Scoping Study for the Specialist Climate Change Assessment of the Proposed Mutsho Power Project

Produced by Promethium Carbon
for Savannah Environmental (PTY) LTD
on behalf of Eskom

July 2017

CONTENTS

DECLARATION OF INDEPENDENCE

Robbie Louw, Harmke Immink and Sam Vosper as the authors of this report, do hereby declare their independence as consultants appointed by Savannah Environmental (Pty) Ltd to undertake a scoping study for the specialist climate change assessment of the proposed Mutsho Power Project. 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 the report are their own.

Robbie Louw

Harmke Immink

Sam Vosper

DETAILS OF SPECIALIST

Promethium Carbon

Promethium Carbon is a South African climate change and carbon advisory company group based in Johannesburg. With a vision to making a difference in climate change in Africa and a focus on technical expertise, our team of climate change professionals assists businesses ranging from small enterprises to multinational entities on their journey towards a low carbon economy. We also assist governments and government institutions in planning for the coming global carbon constrained environment. Through our participation on various working groups and standards boards, we have established ourselves as knowledge leaders in the climate space and act as trusted advisors to our clients.

Promethium Carbon has been active in the climate change and carbon management space since 2004. Our client base includes many of the international mining houses and industrial companies that are operating in and from South Africa. One of our clients was awarded the European Energy Risk Deal of the Year award in 2010 for a carbon credit commercial transaction that Promethium advised the client on. Promethium Carbon also received the Star Excellence Award in recognition of its outstanding contribution to Africa's Economic Growth and Development. This award was received in Abu Dhabi during the World Future Energy Summit 2014. Promethium was furthermore awarded with the Best Project Implementer award by the British High Commission in 2015.

An accurate carbon footprint forms the basis from which an organisation can plan its journey into the low carbon economy. The rules, according to which a carbon footprint is calculated, have been developed at a fast pace over a short number of years, and have reached a level of maturity. Promethium has calculated the carbon footprints and greenhouse gas inventories for numerous companies. Through these carbon footprints and strategy documents Promethium Carbon has helped companies to understand their climate change impacts as well as the associated risks.

Robbie Louw

Robbie is the founder and director of Promethium Carbon. He has over 10 years of experience in the climate change industry. His experience over a period of 28 years covers the chemical, mining, minerals process and energy fields, in which he was involved in R&D, project, operational and management levels.

Robbie's experience in climate change includes but is not limited to:

- Carbon footprinting: He has extensive experience in carbon footprinting. The team under his leadership has performed carbon footprint calculations for major international corporations operating complex businesses in multiple jurisdictions and on multiple continents.
- Climate strategy development: He has developed carbon and climate change strategies for major international corporations.

- Climate change impact and risk assessments: He has developed climate change risk assessments for various companies and projects.
- Project development: He has extensive experience in project development in the energy, chemical and mining industries. This covers the scope from project identification, feasibility studies to project implementation. Some examples include carbon sequestration projects focussed on the restoration of impacted grasslands and mining impacted land and greenhouse gas mitigation projects in many industries including farming, mine land restoration and bio-energy production.
- Carbon trading systems: He is the lead author of numerous publications on the design of a potential carbon trading system for South Africa.

Harmke Immink

Harmke is a Director at Promethium Carbon. Her 12 years of climate change expertise is developed from environmental life cycle assessments (LCA), environmental audits and technical performance evaluation. She has a Masters degree in Environmental Measurement Techniques (Sweden), and gained experience across industry sectors through a variety of technical surveys and industry roadmaps.

Harmke's experience in climate change includes but is not limited to:

- South African representative for ISO technical committee 207 on GHG standards, including eco-labelling and carbon footprint of products;
- Technical assessor for SANAS accredited: ISO 14065 GHG validation and verification;
- Part of the World Resource Institute technical development team for the GHG Protocol standard on accounting for goals and targets;
- Climate change related services include GHG baseline evaluations, a survey for practical sustainable development indicators for Clean Development Mechanism (CDM) projects, four new or revised methodologies, twelve successful registration of CDM projects as well as three projects assisted with issuance of carbon credits;
- Standardised Baseline Calculations for Grid Emission Factors in Kenya and South Africa;
- Climate change adaptation projects for mining clients, focused on community vulnerabilities and strategically linking with social responsibility;
- Carbon Disclosure Projects (CDP) is a global initiative to collect and distribute high quality information that motivates investors, corporations and governments to take action in the attempt to mitigate climate change. Promethium Carbon CDP clients consistently are in both the top ten disclosure as well as the performance leadership index since 2007; and
- Project leader for the Private Sector Energy Efficiency audits through the NBI.

Sam Vosper

Sam holds the following degrees: Bachelor of Science (Rhodes University), Bachelor of Science (Hons) (Rhodes University), MPhil Environmental Policy (University of Cambridge). He has completed postgraduate courses in: Energy & Climate Change, Environmental Economics, Climate Change Policy, Policy Assessment & Evaluation, International Environmental Law, Ecological Modelling, Climate Change Adaptability and General Linear Models. Sam's undergraduate studies included: Environmental Science, Mathematics, Mathematical Statistics and Economics. Sam currently works as an environmental consultant specialising in services which include:

- Carbon footprints and Water footprints;
- Researching for South Africa's Third National Communication to the UNFCCC;
- Researching and drafting a measuring, reporting and verification policy for Swaziland to apply to their nationally determined contributions; and
- Energy efficiency and energy management studies.

Sam has previously executed a research project on water supply and catchment sustainability for the town of Mussoorie in the Himalayan foothills. The project involved amalgamating and mapping data on; forest composition, climate change, infrastructural upgrades and land use.

The above listed authors have all worked on previous climate change assessments for power generation projects such as coal fired power plants.

1. INTRODUCTION

Mutsho Power (Pty) proposes to develop a 600MW coal based power plant near Makhado, in the Limpopo Province. The project aims to provide new baseload electricity generation capacity for South Africa.

In accordance with the relevant regulations, an Environmental Impact Assessment process must be completed before project development can proceed. In addition to the Environmental Impact Assessment, Promethium Carbon has been appointed to undertake a Specialist Climate Change Impact Assessment of the project.

This report is a scoping report which aims to highlight the key potential climate change impacts of the project and the methodologies that can be used to assess these impacts. It will also provide a preliminary evaluation of these impacts and identify any relevant legislation or policies, no-go areas, project alternatives and mitigation actions that will be assessed in the Specialist Climate Change Impact Assessment.

2. Climate Change Impact of a Coal Fired Power Plant

A power plant's contribution to global climate change is dependent on the greenhouse gas emissions produced by the plant. Therefore, in order to assess a power plant's climate change impact the plant's prospective emissions of greenhouse gases (GHG), such as carbon dioxide (CO_2), methane (CH_4) and Nitrous Oxide (N_20), need to be determined. There are emissions associated with both the construction and operation of the power plant. However, the vast majority of the plant's lifetime emissions will be attributed to the combustion of coal during operations.

The greenhouse gas emissions from any individual source cannot be attributed, directly or indirectly, with any specific environmental impact as a consequence of climate change. The reason for this is that climate change is a global phenomenon that is brought about by the accumulation of greenhouse gases in the atmosphere from all the world's emitting sources. As such any local environmental impacts resulting from climatic changes is a consequence of the world's collective greenhouse gas emissions and not a single source.

It is therefore important to parameterise the impact of the proposed coal fired power plant in a way that the significance of its impacts can be interpreted at a local (national) scale. To do this it is necessary to assess the impact of the power plant's prospective emissions on the national greenhouse gas inventory of South Africa. The impact of the project's prospective emissions can then also be compared to project alternatives and mitigation options.

The power plant may still be exposed to negative climate change impacts even though they may not be directly attributed to the power plant's greenhouse gas emissions. Negative climate change impacts could include droughts or heatwaves. To gain a thorough

understanding of the climate change risks faced by the power plant, a climate change risk and vulnerability assessment will be conducted. The assessment considers risks within the core operations of the power plant, the power plant's value chain as well as the broader environment. The broader environment includes local communities surrounding the power plant.

Based on the above description the broad terms of reference and scope of work for the Specialist Climate Change Impact Assessment will include the following:

1) Calculating the construction and operational greenhouse gas emissions of the project.
2) Calculating the construction and operational greenhouse gas emissions of the project alternatives.
3) Reviewing the greenhouse gas emissions mitigation options for the project.
4) Conducting an impact assessment of the project, its alternatives and mitigation options by:
    - Considering its contribution to the national emissions inventory and the onset of global anthropogenic climate change;
    - Comparing it against the current national grid baseline with consideration of impacts on the future baseline; and
    - Exploring the potential climate change impacts and risks faced by the Makhado area.
5) Assessing requirements for greenhouse gas emission management activities for the plant's operations.

3. RELEVANT LEGISLATION AND POLICIES

South Africa has articulated its climate change mitigation commitments in the National Climate Change Response White Paper (2011), the National Development Plan (2011) and its Intended Nationally Determined Contribution to the UNFCCC (2015). This commitment is in the form of a greenhouse gas emissions trajectory known as the peak, plateau and decline trajectory. This trajectory gives a national greenhouse gas emissions range which South Africa intends to remain below. It will be important to consider the policies and legislation related this trajectory in the Specialist Climate Change Impact Assessment.

The peak plateau and decline trajectory is used in a number of other national planning processes, such as energy planning. The emissions trajectory is used to inform emissions constraints in the national energy modelling conducted within the Integrated Resource Plan (IRP) and Integrated Energy Plan (IEP). Both of these policy documents have had updated drafts released in 2017. The build programmes such as the Coal Based Independent Power Producers Programme have been modelled within the emissions constraints of the IRP and IEP. Therefore, these planning and policy documents will also provide context for the Specialist Climate Change Impact Assessment.

Other relevant national government documents include the National Greenhouse Gas Inventory published by the Department of Environmental Affairs in 2012 and the Long-Term Adaptation Scenarios Flagship Research Programme published in 2013. The adaptation scenarios include nationwide climate modelling scenarios which can help to inform potential localised impacts of climate change.

4. METHODOLOGY

4.1 Estimating Greenhouse Gas Emissions

The estimation of the prospective greenhouse gas emissions for the proposed power plant can be calculated through a carbon footprint. The carbon footprint approach to be undertaken in the Specialist Climate Change Impact Assessment will be guided by the ISO/SANS 14064-1 standard. This standard specifies principles and requirements at the organisation level for the quantification and reporting of historical figures of greenhouse gas emissions and removals.

Following the ISO/SANS 14064-1, the carbon footprint of the proposed power plant's emissions will be developed through the following process:

- Setting the boundaries of analysis;
- Identifying the greenhouse gas sources inside the boundary;
- Establishing the quantification method that will be applied;
- Selecting or developing greenhouse emission and removal factors; and
- Calculating the greenhouse gas emissions.

The Greenhouse Gas Protocol's Corporate Accounting and Reporting Standard will also be used in addition to the ISO/SANS 14064-1 standard as a guide in the calculation of the carbon footprint. Further details of the boundaries and emissions factors are presented in the subsequent sections of the report.

4.1.1 Emission Factors

It is important that the emission factors used in carbon footprint calculations are appropriate for the local context and relevant to the technology being assessed. Local emission factors, such as the grid emission factor, will be sourced from the reports of local entities such as Eskom as it is the main electricity generator of the country. Other recognised emission factors will also be sourced from South Africa's Draft Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emission by Industry which is based on the 2006 Intergovernmental Panel on Climate Change's Guidelines.

These emissions factors are presented in tonnes of carbon dioxide equivalent (tonne CO_2e) and considers the global warming potential of all emitted greenhouse gasses including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

4.1.2 Assumptions and Limitations

The carbon footprint calculation will be developed based on the assumptions of the possible modes of operation for the power plant as set out in the project design documents. The climate impact evaluation of the specialist study will only be limited by the extent to which a representative carbon footprint can be calculated for the proposed Mutsho Power Plant. This will rely on collecting comprehensive project design information.

4.2 Quantifying Impact of Greenhouse Gas Emissions

The EIA reporting requirements set out the criteria, to describe and assess the environmental impact are listed below. These criteria that will be used to assess the climate change impacts associated with the greenhouse gas emissions from the proposed power plant, and its alternatives and mitigation options, in terms of their contribution to the national greenhouse gas inventory.

Nature: a description of what causes the effect, what will be affected and how it will be affected.
Extent: an indication of whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high). The extent of the impacts of climatic changes.
Duration: an indication of the lifetime of the impact quantified on a scale from 1-5. Impacts with durations that are; very short (0–1 years) are assigned a score of 1, short (2-5 years) are assigned a score of 2, medium-term (5–15 years) are assigned a score of 3, long term (> 15 years) are assigned a score of 4 or permanent are assigned a score of 5. The duration that the project emissions will remain in the atmosphere.
Magnitude: an indication of the consequences of the effect quantified on a scale from 0-10. A score of 0 implies the impact is small, 2 is minor, 4 is low and will cause a slight impact, 6 is moderate, 8 is high with sizable changes, and 10 is very high resulting drastic changes. The quantity of emissions in terms of the national greenhouse gas inventory.
Probability: an indication of the likelihood of the impact actually occurring estimated on a scale of 1–5. A score of 1 implies that the impact is very improbable, 2 is improbable, 3 is probable, 4 is highly probable and 5 is definite with the impact occurring regardless of any prevention measures. The probability that greenhouse gas emissions will contribute to climate change.
Significance: a weighting based on a synthesis of the characteristics described above and can be assessed as low (< 30 points), medium (30-60 points) or high (> 60 points). The significance points are calculated as: $S = (E + D + M) \times P$.

The status of the impact will be described as; positive, negative or neutral. Additional details will also be provided on the degree to which the impact can be reversed and the degree to which the impact may cause irreplaceable loss of resources.

5. TECHNOLOGICAL PROJECT ALTERNATIVES

The technological project alternatives to be assessed in the Specialist Climate Change Impact Assessment will be determined from the bid requirements for the Coal Baseload Independent Power Producer Procurement Programme. However, there are broadly two technologies for providing coal base load power. These are pulverised coal technologies and circulating fluidised bed technologies. These technologies can be subcritical, supercritical or ultra-supercritical depending on their energy efficiencies. The alternatives that are technically and economically available to the project developer will be assessed in the Specialist Climate Change Impact Assessment. These technologies will be assessed for both wet and dry cooling options.

6. MITIGATION OPTIONS

The mitigation options that will be assessed may not have been listed within the project design documents. However, they will be mitigation options that could be considered for future inclusion within the generation facility. These options may include co-firing the coal with sustainably harvested biomass, substituting thermal energy requirements with energy from a concentrated solar power plant and developing carbon capture and storage capacity. The technological information related to these option will be drawn from the updated documents related to the Integrated Resource Plan (2017).

6 PRELIMINARY PROJECT IMPACT EVALUATION

Based on the projected emissions intensities of new build coal based power plants an initial estimate of the annual operational emissions of the proposed Mutsho Power Project can be presented at this stage (Table 1).

Table 1: Summary of the estimated greenhouse gas emissions associated with the proposed Mutsho Power Project

Variable	Value	Unit
Plant Capacity	600	MW
Emissions per unity electricity	0.94	tCO_2e/MWh
Annual emissions	~4 600 000	tCO_2e/year

Based on the greenhouse gas emissions estimates presented in Table 1 a preliminary climate change impact evaluation can be conducted. The outcomes of this evaluation are summarised in Table 2. The information in Table 2 describes the nature and significance of the potential impact of the greenhouse gas emissions from the proposed Mutsho Power Plant.

Table 2: Summary of the preliminary climate change impact evaluation of the proposed Mutsho Power Plant

Impact:
The combustion of coal at the proposed power plant will produce greenhouse gas emissions which will contribute to the global phenomenon of anthropogenic climate change. Climate change is projected to effect many environmental changes across the globe. However, none of the environmental impacts can be linked directly or indirectly on any particular sources of greenhouse gas emissions. The proposed power plant will however contribute substantially to South Africa's national greenhouse gas inventory.

Desktop sensitivity of the site:
The greenhouse gas emissions produced by the power plant will diffuse in the atmosphere and contribute to the increased levels of atmospheric greenhouse gases which contribute global climate change. The plant's impact is directly related to its emissions performance and not its location. As such, there are no project sites which are especially sensitive to the climate change impact of the proposed power plant.

Issue	Nature of Impact	Extent of Impact	No-Go Areas
Accumulation of greenhouse gases in the atmosphere.	On account of the properties of atmospheric greenhouse gases the nature of this impact is long term and definite.	The impact extends nationally in terms of the greenhouse gas inventory and globally in terms of climatic changes.	As the power plant's climate change impact is not related to its location there are no identified "No-go areas" for the development.

Description of expected significance of impact
Based on the national extent, long term duration, definite probability and large magnitude of the greenhouse gas emissions, the expected significance of the climate change impact is likely to be moderate to high. As greenhouse gases are assumed to remain in the atmosphere for such long durations the impact is effectively irreversible with the effects of climate change often resulting in the irreversible loss of resources.

In terms of the national inventory, there will be cumulative climate change impacts when considering the emissions from the project with the emissions from other fossil fuel power plants and other sources. Similarly the onset of climate change is induced by greenhouse gas emissions accumulated in the atmosphere from all sources over time.

The onset of climate change is likely to be accelerated and sustained as emissions accumulate in the atmosphere. The project can only mitigate its contribution to national emissions and climate change by reducing its greenhouse gas emissions. This would involve substituting towards combusting sustainable biofuels or utilising carbon capture and storage technologies. Even if the proposed project is able to reduce its greenhouse emissions and mitigate its contribution to global climate change the risks associated with the onset of climate change will still be prevalent. This is due the vast number of other sources of greenhouse gas emissions around the world.
Gaps in knowledge and recommendations for further study Current knowledge gaps include information around the specific operations of the proposed power plant which will assist in guiding operational emissions management recommendations. Further study of the specific modes of operational and infrastructural set up of the proposed power will also be necessary to inform aspects to be included within an environmental management plan.

While the greenhouse gas emissions from the proposed power plant alone are not likely to significantly impact global climate change it is important that each actor takes on an individual responsibility through minimising its own emissions contributions. This is relevant to the proposed power plant as its operations may be affected by local environmental changes as a consequence of climate change even if they are not as a direct consequence of the power plant.

For the proposed area of operation for the power plant, the Long-Term Adaptation Scenarios predict a general pattern of drying with large rainfall reductions for the Limpopo province in the near future. Strong trends of drying is projected for Limpopo, for the spring, summer and autumn months, with the extent projected to increase over time. Temperatures across the Limpopo province are predicted to increase drastically, reaching a regime never observed before in the recorded climate of the region.

An increase in temperatures and drying could lead to more severe droughts which would negatively impact on the power plant's core operations, value chain and broader network. A lack of water due to drought may cause the power plant to be shut down. Local communities surrounding the power plant will be especially impacted by drought conditions and may have a negative perception regarding the power plant's water consumption.

While not possible at this stage, the Specialist Climate Change Impact Assessment will attempt to determine whether the identified are project alternatives and mitigation options will have a lesser or greater climate change impact than the project case. This will primarily be determined by the operational efficiencies and emissions associated with the fuels used in the alternatives and mitigation options.

7 REQUIRED INFORMATION

In order to complete the Specialist Climate Change Impact Assessment the following information about the proposed Mutsho Power Plant will be required:

- Project design documents;
- Energy consumption figures;
- Fuel properties;
- Water consumption figures; and
- Operational efficiencies.

REFERENCES

Department of Environmental Affairs. Long Term Adaptation Scenarios Flagship Research Programme [Online]. Available at: http://www.sanbi.org/sites/default/files/documents/documents/ltassummary-policy-makers2013high-res.pdf (Accessed: 11/01/2017).

Department of Energy. 2016. Integrated Resource Plan Update [Online]. Available at: http://www.energy.gov.za/IRP/2016/Draft-IRP-2016-Assumptions-Base-Case-and-Observations-Revision1.pdf (Accessed: 12/01/2017).

Department of Environmental Affairs. 2015. Draft Technical Guidelines for Monitoring Reporting and Verification of Greenhouse Gas Emissions by Industry [Online]. Available at: https://www.environment.gov.za/sites/default/files/legislations/technicalguidelines_monitoringreportingandverification_ghg.pdf (Accessed: 04/01/2017).

Department of Environmental Affairs. 2015. South Africa's Intended Nationally Determined Contribution (INDC) [Online]. Available at: https://www.environment.gov.za/sites/default/files/docs/sanational_determinedcontribution.pdf (Accessed: 10/01/2017).

DEFRA. 2016. Greenhouse gas reporting - Conversion factors 2016 [Online]. Available at: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2016 (Accessed: 04/01/2017).

EPRI. 2016. Power Generation Technology Data for Integrated Resource Plan of South Africa [Online]. Available at: http://www.energy.gov.za/IRP/2016/IRP-AnnexureA-EPRI-Report-Power-Generation-Technology-Data-for-IRP-of-SA.pdf (Accessed: 09/01/2017).

Eskom. 2016. Eskom Integrated Annual Report [Online]. Available at: http://www.eskom.co.za/IR2016/Documents/Eskom_integrated_report_2016.pdf (Accessed 13/01/2017).

IPCC. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 Energy [Online]. Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf (Accessed: 04/01/2017).

Standards South Africa. 2006. *SANS 14064-1:2006 Greenhouse Gases Part 1: Specification with guidance at the organisational level for the quantification and reporting of greenhouse gas emissions and removals*. Pretoria: Standards South Africa.