emit as many harmful nitrates (NOx) and sulphates (SOx) as are emitted during the combustion of coal.

A comparison of the emissions per unit of energy from alternative power sources is provided in Table 13 below. Using coal as a feedstock will result in the largest emissions while renewables have minimal operational emissions. Natural gas has an emission factor that is much lower than coal and diesel resulting in less emissions during operation.

Table 13: Alternative generation sources

Power source	Emission Factor
Coal	96.1 tCO_2/TJ
Diesel	74.1 tCO_2/TJ
Natural Gas	56.1 tCO_2/TJ
Renewables	0 tCO_2/TJ

5.1.4.2 Avoided emissions

The implementation of the Project may result in avoided emissions. These are emissions that may be emitted if the project is not implemented. These emissions are calculated in accordance with the GHG Protocol's guidance document for comparing products. In accordance with this guidance, the baseline technology for calculating the avoided emissions is Eskom's coal fleet.

The avoided emissions are only calculated as the emissions avoided from the switch to gas from coal. With the construction of the Scatec Solar 1GWh battery plant[87] as well as the Tesla battery used in Australia for grid stability[88], battery technology has improved sufficiently to be commercially viable for enabling renewables. There may be further avoided emissions from the enabling of additional renewables due to gas power plants load following capabilities. However, these emissions have not been estimated in this report as there is insufficient evidence to support this increased renewable capacity.

The grid emission factor from the IRP has been used to calculate the avoided emissions to reflect the anticipated change in the energy mix as set out by national policy. The emissions are only calculated for the period up to 2030, thereafter it is assumed that the majority of the energy mix will be renewables and there will be no avoided emissions from a coal fleet.

The avoided emissions from the Karpowership Project at Richards Bay are shown in Table 14 below. The total avoided emissions between 2023 and 2030 is approximately 17 million tCO_2e.

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87 https://www.energy-storage.news/scatec-signs-ppa-for-co-located-solar-with-1-1gwh-storage-in-south-africa/

88 https://www.pv-magazine.com/2022/07/27/tesla-big-battery-begins-providing-inertia-grid-services-at-scale-in-world-first-in-australia/

Table 14: Avoided emissions

	2023	2024	2025	2026	2027	2028	2029	2030
IRP Grid EF (tCO_2e/MWh)	0.85	0.86	0.85	0.83	0.81	0.77	0.73	0.67
Avoided emissions (million tCO_2e)	2.27	2.3	2.27	2.2	2.2	2.1	2.0	1.8

5.1.5 Measures to reduce the impact of the Project on Climate Change

There are a few measures that could reduce the impact of the Project on climate change through mitigation. These measures result in lower GHG emissions and therefore reducing its impact.

The first measure is shortening the duration of the PPA. This would result in fewer lifetime emissions from the project as the powerplant would be run for a shorter duration. However, this measure may affect the financial viability for the project.

It is noted that the nature of the RfP for the RMIPPPP is for power to be dispatched at the request of Eskom. In the case that Eskom does not require the dispatch of power, no GHGs will be emitted from the project. It is assumed that Eskom will have increasing access to renewable energy over the duration of the project, and that more renewable energy plus battery storage projects will come on line. This may result in the project emitting significantly less emissions than what has been estimated above.

The other measure is switching the feedstock of the Powership to a renewable energy source such as green hydrogen. This would eliminate the GHG emissions associated with the production, transport and combustion of natural gas. Within the current economic circumstances in South Africa, the use of green hydrogen is not considered an economically viable option for mitigation.

5.2 Project Vulnerability to Climate Change

Vulnerability is defined as the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.[8] Climate change and climate variability are both damaging and costly to much of the world, and South Africa is no exception. Climate-related impacts such as floods, droughts, heat waves and cyclones pose significant risks to infrastructure, economies, livelihoods, and natural ecosystems. However, the impacts usually differ in both magnitude and rate of change across geographical locations and depend on the capacities of human and biological systems to adapt to changing climates.

Pre-existing natural and man-made hazards or disasters already have a major impact on the uMhlathuze Local Municipality, with the effects of climate change only increasing these risks and impacts. This could have an impact on both local, regional, and national socio-economic and environmental development initiatives. The key disaster profiles identified for the municipality include hydrological, biological, environmental, and geological hazards, as shown in Table 15. In terms of the disaster profiles reported on for the province, the trends correlate with the Greenbook

Tool and climate data in Section 3.3. The climate trends for the uMhlathuze Local Municipality include rising temperatures, extreme heat, and increased rainfall variability. Thus, the climate is likely to become hotter, which could lead to environmental hazards that will affect natural resources and ecosystems (e.g., influence water availability in wetlands, shifts in species distribution and both land and coastal degradation. The municipality may also be exposed to more extreme weather events (e.g., tropical cyclones, storm surges, droughts, and flooding). This poses significant risks to the municipality as environmental hazards such as erosion (both in land and sea), landslides and sink holes, caused by heavy rainfall and storms.[89,90,91]

Table 15: Disaster Risk Profile relevant to climate change for uMhlathuze Local Municipality[92]

Hydro-Meteorological	Environmental Hazards	Geological Hazards
Flood (River and Coastal)	Air and Water Pollution	Landslides/mudflow (can be exacerbated through extreme weather such as floods)[90]
Drought	Deforestation	
Hailstorms	Land and coastal degradation	Sinkholes (can be caused because of heavy rains and floods[91]
Tropical Cyclones	Soil and coastal erosion	
Severe Storm Surges	Environmental degradation	
Heavy Rainfall		
Veld and Forest Fires		
Heatwaves and Extreme Temperatures		

5.2.1 Core operations

South Africa is expected to experience a range of climate-related risks and impacts, with some of these impacts having clear implications for energy production, distribution and use. South Africa is expected to experience a range of climate-related risks and impacts, with some of these impacts having clear implications for energy production, distribution, and use. Climate change may affect the efficiency of production processes on site, cost of operations and maintenance. For example, temperature-related impacts can affect cooling systems and to a lesser degree turbine efficiency,

89 Rossouw, M. and Theron, A., 2012. Investigation of potential climate change impacts on ports and maritime operations around the southern African coast. In Maritime Transport and the Climate Change Challenge (pp. 314-332). Routledge.
90 https://www.umhlathuze.gov.za/images/IDP/Dissaster.pdf
91 https://www.umhlathuze.gov.za/images/IDP/Human%20Resettlent.pdf
92 https://www.umhlathuze.gov.za/images/x83427a1.pdf

which could lead to operational stoppages.[93] Extreme temperatures or intense rainfall events could also alter working conditions, affecting workers' safety and productivity. In addition, coastal operations are directly or indirectly affected by extreme weather events and changing ocean conditions (e.g., sea-surface temperature, ocean pH and rising sea levels), with the timing and magnitude of these effects being largely uncertain. Moreover, the resilience of operational systems (i.e., production and transmission systems and infrastructure) may be at direct risk from these extreme events, with the potential to cause significant damage.[94] To effectively account for the potential climate change effects in the planning processes, companies need to consider how climate related risks and opportunities, as well as the associated impacts, may evolve under different conditions. The core operations of the Karpowership Project are related to facilities and site operations.

5.2.1.1 Temperature

The average annual temperature and the frequency of very hot days (>35°C) is expected to increase. The Green Book tool indicates that by 2050, the average temperature will increase by between 0.5°C to 0.8°C under SSP1 scenario, 0.8°C to 1.2°C under the SSP2 scenario and between 1°C to 1.4°C under the SSP5 scenario. The number of very hot days is also predicted to increase by up to 12 days under SSP2 and 18 days under SSP5 scenario. Typical risks associated with the relationship between increased temperatures and the project's core operations, include the following:

- Higher temperatures and more frequent heatwaves places increased stress on pipelines and cooling systems. These climate changes may exceed the thresholds of essential equipment and systems, causing more frequent failures and operational stoppages over time, and increasing potential fire-hazards.
- Onsite offices and rooms will make increased use of air conditioning due to higher temperatures, thus increasing energy demand and associated costs
- Increasing ambient temperatures and extreme hot days increases exposure to heat and in turn, heat stress. Heat stress at work, as result of (climate-related) increasing temperatures, impacts workers health, safety, productivity, and social well-being. Therefore, workers may become more exposed to heat stress and increased temperatures and may impact operations.

93 Wilbanks, T., Bhatt, V., Bilello, D., Bull, S., Ekmann, J., Horak, W., Huang, Y.J., Levine, M.D., Sale, M.J., Schmalzer, D. and Scott, M.J., 2008. Effects of climate change on energy production and use in the United States. US Department of Energy Publications, p.12.

94 Ciscar, J.C. and Dowling, P., 2014. Integrated assessment of climate impacts and adaptation in the energy sector. Energy Economics, 46, pp.531-538.

5.2.1.2 Precipitation

The mean annual precipitation is expected to increase, by around 1.5-4% by 2050. The Green Book tool indicates that by 2050, the average precipitation will decrease by ±30mm/year under SSP1, ±35mm/year under the SSP 2 scenario and ±90mm/year under an SSP5 scenario. The number of extreme rainfall days is expected to decrease by up to 3 days/year under SSP2, with negligible changes under SSP5 scenario. The overall decline in precipitation is unlikely to have a major impact on the core operations, as seawater is used for cooling systems, and therefore, operations should be able to continue during low rainfall periods. During intense rainfall periods, however, performing key operational activities (e.g., maintenance of systems and equipment, loading/unloading of gas etc.) could be affected, while flooding could cause structural damage and lead to operational stoppages.

5.2.1.3 Tropical Cyclones

Every year, tropical cyclones affect many countries around the world, leading to significant loss of life and structural damage. Coastal communities and industries are especially vulnerable to tropical storms, as they bring about heavy rains, strong winds, large swells and storm surges, which significantly increases the risk of flooding.[95] Due to South Africa's latitudinal position, tropical storms have a lesser impact compared to countries such as Madagascar and Mozambique. However, recent evidence indicates that these storms are occurring further south and further west. They are also becoming more frequent and have a higher intensity. Therefore, cities such as Richards Bay are expected to become more exposed to these storms, which will likely increase the risks and vulnerability of the project's operations.

Moreover, tropical cyclones are typical high impact low probability (HILP) hazards and are generally quite difficult to manage due to their unpredictable nature. These storms can have detrimental impacts to LNG operations, by causing "roll overs" or structural damage, resulting in leakages, and/or potential fires and explosions.[96] This could have major financial implications the project, as they would not only halt operations and pose major risks to workers' safety, but could cause an environmental disaster that will impact surrounding communities and ecosystems. This

[95] Bopape, M.J.M., Sebego, E., Ndarana, T., Maseko, B., Netshilema, M., Gijben, M., Landman, S., Phaduli, E., Rambuwani, G., Van Hemert, L. and Mkhwanazi, M., 2021. Evaluating South African weather service information on Idai tropical cyclone and KwaZulu-Natal flood events. South African Journal of Science, 117(3-4), pp.1-13.

[96] Wu, J., Bai, Y., Zhao, H., Hu, X. and Cozzani, V., 2021. A quantitative LNG risk assessment model based on integrated Bayesian-Catastrophe-EPE method. Safety science, 137, p.105184.

is especially true during the process of loading/unloading of gas as high winds and large swells affect the ships stability and therefore loading stops, which in turn may affect the entire operation.[97]

5.2.1.4 Storm Surges

Storms surges are one of the main impacts of tropical and coastal storms. Apart from flooding, storm surges have the potential to affect coastal environments through increased wind speeds and wave impacts. Storm surges increase wind speeds and wave heights, posing major risks to both on-and off-shore activities. Larger storm surges can destabilize sea beds by increasing sediment accretion or erosion, which can lead to embedment or undercutting of underwater pipelines.[98] However, tidal or storm surge barriers at ports often prevent or significantly reduce these processes and therefore the risks are expected to be low.

In addition, the impacts of rising sea-levels (although mostly indirect) should be considered as they pose a major risk to coastal communities and industries. Rising sea-levels increase tidal heights, compounding the effects of tropical storms and/or storm surges and increasing the likelihood of coastal flooding. According to IPCC AR6, the projected sea-level rise for the project's location is 10-40 cm by 2050 under various SSPs, with a 1m rise only being expected in 2095 under SSP5-8.5. While tidal heights are expected to be around 9m within the region. Although, the ships are docked in the port, such wave heights could increase the vulnerability of project operations, by causing detrimental damage to infrastructure and placing workers safety at risk. Therefore, regular maintenance of port infrastructure is crucial for reducing these risks and impacts.

97 McBride, J.L., 2012. The estimated cost of tropical cyclone impacts in Western Australia. Indian Ocean Climate Initiative (IOCI) Technical Report, Stage, 3.

98 Zhang, M., Huang, Y. and Bao, Y., 2016. The mechanism of shallow submarine landslides triggered by storm surge. Natural Hazards, 81(2), pp.1373-1383.

5.2.1.5 Ocean Conditions

Sea-surface temperature and pH could have an impact on the corrosion rates of underwater pipelines and infrastructure. Climate-related impacts involving rising sea-surface temperatures and declining pH levels (through ocean acidification) may accelerate the corrosion rates of marine infrastructure, reducing its durability and lifespan.[99] In the project area, sea-surface temperature is expected to increase from 24.33˚C to ±25.3˚C by the late 2040s. The pH levels of the sea show a slight decline from 8.12 in 1985 to 8.07 in 2023, suggesting that pH levels are likely to remain above 8 throughout the project's lifetime (20 years). These environmental changes may increase corrosion rates marginally, however, it's impact may be minimal to underwater pipelines and systems.

5.2.2 Value chain

Analysing the impacts that climate change may have on the value chain for the Karpowerships Project will allow for an understanding of how the upstream (transportation and storage of the gas) and downstream (transmission of power) process will be affected.

5.2.2.1 Upstream Value Chain

The upstream value chain for the Karpowerships Project will be impacted by climate change, as indicated in Table 16.

[99] Garcia, A., Valdez, B., Schorr, M., Zlatev, R., Eliezer, A. and Hadad, J., 2010. Assessment of marine and fluvial corrosion of steel and aluminium. Journal of Marine Engineering & Technology, 9(3), pp.3-9.

Table 16: Climate change impacts on the upstream value chain of the Karpowerships Project.

Trend and climatic driver	Impact on upstream value chain
↑ Air temperature	• Rising temperatures may place more strain on pipelines, which could shorten their durability and require replacing more frequently. • Hotter temperatures would lead to an increase in the energy demand of cooling systems as LNG needs to be stored at very low temperatures. • More frequent and intense heat waves adversely impact employee health and productivity.
↑ Rainfall intensity	• Heavy rains could affect key operational processes (e.g., loading/unloading, maintenance of systems and equipment)
↑ Tropical cyclones and storm surges	• More intense storm storms could lead to structural damage to the ships. • Extreme weather events could delay deliveries, which would further impact project operations. This is a major risk for the entire Project, as the electricity generation depends on a continuous and reliable gas supply.
↓ Ocean pH	• Ocean pH will depend on transport routes. Lower pH levels could increase corrosion rates of infrastructure and equipment.

5.2.2.2 Downstream Value Chain

The upstream value chain for the Karpowerships Project will be impacted by climate change, as indicated in Table 17 below.

Table 17: Climate change impacts on the downstream value chain of the Karpowerships Project.

Trend and climatic driver	Impact on downstream value chain
↑ Air temperature	• Increase thermal expansion of transmission and distribution power lines cause line sag, reducing the amount of power transported • Extreme heat could adversely impact employee health and productivity • Hotter temperatures pose a fire hazard, particularly during drier parts of the year.
↑ Rainfall intensity	• Potentially delay construction of necessary infrastructure • Damage critical infrastructure due to localized flooding • Prolonged periods of intense rainfall could prevent key maintenance and management operations from being carried out
↑ Tropical cyclones and storm surges	• More intense storm storms could lead to structural damage to the ships • Extreme weather events could delay deliveries, which would further impact project operations. This is a major risk for the entire Project, as the electricity generation depends on a continuous and reliable gas supply.
↑ Sea-level rise	• Rising sea-levels will amplify the effects of extreme weather events
↑ Fires	• Fires could cause significant structural damage to the sub-station and powerlines

5.2.3 Broader Social Context

Promethium understands that a social specialist study will be undertaken as part of the EA process and will include a Social Impact Assessment. This CCIA will therefore not provide details with respect to demographics, inequality, education, employment, household income or service delivery for the local municipality.

We do however note the following key points that should be considered with respect to climate change and the broader local community:

- Considering the demographic profile, women-headed households account for 43.3% of all households within the uMhlathuze Local Municipality.[100] This is a major concern with regards to climate change and socio-economic development, as women are generally more vulnerable than their male counterparts, have lower incomes and higher dependency ratios.[101,102]
- A high unemployment rate points to existing socio-economic vulnerabilities. High levels of poverty, low-income distribution and low education levels are all observed in uMhlathuze.[103] Social vulnerability from climate change will result in further inequalities and reduced capacity to cope with climate shocks. It is important to note, however, that the project's role is to supply energy to help meet demands, which in turn could increase socio-economic growth[104]. Such growth would assist in building community resilience to climate change impacts.[105]

  A local community that is largely younger than 15 or older than 65 indicates a higher dependency ratio. uMhlathuze has a relatively high dependency ratio as only 54% of the population falls within the 18-64 years old bracket. This places significant economic strain on households, which could lead to increased vulnerability to climate change impacts;[106]
- More frequent and intense weather events (e.g., coastal flooding, droughts, storm surges etc.) could directly impact human health (i.e., through heat-related illness, or chronic and vector-borne diseases etc.), and contribute to food and water insecurity in the region. Consequently, increased vulnerability and reducing the capacity to adapt to future climate changes.
- More frequent and intense weather events (e.g., coastal flooding, droughts, storm surges etc.) could directly impact human health (i.e., through heat-related illness, or chronic and vector-borne diseases etc.), and contribute to food and water insecurity in the region. Consequently, increased vulnerability and reducing the capacity to adapt to future climate changes.

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100 https://wazimap.co.za/profiles/municipality-KZN282-umhlathuze/
101 Shozi, D.M., 2007. The participation of women in the preparation and formulation of Local Council budget: a case study of Enseleni Community in uMhlathuze Local Municipality in KwaZulu-Natal (Doctoral dissertation).
102 Alston, M., 2014, November. Gender mainstreaming and climate change. In Women's Studies International Forum (Vol. 47, pp. 287-294). Pergamon.
103 Babugura, A., Mtshali, N. and Mtshali, M., 2010. Gender and climate change: South Africa case study. Heinrich Böll Stiftung Southern.
104 Cirella, G.T. and Pawłowska, B., 2021. Advancements in the Energy Sector and the Socioeconomic Development Nexus. Energies, 14(23), p.8078.
105 https://betterbuildingssolutioncenter.energy.gov/resilience/communities
106 Abegunde, V.O., Sibanda, M. and Obi, A., 2022. Effect of climate-smart agriculture on household food security in small-scale production systems: A micro-level analysis from South Africa. Cogent Social Sciences, 8(1), p.2086343.

- Tropical storms and cyclones seem to be moving further south and west over the Indian Ocean and Mozambique Channel. Although most tropical storms rarely reach landfall, the impacts of climate change may increase the intensity and likelihood of these storms reaching land. Subsequently, increasing vulnerability of coastal communities further south and west of original locations;
- Loss of biodiversity (e.g., fish, crustaceans, mangroves, estuaries etc.) could negatively affect tourism, resulting in the loss of tourism-related jobs, placing further economic strain on local communities;
- Loss of coastal vegetation and ecosystems (e.g., mangroves) may increase vulnerability to climate change impacts within the region and along coastlines, as they act as natural barriers to storm surges and floods;
- Households that rely on marine ecosystems for survival (e.g., fisherman) could become more vulnerable, as the impacts of climate change may alter or destroy marine environments (i.e., through increasing temperatures, storm surges, or altering of the ocean's chemistry) Biodiversity may therefore be lost and increase food insecurity within the region;
- Loss of coastal vegetation and ecosystems (e.g., mangroves) may increase vulnerability to climate change impacts within the region and along coastlines, as they act as natural barriers to storm surges and floods;
- Households that rely on marine ecosystems for survival (e.g., fisherman) could become more vulnerable, as the impacts of climate change may alter or destroy marine environments (i.e., through increasing temperatures, storm surges, or altering of the ocean's chemistry) Biodiversity may therefore be lost and increase food insecurity within the region;
- Change in sea levels is relatively insignificant and may not directly impact coastal communities, however, these changes increase the risks and impacts of storm surges and tropical cyclones (thereby increasing vulnerability to future climatic events);[107] and
- Some of uMhlathuze's residents already experience a high to extremely high risk of veld fires.[108] The risk of damages to infrastructure and loss of life may increase as impacts of climate change become more prevalent, increasing vulnerability of communities in the region. This is especially true for lower-income communities may experience the greatest

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107 Muis, S., Apecechea, M.I., Dullaart, J., de Lima Rego, J., Madsen, K.S., Su, J., Yan, K. and Verlaan, M., 2020. A high-resolution global dataset of extreme sea levels, tides, and storm surges, including future projections. Frontiers in Marine Science, 7, p.263.

108 https://www.umhlathuze.gov.za/images/x02943-1.pdf

vulnerability to veld fires, as most do not have the financial means to cope and/or rebuild following a devastating fire.[109]

5.2.4 Broader Environmental Context

In addition to this specialist CCIA, other specialist studies have been conducted for the proposed Karpowership Project at Richards Bay, specifically Appendices I1 to I16:

- Terrestrial Ecology Assessment
- Heritage and Palaeontology Impact Assessment
- Wetland Rehabilitation Plan
- Wetland Delineation and Functional Assessment
- Geohydrological Assessment
- Hydrological Assessment
- Aquatic Assessment
- Hydropedology Assessment
- Avifaunal Assessment
- Estuarine and Coastal Assessment
- Marine Ecology Assessment
- Atmospheric Impact Assessment
- Climate Change Impact Assessment
- Major Hazard Installation Risk Assessment
- Socio-Economic Assessment
- Noise Impact Assessment

This CCIA will therefore not provide additional details with respect to the above-mentioned disciplines.

We do however note the following key points that should be considered with respect to climate change and the broader environmental context:

- Climate change will affect terrestrial and marine natural ecosystems, reducing their ability to withstand impacts. This would increase the loss of biodiversity in the region as these environments play a crucial role in supporting both marine and terrestrial life. For example, coastal environments (e.g. mangroves, estuaries, swamp forests etc.) provides sanctuary

[109] Hlahla, S. and Hill, T.R., 2018. Responses to climate variability in urban poor communities in Pietermaritzburg, KwaZulu-Natal, South Africa. *Sage Open*, 8(3), p.2158244018800914.

for juvenile marine (fish and crustaceans) and supports many threatened species within the region (e.g. Pickersgill's Reed frog, Pink-backed Pelican, Mangrove Kingfisher, Greater Flamingo).[110,111,112,113]

- According to the South African National Biodiversity Institute's summary, the uMhlathuze Local Municipality supports a total of 174 Red Data Species, which reported to be among one of the highest in the country for an area its size. It is also identified that the region is home to more than 100 wetlands (including estuaries, mangroves, lakes, swamps etc.), with critically endangered ecosystems (e.g., KwaMbonambi Dune Forest; KwaMbonambi Hygrophilous Grassland; coastal and swamp forests, protected mangroves and Richards Bay Nature Reserve etc.).[112,113] Wetlands have important regulatory functions in that they moderate floods. They allow for attenuation of flood peaks thus reducing the risks to people and infrastructure and improves water quality though filtration and detoxification. In addition, it plays an important role in mitigation and adaptation to climate change, by reducing carbon emissions through carbon sequestration. However, climate change will negatively impact wetlands and their ability to provide essential services.

5.2.5 Adaptation Measures to Increase the Project's Resilience to Climate Change

The following adaptation measures are recommended:

- Advanced warning systems to prepare for extreme weather events;
    - Close collaboration and communication with port officials/authorities, local disaster management and the South African Weather Service with respect to advance notification of storm events
- Upstream transport of gas:
    - Awareness of poor weather and extreme events/hazards and managing routing:

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110 https://www.birdlife.org.za/iba-directory/richards-bay-game-reserve/
111 https://sahris.sahra.org.za/sites/default/files/additionaldocs/13642%20-%20TNPA%20Cassuarina%20-%20Faunal%20Final%20Report%20March%202016%20Rev%201%5B1%5D_1.pdf
112 http://www.umhlathuze.gov.za/images/mayor/DRAFT-SDF-CHAPTER.pdf
113 https://sahris.sahra.org.za/sites/default/files/additionaldocs/RBay%20CCPP%20App%20D%20-%20Ecological%20Assessment.pdf

6 Needs and Desirability Assessment

This section addresses the proposed Project from a need and desirability perspective, especially considering that the Project was launched in response to an RfP for New Generation Capacity under the RMIPPPP issued by the DMRE. This issue is addressed in the context that the purpose of the RMIPPPP is to alleviate the immediate and future power generation capacity deficit of South Africa. According to the Need and Desirability Guideline (2017), the need for and desirability of a proposed activity should specifically and explicitly be addressed throughout the EIA Process. The Guideline contains questions that should be addressed when considering the need and desirability of a proposed project, which, broadly speaking, requires a balancing act of considering whether the proposed activity secures ecological sustainable development and the use of natural resources, and whether the proposed activity promotes justifiable economic and social development[114].

As previously mentioned, the baseline technology for calculating the avoided emissions in this project is Eskom's coal fleet. South Africa is currently facing an energy supply deficit and through the RMIPPP, it has been proven that gas is a cheaper option to balance the energy system, with combined renewables and battery energy storage being competitive, but not necessarily the cheapest[115]. Furthermore, in terms of the RMIPPP, it is required that each project must provide Ancillary Services[116], which is necessary for grid stabilisation[117]. The RfP further sets out this condition whereby the Project Company of a Preferred Bidder will need to enter a PPA with a buyer for the supply of energy output, as well as the supply of Ancillary Services. Such projects will generate energy output when called upon (to avoid load shedding) and provide Ancillary Services to reduce the significant cost of using diesel. At the same time the programme will support socio-economic development, job creation, local manufacturing and competitive participation by South African. Therefore, and within the context of energy needs and promoting justifiable economic and social development, the proposed project is deemed as desirable. The proposed activity promotes justifiable economic and social development[118]

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[114] Section 24 of the Constitution of the Republic of South Africa.

[115] The Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP) in Context, page 6.

[116] Electricity Regulation Amendment Bill, No. 45898 of 10 February 2022. Section 1 definition: "*ancillary services" means those services necessary to support the continuous and secure operation of electric power system and necessary to maintain reliable operations of the interconnected power system, including, but not limited to, those services necessary for voltage and reactive power control, automatic generation control frequency control and black start capabilities;*

[117] The Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP) in Context, page 2.

[118] The Department of Environmental Affairs in the Republic of South Africa. Integrated Environmental Management Guideline: Guideline on Need and Desirability 2017. Question 2 for consideration of need and desirability. Pages 14 to 18.

In terms of the specialist impact assessments, the ecological impacts and the use of natural resources has been established. The IRP makes provision for 2 000 MW of gas-generated electricity onto the grid by 2030 while ensuring the South African electricity generation capacity expansion plan meets national climate change policies. The use of a natural resource needs to be viewed in the context of the global carbon budget, rather than the country specific carbon budget, as the implementation of the proposed project is justifiable in terms of the needs and development requirements of the South Africa.

In accordance with the above, it is evident that the proposed project is both needed and desirable in the context of South Africa and the dire need of energy supply stability.

7 Opinion of the Project

The assessment of the climate change impact of this project has been done on the impact of the project on climate change, the resilience of the project to climate change, as well as the options for mitigation of the impacts.

The impact of the project on climate change was assessed in the context of both GHG emissions from the project, as well as the potential positive impact the project will have for the transition to a low-carbon economy.

The project will emit 31 million tons of CO_2e over its lifetime if it runs at 100% of the contracted capacity. We note that the RMIPPP RfP states that the power from the plant must be dispatchable at required of the grid operator and requires that the plant bid into this program must be capable of stable operation at 25% of the contacted capacity. Should the plant run at this level, the total emissions of the plant over its lifetime will be 7.7 million tons CO_2e.

In accordance with the findings of this CCIA, we advise that the proposed Karpowership Project at Richards Bay should not be refused environmental authorisation based on climate change related issues.

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

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

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File Reference Number:	
NEAS Reference Number:	DEA/EIA/14/12/16/3/3/2007
Date Received:	02 November 2020

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

PROJECT TITLE

The Proposed Gas to Power Powership Project at the Port of Richards Bay, Umhlathuze Local Municipality, King Cetshwayo District, Kwazulu-Natal.

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Departmental Details

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

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

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

1. SPECIALIST INFORMATION

Specialist Company Name:	**Promethium Carbon (Pty.) Ltd**			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	**Level 4**	Percentage Procurement recognition	**100%**
Specialist name:	**Robert Truter Louw**			
Specialist Qualifications:	**BCom (Hons) (Economics); BSc Engineering (Chemical)**			
Professional affiliation/registration:	**Institute of Directors in South Africa (IoDSA)** **South African Institute of Mining and Metallurgy (SAIMM)**			
Physical address:	**1st Floor, Block 2, The Courtyards, 32 Peter Place, Bryanston, 2060**			
Postal address:	**PO Box 131253, Bryanston**			
Postal code:	**2021**	Cell:	**082-557-8646**	
Telephone:	**011-706-8185**	Fax:	**086-589-3466**	
E-mail:	**robbie@promethium.co.za**			

2. DECLARATION BY THE SPECIALIST

I, **Robert Truter Louw**, declare that –

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

Signature of the Specialist

Promethium Carbon (Pty.) Ltd

Name of Company:

18/10/2022

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

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

Signature of the Specialist

Promethium Carbon (Pty) Ltd

Name of Company

Date 18/10/2022.

I certify that the deponent acknowledged that he/she knows and understands the contents of this declaration which was signed and sworn to before me, under compliance with the regulations contained in Government Notice R1258 dated 21 July 1972, (as amended), at Johannesburg on 18 October 2022

Signature of the Commissioner of Oaths

Date 18/10/2022.

Commissioner of Oaths (RSA)
26 Augrables Road
Waterfall Park,
Off Bekker Road, Midrand, 1685
Signed:..........................
Date:............ 18/10/2022.

Yuraisha Mari
Non-Practising Attorney

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

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

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/14/12/16/3/3/2007
Date Received:	02 November 2020

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

PROJECT TITLE

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Environment House
473 Steve Biko Road
Arcadia

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

1. SPECIALIST INFORMATION

Specialist Company Name:	**Promethium Carbon (Pty.) Ltd**			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	**Level 4**	Percentage Procurement recognition	**100%**
Specialist name:	**Shannon Lee Murray**			
Specialist Qualifications:	**BA (LLB); LLB**			
Professional affiliation/registration:	**Attorney of the High Court of South Africa – Law Society of the Northern Provinces**			
Physical address:	**1st Floor, Block 2, The Courtyards, 32 Peter Place, Bryanston, 2060**			
Postal address:	**PO Box 131253, Bryanston**			
Postal code:	**2021**	Cell:	**082-553-2152**	
Telephone:	**011-706-8185**	Fax:	**086-589-3466**	
E-mail:	**shannon@promethium.co.za**			

2. DECLARATION BY THE SPECIALIST

I, **Shannon Lee Murray,** declare that –

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

[signature]

Signature of the Specialist

Promethium Carbon (Pty.) Ltd

Name of Company:

18/10/22

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

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

Murray

Signature of the Specialist

Promethium Carbon (Pty.) Ltd

Name of Company

18/10/22

Date

I certify that the deponent acknowledged that he/she knows and understands the contents of this declaration which was signed and sworn to before me, under compliance with the regulations contained in Government Notice R1258 dated 21 July 1972, (as amended), at Johannesburg on 18 October 2022

Signature of the Commissioner of Oaths

18/10/2022

Date

Commissioner of Oaths (RSA)
26 Augrables Road
Waterfall Park,
Off Bekker Road, Midrand, 1685
Signed:..............................
Date:.......... 18/10/2022

Yuraisha Mari
Non-Practising Attorney

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

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

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PROJECT TITLE

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473 Steve Biko Road
Arcadia

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Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	**Promethium Carbon (Pty.) Ltd**			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	**Level 4**	Percentage Procurement recognition	**100%**
Specialist name:	**Kenneth Slabbert**			
Specialist Qualifications:	**MEng (Mechanical); BIng (Mechanical)**			
Professional affiliation/registration:	**South African Institute for Mechanical Engineers**			
Physical address:	**1st Floor, Block 2, The Courtyards, 32 Peter Place, Bryanston, 2060**			
Postal address:	**PO Box 131253, Bryanston**			
Postal code:	**2021**	Cell:	**079-922-9393**	
Telephone:	**011-706-8185**	Fax:	**086-589-3466**	
E-mail:	**kenneth@promethium.co.za**			

2. DECLARATION BY THE SPECIALIST

I, **Kenneth Slabbert**, declare that –

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

[signature]

Signature of the Specialist

Promethium Carbon (Pty) Ltd

Name of Company:

24/10/2022

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

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

KS

Signature of the Specialist

Promethium Carbon (Pty) Ltd

Name of Company

24/10/2022

Date

Signature of the Commissioner of Oaths

2022-10-24

Date

SOUTH AFRICAN POLICE SERVICE
CLIENT SERVICE CENTRE
2022 -10- 24
RANDBURG
SUID-AFRIKAANSE POLISIEDIENS

Ek sertifiseer dat bostaande verklaring deur my afgeneem is en dat verklaarder erken het dat hy/sy vertroud is met die inhoud van die verklaring en dit begryp. Hierdie verklaring is voor my beëdig/bevestig en verklaarder se handtekening/merk/duimafdruk is in my teenwoordigheid daarop aangebring.

I certify that the above statement was taken by me and that the deponent has acknowledged that he/she knows and understands the contents of this statement. This statement was sworn to/affirmed before me and the deponent's signature/mark/thumbprint was placed thereon in my presence.

te / at Randburg op / on 2022-10-24 om / at 16:40

(HANDTEKENING) KOMMISSARIS VAN EDE
(SIGNATURE) COMMISSIONER OF OATHS

Castamuse Thembi

VOLLE VOORNAME EN VAN IN DRUKSKRIF
FULL FIRST NAMES AND SURNAME IN BLOCK LETTERS

76 Shepherd Avenue

BESIGHEIDSADRES (STRAATADRES)
BUSINESS ADDRESS (STREET ADDRESS)

Pers/rotor B

RANG/RANK

SA POLIS

KS

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

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

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Email: EIAAdmin@environment.gov.za

I.M

1. SPECIALIST INFORMATION

Specialist Company Name:	**Promethium Carbon (Pty.) Ltd**			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	**Level 4**	Percentage Procurement recognition	**100%**
Specialist name:	**Indiana Mann**			
Specialist Qualifications:	**BSc (Hons) in Atmospheric Science; BSc in Environmental and Geographical Science**			
Professional affiliation/registration:	-			
Physical address:	**1st Floor, Block 2, The Courtyards, 32 Peter Place, Bryanston, 2060**			
Postal address:	**PO Box 131253, Bryanston**			
Postal code:	**2021**	Cell:	**073-255-2347**	
Telephone:	**011-706-8185**	Fax:	**086-589-3466**	
E-mail:	**indiana@promethium.co.za**			

2. DECLARATION BY THE SPECIALIST

I, **Indiana Mann**, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
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- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

[signature]

Signature of the Specialist

Promethium Carbon (Pty) Ltd

Name of Company:

18/10/22

Date

I.M

3. **UNDERTAKING UNDER OATH/ AFFIRMATION**

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

Signature of the Specialist

Promethium Carbon (Pty) Ltd

Name of Company

18/10/22

Date

I certify that the deponent acknowledged that he/she knows and understands the contents of this declaration which was signed and sworn to before me, under compliance with the regulations contained in Government Notice R1258 dated 21 July 1972, (as amended), at Johannesburg on 18 October 2022

Signature of the Commissioner of Oaths

18/10/2022

Date

Commissioner of Oaths (RSA)
26 Augrabies Road
Waterfall Park,
Off Bekker Road, Midrand, 1685
Signed:..................................
Date:..........................18/10/2022

Yuraisha Mari
Non-Practising Attorney

I.M

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

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

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JW

1. SPECIALIST INFORMATION

Specialist Company Name:	**Promethium Carbon (Pty.) Ltd**			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	**Level 4**	Percentage Procurement recognition	**100%**
Specialist name:	**Joshua Weiss**			
Specialist Qualifications:	**MSc Conservation Biology; BSc (Hons) Ecology, Environment and Conservation; BSc Geography and Ecology, Environment and Conservation**			
Professional affiliation/registration:	**Professional Natural Scientist (118208), South African Council for Natural Science Professionals (SACNASP)**			
Physical address:	**1st Floor, Block 2, The Courtyards, 32 Peter Place, Bryanston, 2060**			
Postal address:	**PO Box 131253, Bryanston**			
Postal code:	**2021**	Cell:	**076-117-0160**	
Telephone:	**011-706-8185**	Fax:	**086-589-3466**	
E-mail:	**joshua@promethium.co.za**			

2. DECLARATION BY THE SPECIALIST

I, **Joshua Weiss**, 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;
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- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

[signature]

Signature of the Specialist

Promethium Carbon (Pty) Ltd

Name of Company:

18 / 10 / 2022

Date

JW

3. UNDERTAKING UNDER OATH/ AFFIRMATION

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

____

Signature of the Specialist

Promethium Carbon (Pty) Ltd

Name of Company

18/10/2022

Date

I certify that the deponent acknowledged that he/she knows and understands the contents of this declaration which was signed and sworn to before me, under compliance with the regulations contained in Government Notice R1258 dated 21 July 1972, (as amended), at Johannesburg on 18 October 2022

____

Signature of the Commissioner of Oaths

18/10/2022

Date

Commissioner of Oaths (RSA)
26 Augrables Road
Waterfall Park,
Off Bekker Road, Midrand, 1685
Signed:..............................
Date:.......................18/10/2022

Yuraisha Mari
Non-Practising Attorney

JW