Proposed Rietkol Mining Operation

Air Quality Impact Assessment: Greenhouse Gas Emissions Statement

Prepared for:

Jacana Environmentals CC

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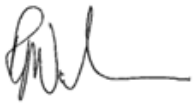

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1. INTRODUCTION

The contents of this report form part of the Air Quality Impact Assessment (AQIA) assignment for the proposed Rietkol mine and must therefore be read alongside the consolidated report. The focus here is to quantify and contextualise the project's greenhouse gas (GHG) emissions against the relevant national benchmarks.

2. METHODOLOGY

Emissions from road transport for the proposed activity were considered for this GHG inventory. The methodologies for these aspects, as well as assumptions and limitations, are detailed in the following sections.

2.1. Source data

Table 1 below was provided in the final scoping report for the Rietkol mining operation. It was communicated that the vehicle movements are based on the highest production level envisaged per annum for 20 years. The majority of the product will be transported to Consol in Wadeville, about 60km from the mine site (one-way along the N12 and N17). Movement of buses and light vehicles will depend on where the employees will reside.

Table 1: Transport of product from Rietkol

Type of vehicle	**Estimated Vehicle Movements (round trips)**		
	Per day	Per month	Per annum
Light vehicle traffic	16	350	4200
Buses	12	360	4320
Deliveries	3 trips per week	12	120
Other (Customers etc.)	2	44	528
Product Transport			
Tippers (40 ton)	54	1620	19440
33-ton tipper and flatbed vehicles	4	120	1440
Flatbed trucks	10	300	3600
Bulk tankers	4	96	1152

2.2. Scope 1: Direct Emissions

Scope 1 emissions, which are direct greenhouse (GHG) emissions that occur from sources that are controlled or owned by the mining operation (e.g., emissions associated with transportation and fuel combustion in generators, boilers, furnaces etc) were considered for the GHG inventory.

For the Scope 1 emission calculations the product transport was considered, amounting to 72 one-way trips per day, and a total of 25 632 round trips per annum. Movement of light vehicle traffic, buses, deliveries, and others were not considered in the present study due to the unknown vehicle movements.

Estimated Vehicle Round Trip Movements			
Vehicle type	**Per day**	**Per month**	**Per annum**
Product Transport			
Tippers (40 ton)	54	1620	**19440**

Estimated Vehicle Round Trip Movements			
Vehicle type	**Per day**	**Per month**	**Per annum**
33-ton tipper and flatbed vehicles	4	120	**1440**
Flatbed trucks	10	300	**3600**
Bulk tankers	4	96	**1152**
Total	72	2136	25632

The vehicle traffic related to the mine includes:

- Transport of staff to and from work working on a three (3) shift rotation per day;
- Routine maintenance of equipment, site vehicles and production equipment;
- Transport of fuel and on-site refuelling;
- Management and visitor transport and supervision activities; and

Transport of final product to the markets, estimated at approximately 36 trucks (one-way) per day, at highest production levels (worst-case scenario). Product will be transported from Monday through to Sunday during daylight hours.

The Department for Environment, Food and Rural Affairs (DEFRA) GHG inventory was utilised to obtain the emission factors for Heavy Goods Vehicles (HGVs).

Heavy Goods Vehicles (HGV) Emission factors	**kg CO_2e/km**
Articulated (> 3.5 - 33 t)	0.92829
Articulated (> 33 t)	1.07286

Heavy Goods Vehicles (HGV) Emission factors	**kg CO_2e/km**	**One-way trip distance**	**Total annual trips**	**kg CO_2e**	**t CO_2e**
Articulated (> 3.5 - 33 t)	0.92829	60	19440	1 082 757	1 083
Articulated (> 33 t)	1.07286	60	6192	398 589	399

The total estimated emissions for product transportation for year one of the project amounts to **1 481 t CO_2e**. Assuming the highest production output (worst-case scenario) over the 20-year project lifespan, the total emissions are estimated at **29 627 t CO_2e**.

2.3. Scope 2: Bulk Electricity

An 11 kV electricity supply line is located on the northern boundary of the MRA area and discussions with Eskom is underway to connect to this supply line. Generators will be installed to supplement Eskom power where required.

Electricity supplied by Eskom is considered within Scope 2 emissions, however, energy generation using generators would fall within the Scope 1 inventory. At the time of this assessment data pertaining to the type

of generators and anticipated fuel consumption required was not available to determine the emissions arising from bulk electricity supply. Emissions arising from bulk electricity were considered within Scope 2 for the GHG inventory on the basis that power supply will be predominantly provided by Eskom.

The emission factor provided by Eskom for Scope 2 emissions is reported at 1.02 kgC02e/kWh.

Table 2: Anticipated Power Requirements (MWP, 2019)

Lighting, Workshops and Offices		
Energy	Kilo Watt Hour/month	14 040
Average Power	Kilo Watt	30
Peak Power	Kilo Watt	50
Plant Conveyors and screens		
Energy	Kilo Watt Hour/month	156 000
Average Power	Kilo Watt	250
Peak Power	Kilo Watt	400
Pumps		
Energy	Kilo Watt Hour/month	436 800
Average Power	Kilo Watt	700
Peak Power	Kilo Watt	950
Crushers		
Energy	Kilo Watt Hour/month	280 800
Average Power	Kilo Watt	450
Peak Power	Kilo Watt	790

Bulk electricity supply was considered per annum and over the 20-year project period.

Table 3: Scope 2 emissions per annum

	Kilo Watt Hour/month	**Kilo Watt Hour/annum**	**kgCO2e per annum**	**tCO2e per annum**
Lighting, Workshops and Offices	14 040	168480	171 850	172
Plant Conveyors and screens	156 000	1872000	1 909 440	1 909
Pumps	436 800	5241600	5 346 432	5 346
Crushers	280 800	3369600	3 436 992	3 437
Total	887 640	10 651 680	10 864 714	10 865

Table 4: Scope 2 emissions for 20-year project period

	Kilo Watt Hour/project	20 year kgCO2e	20 year tCO2e
Lighting, Workshops and Offices	3369600	3 436 992	3 437
Plant Conveyors and screens	37440000	38 188 800	38 189
Pumps	104832000	106 928 640	106 929
Crushers	67392000	68 739 840	68 740
Total	213 033 600	217 294 272	217 294

The total estimated emissions for bulk electricity supply considered within Scope 2 for year one of the project amounts to **10 865 t CO_2e**. Over the 20-year project lifespan, the total Scope 2 emissions are estimated at **217 294 t CO_2e**.

3. RATING OF GREENHOUSE GAS EMISSIONS

Having quantified the expected annual and lifetime emissions from the proposed activities, it is necessary to contextualise them within the national setting. This is detailed below by showing recent gross national GHG emissions, followed by comparing the lifetime emissions from the proposed activity to the national carbon budget.

3.1. National GHG emissions

South Africa's gross emissions showed a general upward trend in the 17-year period shown below, with peak emissions of ~555 000 Gg $C0_2e$ occurring in 2017[1]. There was a relatively marginal increase in emissions between 2015 and 2017 of 1 703 Gg $C0_2e$ (Figure 1).

[1] National Environmental Management: Air Quality Act (39/2004): Draft 7th National Greenhouse Gas Inventory Report for the Republic of South Africa for public comment. Online: https://www.environment.gov.za/sites/default/files/gazetted_notices/nemaqa_draft7greenhousegasinventoryeport_g43706gon989.pdf

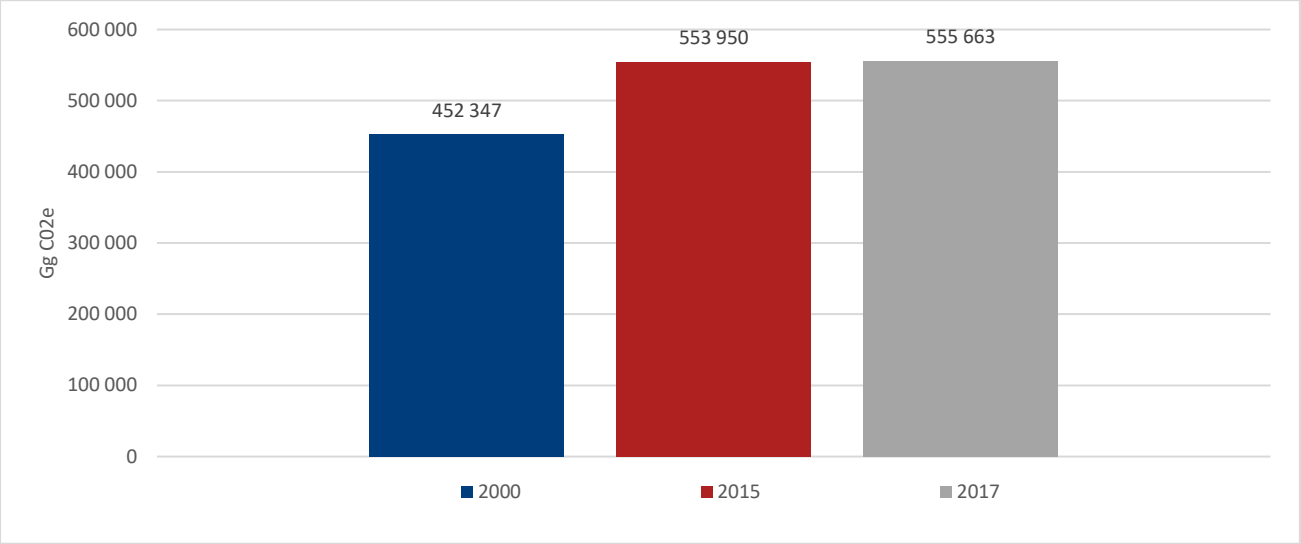
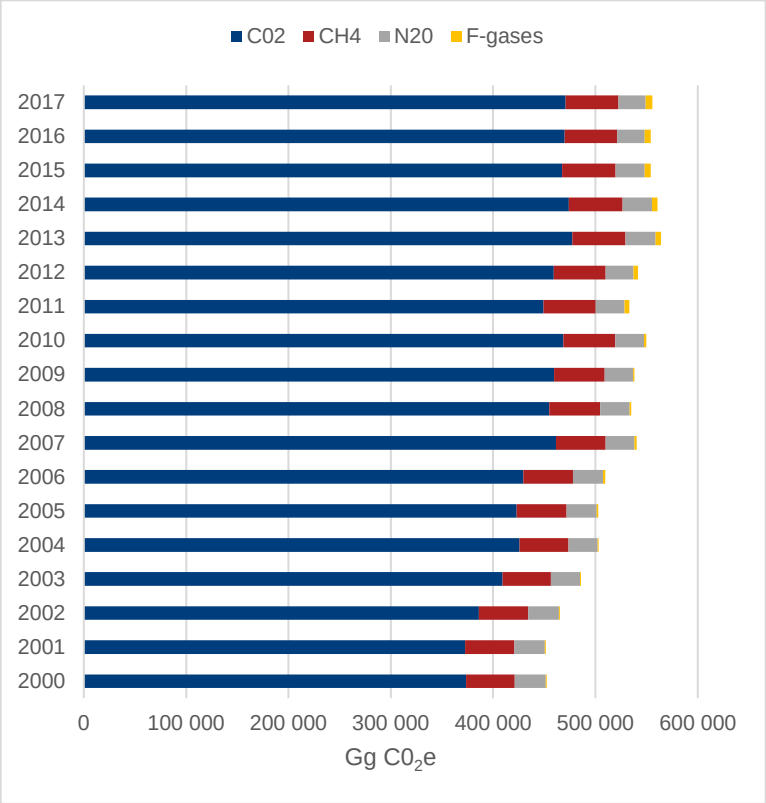


Figure 1. Gross greenhouse gas emissions (Gg $C0_2e$) for South Africa between 2000 and 2017, excluding forestry and other land uses (FOLU).

Figure 2 disaggregates the abovementioned total emissions into four categories of long-lived GHGs: i) $C0_2$; ii) CH_4; iii) N_20; and iv) Fluorinated gases[2] . The ratio of each gas compared to annual total emissions for a 17-year period is also indicated. Emissions of $C0_2$ in South Africa peaked between 2007 and 2009 where $C0_2$ accounted for 85.4% of national GHG emissions. By contrast, emissions of Fluorinated gases[3](F-gases, which have a substantively higher global warming potential than $C0_2$) have been increasing steadily between 2000 and 2017, increasing to 1.2% in 2017 from 0.2% in 2000. Emissions of N_20 and CH_4 both peaked during the early 2000s, declining thereafter by ~ 1.2% and 1.9%, respectively (Figure 2).

[2] Hydrofluorocarbon (HFC), Perfluorocarbon (PFC), SF_6 (Sulphur hexafluoride,) and Nitrogen trifluoride (NF_3).
[3] Hydrofluorocarbon (HFC), Perfluorocarbon (PFC), SF_6 (Sulphur hexafluoride,) and Nitrogen trifluoride (NF_3).



Year	Percentage of total emissions			
	CO_2	CH_4	N_20	F-gases
2000	82.6%	10.5%	6.7%	0.2%
2001	82.5%	10.6%	6.6%	0.2%
2002	83.0%	10.3%	6.5%	0.2%
2003	84.2%	9.8%	5.8%	0.2%
2004	84.7%	9.5%	5.7%	0.2%
2005	84.2%	9.7%	5.8%	0.3%
2006	84.3%	9.5%	5.8%	0.4%
2007	85.4%	9.0%	5.2%	0.4%
2008	85.0%	9.3%	5.4%	0.3%
2009	85.4%	9.2%	5.2%	0.2%
2010	85.2%	9.2%	5.1%	0.4%
2011	84.3%	9.5%	5.3%	0.9%
2012	84.8%	9.3%	5.0%	0.8%
2013	84.7%	9.2%	5.2%	0.9%
2014	84.5%	9.3%	5.2%	1.0%
2015	84.4%	9.5%	5.1%	1.0%
2016	84.8%	9.3%	4.8%	1.1%
2017	84.8%	9.3%	4.8%	1.2%

Figure 2. Annual emissions of CO_2, CH_4, N_20, and Fluorinated gases[4] in gigatons of carbon dioxide equivalents (left) and relative percentages of total emissions (right) for South Africa between 2000 and 2017[5]

The energy sector emitted most of South Africa's GHGs between 2000 and 2017, ranging between 77% and 79% of total emissions (Figure 3). The remaining contributors to the country's GHG emissions are aggregated into: i) industrial process and product use (IPPU); ii) waste; and iii) agriculture (including livestock), forestry and other land use (AFOLU).

[4] Hydrofluorocarbon (HFC), Perfluorocarbon (PFC), SF_6 (Sulphur hexafluoride,) and Nitrogen trifluoride (NF_3).

[5] National Environmental Management: Air Quality Act (39/2004): Draft 7th National Greenhouse Gas Inventory Report for the Republic of South Africa for public comment. Online: https://www.environment.gov.za/sites/default/files/gazetted_notices/nemaqa_draft7greenhousegasinventoryeport_g43706gon989.pdf

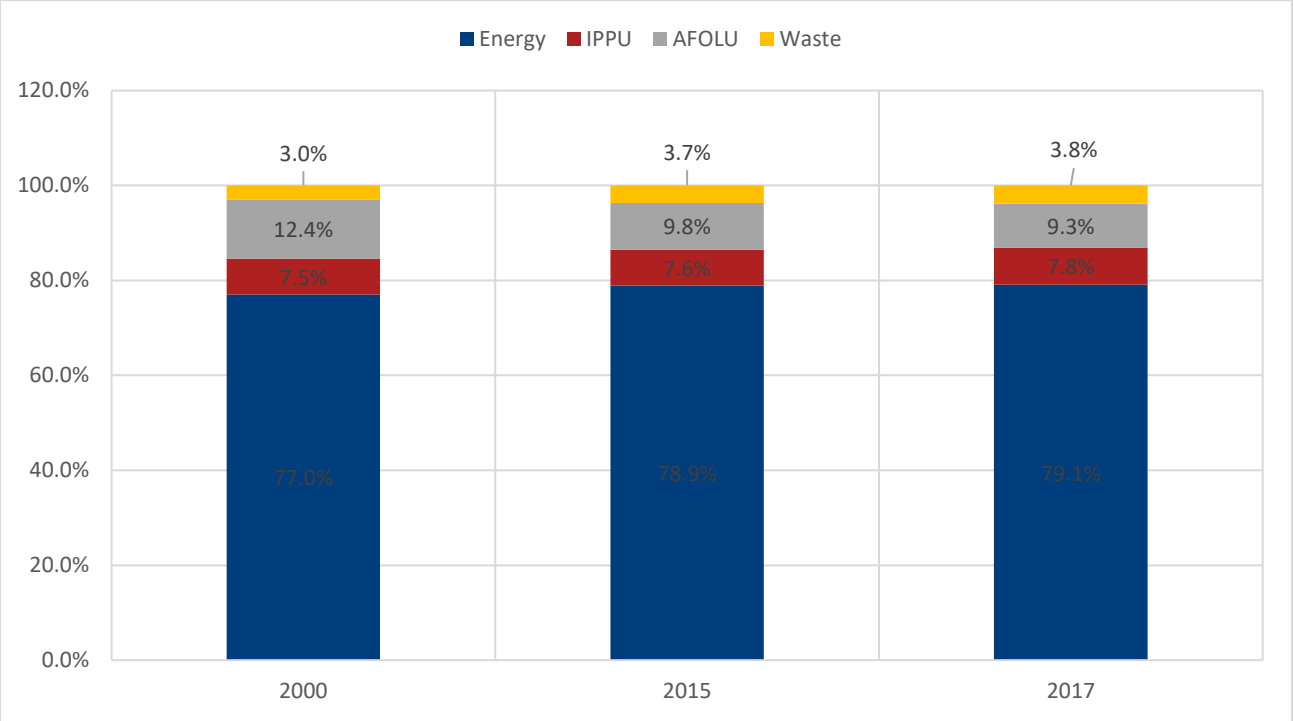


Figure 3. Percentage breakdown of gross greenhouse gas emissions in for South Africa in 2000, 2015 and 2017.

3.2. Carbon budgets

Carbon budgets measure the additional emissions that can enter the atmosphere at a global level if warming is to be restricted to pre-determined levels such as 1.5°C or 2°C[6]. Carbon budgets depend on the relationship between the total amount of $C0_2$ (or, for comparative purposes, $C0_2$ equivalents [$C0_2e$]) emitted and the resultant warming that will occur. The IPCC states with medium confidence in its Special Report on 1.5°C warming that the global carbon budget for the 1.5°C scenario is 580 Gigatons, resulting in a 50% probability of limiting warming to 1.5°C, and 420 $GtCO_2$ for a 66% probability of attaining the targeted warming limitation[7].

3.3. The national carbon budget

South Africa's nationally determined contributions (NDCs) to global emissions are detailed in the Third National Communication (TNC) to the UNFCC and have been framed under a 'peak-plateau-decline' (PPD) trajectory model (Table 5 and Figure 4).

[6] Carbon Brief. 2018. Analysis: Why the IPCC 1.5°C report expanded the carbon budget. Online: https://www.carbonbrief.org/analysis-why-the-ipcc-1-5c-report-expanded-the-carbon-budget

[7] Intergovernmental Panel on Climate Change. 2018. Global Warming of 1.5°C: an IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Online: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf

Table 5. Overview of South Africa's peak-plateau-decline emissions trajectory between 2020 and 2050[8].

Date range	Lower limit (million tons of CO_2e/annum)	Upper limit (million tons of CO_2e/annum)
2020	398	583
2025 (peak)	398	614
2025-2035 (plateau)	398	614
2036-2050 (decline)	212	428

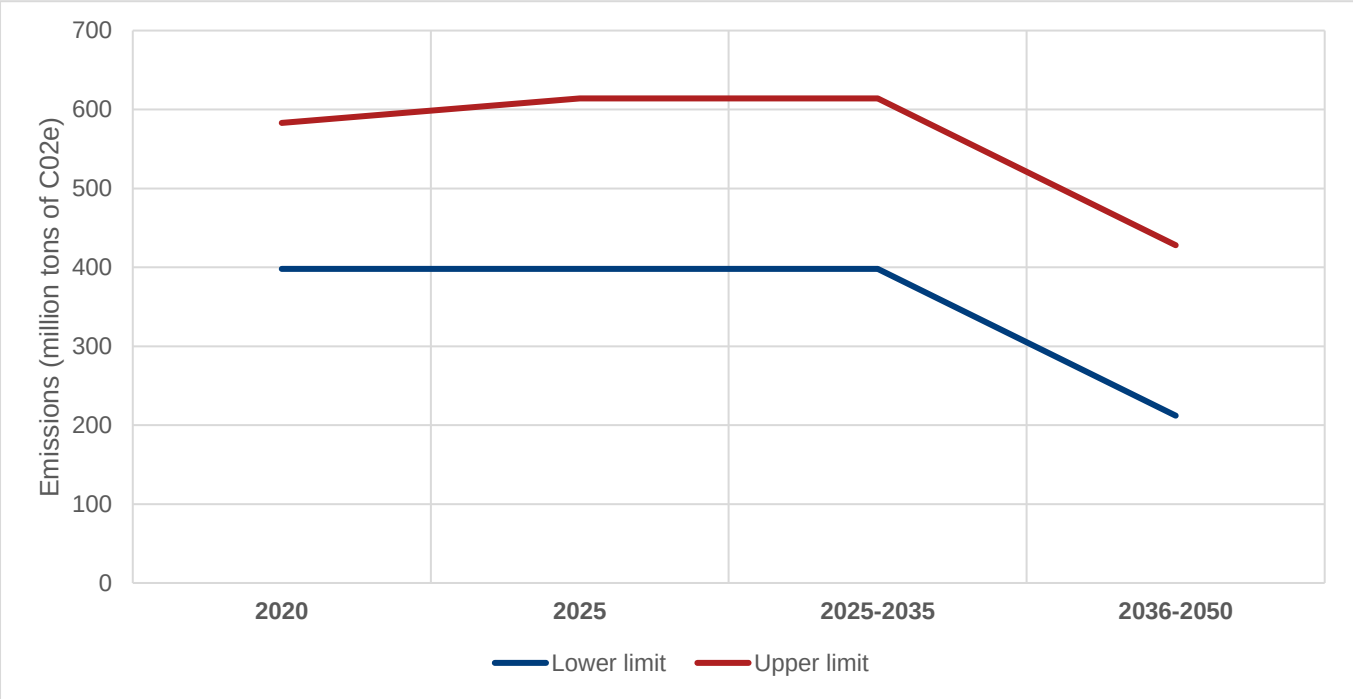


Figure 4. Lower and upper limits of South Africa's greenhouse gas emissions trajectories between 2020 and 2050[9]

3.3.1. *National carbon budget in context*

However, the abovementioned commitments under the PPD scenarios are widely considered to be inadequate to limit warming to less than 2°C. In fact, the Climate Action Tracker (CAT) — an independent scientific analysis that tracks government climate action and measures it against the globally agreed Paris Agreement aim of holding warming well below 2°C, and pursuing efforts to limit warming to 1.5°C[10] — categorises South Africa's pledges and targets for 2030 as 'Highly Insufficient' and elaborates as follows:

"*The 'Highly Insufficient' rating indicates that South Africa's climate commitment in 2030 is not consistent with holding warming to below 2°C, let alone limiting it to 1.5°C as required under the Paris Agreement, and is instead consistent with warming between 3°C and 4°C: if all countries were to follow South Africa's approach,*

[8] Adapted from Winkler, H. and Marquard, A. 2012. Methodologies for carbon budgets in South Africa. University of Cape Town Energy Research Centre. Cape Town, 35 pp.
[9] Ibid.
[10] https://climateactiontracker.org/about/

warming could reach over 3°C and up to 4°C. This means South Africa's climate commitment is not in line with any interpretation of a "fair" approach to the former 2°C goal, let alone the Paris Agreement's 1.5°C limit".

It is therefore necessary to assess project-scale emissions against a more realistic standard, as described below.

3.3.2. *Determining a reasonable national proportion of the global carbon budget*

The methodology for estimating the South African allocation of the global carbon budget used for this GHG inventory has been developed by Promethium Carbon. The methodology below is excerpted from a recent climate change impact assessment (CCIA)[11] undertaken by the abovementioned authors, who are duly acknowledged.

To make a reasonable allocation of the country's fair share to this budget[30], the global budget was calculated using a per capita basis, as indicated below. This indiscriminate allocation is due to the inherent indiscriminate nature of climate change.

Given that:

1. Population of South Africa = 59.18 *million people*[31]
2. Global population = 7.781 *billion people* = 7 781 *million people*[32]
3. Global carbon budget = 580 $GtCO_2e$ = 580 000 $MtCO_2e$

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

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

$$= 4\ 411\ MtCO_2e$$

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

A rating scale was also developed by Promethium Carbon, to determine the anticipated impact of project-scale emissions for decision-making purposes. This scale is shown below in Table 6.

[11] Promethium Carbon. 2021. Specialist Climate Change Assessment: 320MW Risk Mitigation Power Plant. Prepared for Savannah Environmental.

Table 6. Estimated South African carbon budget and the associated rating scale for comparison analysis[12]

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

4. EMISSIONS STATEMENT

Table 7 below shows the annual and lifetime emissions from the proposed activity as a percentage of the adjusted national carbon budget described in Section 3.3.2.

Table 7. Emissions for the proposed activity as a percentage of the national carbon budget

Emission category	**Annual emissions (tCO_2e / year)**	**Lifetime emissions (over 20 years, tCO_2e)**	**% of South African carbon budget – annual emissions**	**% of South African carbon budget – lifetime**
Scope 1 & 2	12 346	246 921	0.00028%	0.00560%
National carbon budget expenditure if approved				**0.00560%**

Based on the abovementioned calculations, the proposed project will exhaust approximately **0.00560%** of the adjusted national carbon budget if approved. The impact rating of the proposed activity's emissions is therefore '**Medium**'.

[12] Promethium Carbon. 2021. Specialist Climate Change Assessment: 320MW Risk Mitigation Power Plant. Prepared for Savannah Environmental.