Appendix 6.2 Greenhouse Gas Emissions Assessment

Purpose of this Appendix

The purpose of this appendix is to define and estimate, as accurately as possible, the anticipated Greenhouse Gas Emissions (GHG) associated with the proposed Nyumba Ya Akiba cement project in the Democratic Republic of Congo.

Approach to Assessment

The approach to the assessment is informed by a number of key documents including:

- "CO_2 and Energy Accounting and Reporting Standard for the Cement Industry" May 2011 Version 3.0 (Cement Sustainability Initiative, World Business Council for Sustainable Development).
- ISO 14064-1-06 Standard, Greenhouse Gases – Part 1: Specification with Guidance at the Organizational Level for Quantification and Reporting of Greenhouse Gas Emissions and Reporting.
- WRI/WBCSD 2004. The Greenhouse Gas Protocol. A Corporate and Reporting Standard. Revised Edition.

The steps followed are as follows:

- Definition of the boundary of the assessment;
- Identification of all sources of GHG emissions;
- Calculation of the GHG emissions (this includes an assessment of the limitations with regard to the data available); and,
- A final section is used to define possible mitigation measures and approaches to reduce the GHG emissions associated with the project.

Boundary for Assessment

The approach to defining the boundary is an "Operational Approach". This is the most appropriate for an analysis such as this, as it is defined as a company's full authority to introduce and implement its operating policies at an operation. Taking this approach then the assessment boundary includes two operational elements (and their associated infrastructure):

- The quarrying operation; and,
- The cement plant.

Identification of Emission Sources

Two types of emissions sources are identified below. These are:

- **Direct** (referred to as **Scope 1** in terms of the revised WRI/WBCSD Protocol) – these are emissions from sources that are owned or controlled by the reporting company. In the case of a cement plant the carbon dioxide ($CO_{2)}$ emissions from the use of coal as fuel in the kiln would be direct emissions as the company controls the kiln.

- **Indirect (**referred to as **Scope 2** in terms of the revised WRI/WBCSD Protocol) – these are emissions that are a result of the company's activities but happen under another entity's ownership and\or control. In the case of this project an example would be the emissions associated with the use of grid electricity that is generated elsewhere.

The direct and indirect GHG emission sources for both the quarrying and cement plant are detailed below.

Quarrying Operation

	Source	Description
Direct Emissions (Scope 1)	**CO_2 from Diesel Use**	This includes diesel to be used by vehicles in the quarry itself, as well as the transport of mined material to the cement plant. Diesel will also be used in pumping for dewatering purposes at the quarry. Assumed that no petrol is used at the quarry.
	N_2O Emissions from the Use of Explosives	The quarry will be using explosives for blasting and therefore there will be GHG emissions in the form of nitrous oxide (N_2O).
Indirect Emissions (Scope 2)	**Not applicable**	No indirect emissions are anticipated to occur as a result of the quarrying operation. The feasibility study report indicates that no electricity is to be used at the site because it will only operate in daylight hours – if this were to change this would add a potential indirect emission source as a result of the use of grid electricity (depending on the grid emission factor to be used – please see below for a discussion of this).

Cement Plant

	Source	Description
Direct Emissions (Scope 1)	**CO_2 from Raw Material Calcination**	Calcination is the release of carbon dioxide from carbonates during the pyro-processing of raw meal and is directly linked to clinker production.
	CO_2 from Cement Kiln Dust (CKD) Calcination	As a result of calcination – this is assumed to be zero as the facility will use a dry process kiln and in this process CKD is usually not or only to a negligible degree calcined. This will therefore be ignored in the calculation section below.
	CO_2 from Bypass Dust	As a result of calcination.
	CO_2 from Organic Carbon in Raw Materials	In addition to inorganic carbonates, the raw materials used for clinker production usually contain a small fraction of organic carbon which is mostly converted to CO_2 during the pyro-processing of raw meal.
	CO_2 from Use of Coal in Clinker Production	Coal used in the process will be a major source of CO_2 as a result of its combustion.
	CO_2 from Use of Fossil-Fuel based Liquid Fuels on Site.	Heavy Fuel Oil (HFO) will be used on site - for example for kiln start-up. Diesel is likely to be used for site vehicles and emergency generator use.
Indirect Emissions (Scope 2)	**CO_2 Emissions from the Use of Grid Electricity**	Depending on what grid emission factor is used, there may be GHG emissions associated with the use of electricity on site.

GHG Emissions Estimations

Using the sources identified above as a basis, the anticipated annual emissions associated with the operation are calculated below. There are a number of key assumptions and uncertainties as a result of the lack of data availability – these have all been detailed below.

Estimated Emissions Associated with the Quarrying Operations

No estimation for the emissions associated can be made as there is no data available for the use of diesel and explosives at the quarrying operation. In the implementation of the inventory associated with the operation's GHG Emissions Management Plan (see Annex 14) this will need to be a focus area. Emission factors for the various materials identified should be sourced from the suppliers to move the inventory away from the use of default factors as much as possible. To improve quality of the inventory it should move to as many plant-specific factors as possible – the fact that the project will have an analytical laboratory on site will assist in this.

In terms of the grid emission factor for the Democratic Republic of Congo there is no formal Government or SNEL approved figure, and the variation within the literature is quite significant i.e.

- In Ecometrica's paper "Electricity Specific Emission Factors for Grid Electricity" (2011), based on IEA data, it is reported that the factor is 0.004kg CO_2/kWh. This is a figure that appears to be consistent with a generation sector that is dominated by hydro sources, with extremely limited thermal generation capacity;
- In their study of 2012, the UNEP supported "African Carbon Asset Development (ACAD) Facility" reports that the DRC grid has a zero emission factor. This as part of ACAD's work towards defining a regional grid emission factor for the Southern African Power Pool (SAPP) of which the Democratic Republic of Congo is a member; and,
- The CDM's Executive Board recently approved a "Standardized Baseline – Grid Emission Factor for the Southern African Power Pool" (Version 01.0, 31st May 2013). This baseline reflects the fact that the SAPP, which SNEL participates in, is a system and so it should be considered as such when looking at its emissions, rather than on a country by country separate grid basis. The Executive Board process also reflects the most rigorous (including extensive peer review) analysis of this issue and though primarily designed for use with regard to proposed CDM projects in the region it is a useful indicator. However its operating margin CO_2 factor of 0.9958 kgCO_2 per kWh is not one that feels intuitively correct for corporate level reporting in the DRC – or would likely be accepted by stakeholders.

As the International Institute for Sustainable Development (IISD) indicate in their report "Democratic Republic of Congo: Greenhouse Gas Emissions Baseline Projection" (Seton Steibert, March 2013), the development of a reference case for DRC's electricity sector is challenging because there is considerable uncertainty with regard to the amount of fossil fuels consumed by the sector.

For the purposes of this assessment it has been decided to use the Ecometrica figure, as this reflects an analysis that reflects the large hydro component as well as the small thermal component. The ACAD and EB figures in this sense reflects extremes of approach which will not assist the cement project to correctly prioritize what emission sources it should focus on in its GHG Management programme. It also reflects the practical situation that the Nyumba Ya Akiba project will be supplied from a transmission line directly connected to the Inga Hydropower facility.

It is however recommended that the company, when starting the process of building their inventory, approach the DRC Government on this issue, as a commonly accepted figure for use by all corporate entities in the DRC is required for accurate GHG reporting.

Estimated Emissions Associated with the Cement Plant

	Source	Data Availability, Assumptions and Default Factors Used	Calculation Method (to report in GHG Emissions in tCO_2e per year)	Estimated Value (tCO_2 per year)
Direct Emissions (Scope 1)	**D.1 CO_2 from Raw Material Calcination**	Assume clinker production is 3000 tonnes per day and the plant operates for 330 days per year. Total annual production is therefore 990 000 tonnes. Cement Sustainability Initiative Default Emission Factor is 525 $kgCO_2$/tonne of clinker (0.525 tCO_2/tonne of clinker)	(total annual production of clinker) x (default emission factor) (990 000) x (0.525)	**519 750**
	D.2 CO_2 from Cement Kiln Dust (CKD) Calcination	As per discussion in section above assumed to be zero for dry kiln system.	Not applicable.	**Not applicable**
	D.3 CO_2 from Bypass Dust	In the absence of plant-specific data on dust volumes, the IPCC default for CO_2 from discarded dust (2% of clinker CO_2) shall be used.	(Clinker CO_2 Emissions - see D.1 above) x (0.02) (519 750) x (0.02)	**10395**
	D.4 CO_2 from Organic Carbon in Raw Materials	Assume approximately 10 $kgCO_2$ per tonne of clinker as per CSI data. This is equivalent to 0.01tCO_2/tonne of clinker.	(total annual production of clinker) x (default emission factor) (990 000) x (0.01)	**9900**
	D.5 CO_2 from Use of Coal in Clinker Production	From feasibility study - 336 tonnes per day used in pre-heater/pre-calciner and 240 tonnes of coal used per day in kiln. Total coal per day used is 576 tonnes. Annual use (assume 330 days) is 190 080 tonnes per coal. Assume 2.139 tCO_2 per tonne of coal used (Source Department of Environment, Food and Rural Affairs, DEFRA, UK Government)	(total annual use of coal) x (default emission factor) (190 080) x (2.139)	**406 581**

	Source	Data Availability, Assumptions and Default Factors Used	Calculation Method (to report in GHG Emissions in tCO_2e per year)	Estimated Value (tCO_2 per year)
	D.6 CO_2 from Use of Fossil-Fuel based Liquid Fuels on Site.	No data available.	Not applicable	**Not applicable**
Indirect Emissions (Scope 2)	**ID.1 CO_2 Emissions from the Use of Grid Electricity**	Anticipated grid electricity consumption is based on the following data from the feasibility study: Clinker Production (57 kWh/t of clinker); Packing/Despatch (1.5 kWh/t for CEM I and CEM II); Miscellaneous Services (1.5 kWh/t cement); Cement Production Plant (86 kWh/t CEM I and 78 kWh/t CEM II). Annual Production of CEM I : 295 350 tonnes Annual Production of CEM II: 886 050 tonnes Total cement Production: 1 181 400tonnes Annual Production of Clinker: 990 000 tonnes Therefore total anticipated annual grid electricity consumption is: 154 486 200 kWh.	(total anticipated annual consumption of grid electricity in kWh) x (grid emission factor in tCO_2e/kWh) / 1000 (to convert to tonnes) See discussion below re grid emission factor. (154 486 200) x (0.004)/1000	**618**
			Total	**947 244**

Analysis of Results

From the analysis of the results it can be seen that the proposed cement plant will be a significant emitter of greenhouse gases - approximately 950 000 tonnes of CO_2e per year. This clearly indicates the importance of having an effective GHG Management System in place that will clarify the uncertainties and data gaps identified in this analysis, but also the need to focus on measures to reduce these impacts. The lack of data for fossil-fuel based liquid fuels (including diesel and HFO) should not distract from the importance of these as GHG sources – as reflected in the experience and formal reporting of other mining operations in region and internationally. The uncertainties and data gaps highlighted in this analysis need to be addressed in order for the project's management team to correctly focus their resources with regard to this issue.

The two key sources identified from this analysis are CO_2 from calcination and coal use – currently then these should be prioritized. In the next section measures to reduce all the emissions are proposed for consideration in the proposed GHG Management Plan as discussed in Appendix 14.

Proposed GHG Mitigation Measures

The cement industry produces approximately 5% of current global man-made CO_2 emissions *Cement technology Roadmap, WBCSD/IEA, 2009). This is a result of the inherent nature of the process, as well as the associated use of fossil fuels. There a number of mitigation options available for consideration by the project which are detailed below:

- **Developing an Effective GHG Management Plan and System –** just the process of developing a plan and the associated reporting leads to reduced emissions, as a result of management focus and the identification of "quick wins".
- **Energy Efficiency Improvements –** these opportunities exist throughout the process (for example the use of variable speed drives or the use of more fuel efficient vehicles).
- **Raw Material Substitution –** this can involve the use of decarbonated feedstocks such steel slag or flyash, to reduce the amount of raw material needed to produce a given amount of clinker. This would require the identification of such sources close enough to the plant site as to be feasible.
- **Use of Mineral Components to Substitute Clinker** – these are termed blended cements and contain supplementary cementitious materials that replace a portion of the clinker used to make Portland cement.
- **Use of Alternative Fuels –** these can be waste materials (such as solvents, tyres) or renewable sources (such as biomass) that can substitute coal in the process, or diesel for example in the base of biofuels. The benefit of potentially large users of such alternative fuels like the cement project is that long-term markets supplying these can be developed in the vicinity of the project.
- **Carbon Capture and Storage** – this is an emerging technology, especially when considering it in terms of geological storage. However an alternative view is to consider supplying the CO_2 to those industries that use it as a raw material e.g. industrial scale flower growing and carbonated drink production.

The measures above reflect direct interventions in the process. The cement project could also reduce its greenhouse gas footprint in supporting projects that offset its emissions e.g. through installing solar water heaters on houses which currently use fossil-fuel sources for heating and\or the replacement of diesel gensets with solar photovoltaic installations. Another significant opportunity in this regard is the potential support for reforestation projects (an opportunity identified in the original Ectech ESIA). All of those provide opportunities to link the company's social development programmes to assisting it in managing its carbon footprint, as well as supporting the DRC in one of its environmental management policy priorities.

Those these are potential options, they will only materialize practically through their formal analysis as part of the GHG Management Plan (as detailed in Appendix 14) in terms of their technical and financial viability.