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PREFEASIBILITY STUDY FOR BIOMASS POWER PLANT, NAMIBIA



PRELIMINARY CARBON FUNDING ANALYSIS

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Prepared by	Helen Hulett	Helen Hulett		
Signature				
Checked by	Elan Theeboom	Elan Theeboom		
Signature				
Authorised by	Elan Theeboom	Elan Theeboom		
Signature				
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Client

Nampower
15 Luther Street,
Windhoek
Namibia

Consultant

Helen Hulett
Block A, 1 on Langford
Langford Road, Westville
Durban
3629
South Africa

Tel: +27 31 240 8820
Fax: +27 33 347 5391

www.wspgroup.co.za

Registered Address

WSP Group Africa (Pty) Ltd
1999/008928/07
WSP House, Bryanston Place, 199 Bryanston Drive,
Bryanston, 2191, South Africa

WSP Contacts

Elan Theeboom
Tel: +27 21 481 8646
Elen.Theeboom@wspgroup.co.za

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1 Introduction

The national power utility of Namibia, NamPower, has contracted WSP Environment & Energy (WSP) to undertake a Prefeasibility Study investigating the use of encroacher bush as a biomass feedstock to generate electricity. The study focusses on the economic, environmental and technical aspects of the supply chain, from harvesting of the encroacher bush through to electricity generation and distribution. A number of seemingly viable bush-to-energy supply chain scenarios have been proposed by the project team. These scenarios are summarised in Table 1. For more details regarding the proposed scenarios refer to the Encroacher Bush to Power (EBtP) Technical Report.

Table 1: Proposed supply chain scenario options

No.	Area	Partnership	Harvesting Method	Fuel	Technology	Capacity
1	Otjiwarongo	CCF	Skid Steer & Manual Chipping	Wood Chips	Grate Boiler & ST	5 MW
2a	Ohorongo Cement	EFF	Cutter Chipper	Wood Chips	Grate Boiler & ST	2 x 10 MW
2b	Ohorongo Cement	EFF	Cutter Chipper	Wood Chips	BFB & ST	2 x 10 MW
2c	Otjikoto Substation	-	Cutter Chipper	Wood Chips	Grate Boiler & ST	2 x 10 MW
2d	Otjikoto Substation	-	Cutter Chipper	Wood Chips	BFB & ST	2 x 10 MW

CCF- Cheetah Conservation Fund; EFF – Energy for Future; BFB – Bubbling Fluidised Bed; ST – Steam Turbine

Included within the terms of reference of the Prefeasibility Study is the investigation of carbon financing options related to the renewable energy project as well as the estimation of greenhouse gas (GHG) emissions associated with the baseline and project activities. This report summarises the findings related to these specific deliverables.

2 Carbon Finance

Carbon offsetting is an increasingly popular means of achieving regulatory or voluntary GHG emission reduction. By paying someone else to reduce GHG emissions elsewhere, the purchaser of a carbon offset aims to compensate for, or “offset”, their own emissions. The need to offset emissions can either be driven by regulatory requirements, such as those imposed by cap-and-trade schemes, or by voluntary requirements, motivated by corporate and national target setting. Mechanisms to facilitate carbon offsetting have been developed to service both the regulatory and voluntary emission markets.

The generation of renewable energy from the proposed EBtP Plant will afford NamPower the opportunity to apply for carbon credits to be traded on either the regulatory or voluntary carbon markets. The process to apply for carbon credits is determined by the market being targeted and the corresponding mechanism standard. For the regulatory market the Clean Development Mechanism (CDM) provides a well-developed standard, whereas the voluntary market comprises a number of standards, in varying stages of maturity. Independent on the market or standard chosen the typical process for applying for carbon credits is illustrated in Figure 1.



Figure 1: Typical carbon offsetting process

2.1 Regulatory Market

The CDM, created by the Kyoto Protocol, was envisioned as a mechanism that would link the carbon market and sustainable development objectives in developing countries. Through the CDM, countries with GHG reduction targets under the Kyoto Protocol can generate emissions credits from emissions offset projects in developing countries, provided that those projects also contribute to sustainable development priorities in their host countries.

Legally binding GHG commitments were due to conclude with the expiration of the Kyoto Protocol at the end of 2012; however a decision was taken during COP17 to extend the second commitment of the Kyoto Protocol. It was also agreed that the CDM will continue post-2012 however; the future structure of the mechanism is unclear.

2.1.1 Additionality

Fundamental to both the regulatory and the voluntary carbon markets is the topic of additionality, which requires that emissions reductions must be 'additional' to those that would have otherwise occurred under a business-as-usual scenario. Lax additionality requirements could result in a project receiving carbon financing without reducing GHG emissions into the atmosphere.

A project is deemed additional if the project developers can document that realistic alternative scenarios to the proposed project would be more economically attractive or that the project faces barriers that CDM helps it overcome. There are four primary steps outlined by the UNFCCC in establishing the additionality of a project:

- **Step 1:** Identifying realistic and credible alternatives to the proposed project activity that are compliant with current laws and regulations.
- **Step 2:** Investment analysis to determine that the proposed project activity is not the most economically or financially attractive.
- **Step 3:** Analysis of barriers that prevent the implementation of the proposed project activity or do not prevent the implementation of one of the other alternatives.
- **Step 4:** Analysis as to whether the proposed project activity is 'commonly practiced' by assessing the extent of diffusion of the proposed project activity.

A commercial assessment of the proposed EBtP scenarios was undertaken as part of the Prefeasibility Study. This assessment concluded that the most economically unfeasible scenario, and therefore the most eligible in terms of additionality, is Scenario 1, the operation of a 5MW Grate Boiler in cooperation with the Cheetah Conservation Fund. This scenario displayed a negative net present value (NPV) and earnings before interest and tax (EBIT) (Figure 2) as well as a negative return on assets and return of equity¹. For more details pertaining to the assessment refer to the EBtP Commercial Assessment Report.

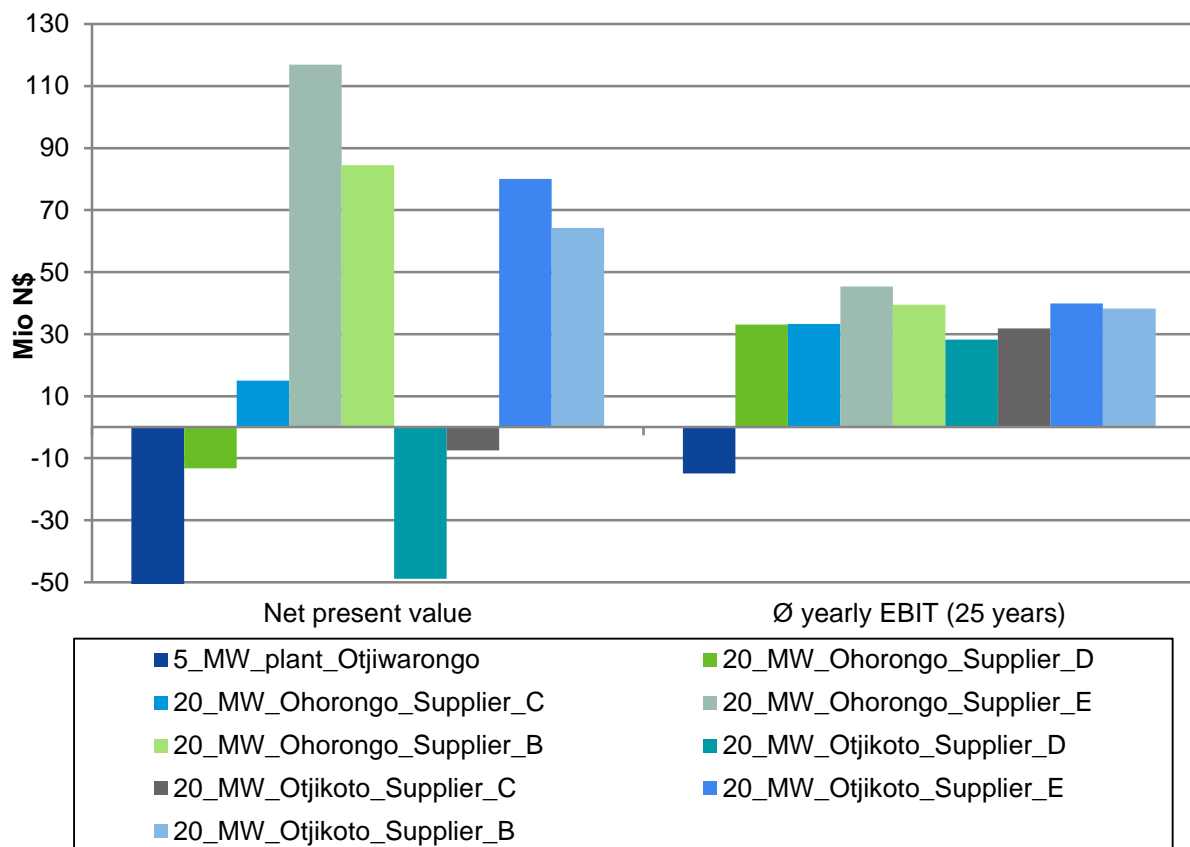


Figure 2: NPV and average EBIT after 25 years for a 5 MW plant at Otjiwarongo and 20 MW power plants at Ohorongo and Ojikoto (NamPower investor scenario)

¹ The financial calculations for the 5MW plant were based solely on European quotes and results may differ if more financially appealing quotes are identified during the tendering process.

The other scenarios may also be able to meet the additionality criteria based on the substantial investment barriers faced and the fact that the project is “the first of its kind” in Namibia. However the decision regarding additionality may vary depending on the interpretation of the DOE undertaking the audit and depending on the specific carbon standard being applied. Based on WSP’s experience, for example, it is considered not improbable that all scenarios would meet the additionality requirements for the VCS standard.

The EBtP Commercial Assessment provides a high level indication of the additionality of each EBtP scenario, however a more thorough additionality assessment will need to be undertaken if carbon funding is sought.

2.1.2 Methodologies

The UNFCCC have approved a number of sector-specific methodologies to facilitate project developers when applying for carbon credits. WSP undertook a high level review of UNFCCC approved methodologies potentially applicable to each of the EBtP supply chain scenarios (Table 2).

Table 2: Review of baseline methodologies

UNFCCC Approved Methodologies		
Code	Large Scale Methodologies (> 15 MW)	Applicability
ACM0018	Consolidated methodology for electricity generation from biomass residues in power-only plants	Potentially Applicable: Scenario 2
ACM0020	Co-firing of biomass residues for heat generation and/or electricity generation in grid connected power plants	Potentially Applicable: Scenario 3
Code	Small Scale Methodologies (<15 MW)	Applicability
AMS-I.D.	Grid connected renewable electricity generation	Potentially Applicable: Scenario 1

For each supply chain scenario a potentially applicable methodology has been identified. However, in order for the scenario to fulfil the requirements of the methodologies certain parameters will need to be met, namely (Figure 3):

1. The biomass being used as a feedstock will need to be approved as a ‘biomass residue’.

The definition provided by the UNFCCC of a biomass residue is: *Non-fossilized and biodegradable organic material originating from plants animals and micro-organisms which is a by-product, residue or waste stream from agriculture, forestry and related industries.*

NamPower would therefore need to motivate that the harvested bush is a biomass residue of the stock farming industry that in the absence of the EBtP Project would have resulted in one of the following options:

- B1: The biomass residues are dumped or left to decay mainly under aerobic conditions. This applies, for example, to dumping and decay of biomass residues on fields;
- B2: The biomass residues are dumped or left to decay under clearly anaerobic conditions. This applies, for example, to landfills which are deeper than 5 meters. This does not apply to biomass residues that are stock-piled or left to decay on fields;
- **B3: The biomass residues are burnt in an uncontrolled manner without utilizing it for energy purposes;**
- B4: The biomass residues are used for electricity generation in power-only plant configuration at the project site in new and/or existing power plants;
- B5: The biomass residues are used for power and/or heat generation in other existing or new power plants at other sites;
- **B6: The biomass residues are used for other energy purposes, such as the generation of bio-fuels;**

- B7: The biomass residues are used for non-energy purposes, e.g. as fertilizer or as feedstock in processes (e.g. in the pulp and paper industry); or
- B8: The primary source of the biomass residues and/or their fate in the absence of the project activity cannot be clearly identified.

For the purpose of this preliminary exercise it is assumed that in the absence of the EBtP Project encroacher bush will still be cleared by farmers with the chief clearing method imposed being arboricide application followed by fire (B3). However, the use of encroacher bush to produce charcoal (B6) is also a likely scenario, which will need to be considered if carbon credits are sort.

The primary assumption of this methodology is that there will **be no additional decreases in carbon stocks as a result of the project compared to the business as usual scenario**. If this assumption cannot be effectively motivated the project proponent will need to develop a new methodology which encompasses considerations of changes to the carbon pool as provided by the CDM Board in the Clarification on Definition of Biomass and Consideration of Changes:

EB20, Annex 8,

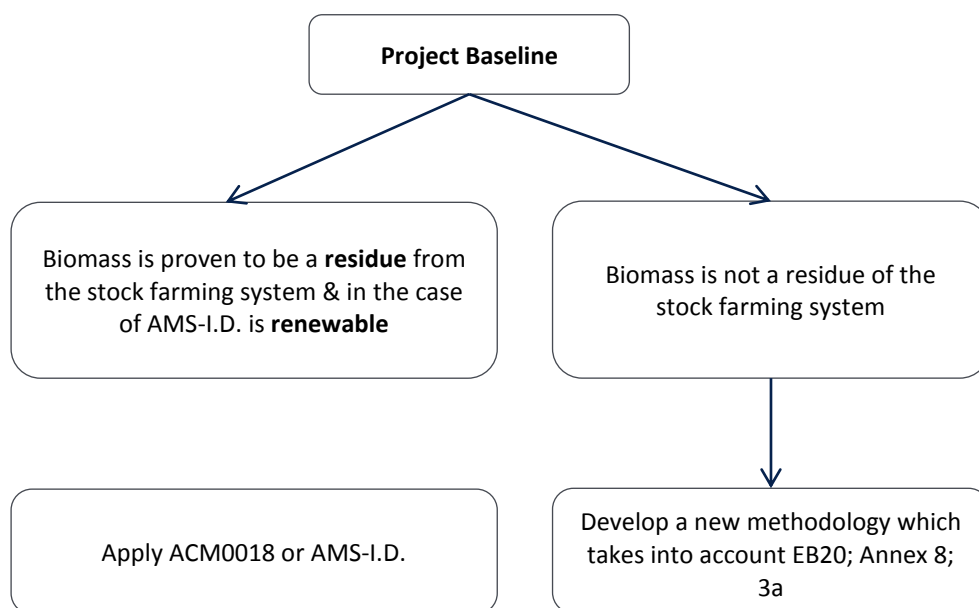
3a: Where a project activity, which does not seek to obtain tCERs or ICERs from afforestation or reforestation project activities, may directly or indirectly results in a net decrease of carbon pools compared to what would occur in the absence of the project activity, such changes should be taken into account in the calculation of emission reductions subtracting the corresponding quantities from emission reductions.

2. The biomass being utilised will need to be approved ‘renewable’ in the case of AMS-ID

A significant aspect of this definition of ‘renewable biomass’ provided by the UNFCCC is that the biomass is a biomass residue and the harvesting of the biomass **will not lead to a decrease in the carbon stocks over time**. The impact the project will have on carbon stocks in the harvested areas is currently undetermined. While debushing is likely to lead to an immediate removal of carbon from the carbon pool, the regeneration of a healthy savanna-type ecosystem in the short to medium term could potentially replenish carbon stocks. The impact on carbon stocks will have to be investigated further if NamPower choose to implement Scenario 1 and earn carbon credits.

An alternative would be to develop a new methodology along the lines of the ACM0018 but for power plant <15 MW. It is not yet clear if this is a viable option.

Figure 3 provides a summary of the process required to determine an applicable baseline methodology.



2.2 Voluntary Markets

The voluntary market refers to entities (companies, governments, NGOs, individuals) that purchase carbon credits for purposes other than meeting regulatory targets. In contrast to the compliance market, the voluntary market has no single regulatory body that determines appropriate methodologies or procedures for emission reduction activities. Rather, the voluntary market consists of a range of standards that are designed to minimize the barriers to project development in the carbon market.

A number of carbon offset standards have been developed in support of the voluntary carbon market. A non-exhaustive list of such standards is provided below.

■ Gold Standard

The Gold Standard is a full-fledged carbon offset standard that can be applied to either voluntary or regulatory projects to improve the social and environmental credibility of a project (Table 3). Crediting periods are either one 10 years period, or a 7 year period renewable three times, except for validated pre-CDM Gold Standard VERs. Gold Standard carbon credits typically place greater focus on ensuring that socio-economic and environmental benefits are also experienced as a result of the project, and typically carry a premium compared to “standard” carbon credits. The Gold Standard is supported by the WWF.

Table 3: Characteristics of CDM methodology identification

Methodologies			Additionality Requirements			Pre-CDM Crediting
Own	CDM	Other	<CDM	=CDM	>CDM	
x	✓	✓*			✓	x

*Supplemental criteria

■ Verified Carbon Standard (VCS)

The Verified (or Voluntary) Carbon Standard is a complete carbon offset standard (Table 4). It focuses on GHG reduction attributes only and does not require projects to have additional environmental or social benefits. Voluntary Carbon Unit's (VCU's), are earned through the VCS, and can have a maximum crediting period of 10 years and can be renewed three times.

Table 4: Characteristics of the VCS

Methodologies			Additionality Requirements			Pre-CDM Crediting
Own	CDM	Other	<CDM	=CDM	>CDM	
✓	✓	CCAR		✓		✓

■ VER+ Standard

The VER+ is a carbon offset standard aligned to the CDM (Table 5). The standard was designed for project developers who have projects that cannot be implemented under CDM yet who want to use very similar procedures as the CDM.

Table 5: Characteristics of the VER+

Methodologies			Additionality Requirements			Pre-CDM Crediting
Own	CDM	Other	<CDM	=CDM	>CDM	
x	✓	x		✓		✓

- Chicago Climate Exchange (CCX) Offsets Registry Program

From 2003 through 2010 CCX operated as a comprehensive cap and trade program with an offsets component. In 2011 CCX launched the CCX Offsets Registry Program to register verified emission reductions based on a comprehensive set of established protocols (Table 6). The CCX Offsets Registry Program is set to run for 2011 and 2012. The operation of the program beyond 2012 will be based on market demand. Offsets will be registered for vintages 2011 and 2012, and earlier vintages will be considered on a case-by-case basis.

Table 6: Characteristics of the CCX Offsets Registry Program

Methodologies			Additionality Requirements			Pre-CDM Crediting
Own	CDM	Other	<CDM	=CDM	>CDM	
✓			✓			✓

- Voluntary Offset Standard (VOS)

The Voluntary Offset Standard (VOS) is a carbon offset screen that accepts other standards and methodologies using certain screening criteria (Table 7). It currently accepts Gold Standards VER projects and projects that employ CDM procedures but which are implemented in countries that have not ratified the Kyoto Protocol and are therefore not eligible for CDM.

Table 7: Characteristics of the VOS

Methodologies			Additionality Requirements			Pre-CDM Crediting
Own	CDM	Other	<CDM	=CDM	>CDM	
	✓	✓		✓		✓

2.2.1 Methodologies

For the majority of these Standards the CDM methodologies outlined in Table 3 will need to be adhered to, the only exception being CCX Offsets Registry Program which will require the CCX Renewable Energy Systems Protocol to be followed.

Biomass renewable energy projects are applicable under this protocol where:

- Biomass used by the project facility is not stored for more than one year; and
- Site preparation does not cause longer-term net emissions from soil carbon i.e. carbon stocks in soil organic matter, litter and deadwood can be expected to decrease more due to soil erosion and human intervention or increase less in the absence of the project activity.

As for the CDM methodology AMS-ID, the applicability of the CCX protocol will depend on the short to medium term impacts on soil carbon stocks.

3 Carbon Offsets

The CDM methodologies provided by the UNFCCC as well as the Protocols provided by the CCX include a breakdown of emission sources that need to be considered when determining the carbon offset potential of a project. These methodologies categorise the emissions into baseline emissions and project activity emissions. Baseline emissions are emissions that will be avoided due to the projects implementation; these would include the emissions from a carbon intensive electricity grid which are being offset. Project activity emissions include emissions that result from the project and include emissions resulting from fossil fuel combustion in the supply chain. A summary of each methodologies emission boundary is provided in Table 8.

Table 8: Emission sources included in carbon offset calculations

Emissions			Methodologies			
	Source	Gas	ACM0018	ACM0020	AMS-I.D.	CCX
Baseline	Electricity Generation	CO2	✓	✓	✓	✓
		CH4	✗	✗	✗	✗
		N2O	✗	✗	✗	✗
	Uncontrolled burning or decay of surplus biomass residues	CO2	✗	✗	✗	✗
		CH4	✓	✗	✗	✗
		N2O	✗	✗	✗	✗
Project Activity	Onsite fossil fuel consumption	CO2	✓	✓	✓	✓
		CH4	✗	✗	✗	✗
		N2O	✗	✗	✗	✗
	Onsite & offsite transportation & processing of biomass residues	CO2	✓	✓	✓	✓
		CH4	✗	✗	✗	✗
		N2O	✗	✗	✗	✗
	Combustion of biomass residues for electricity	CO2	✗	✗	✗	✗
		CH4	✓	✗	✗	✗
		N2O	✗	✗	✗	✗
	Storage of biomass residues	CO2	✗	✗	✗	✗
		CH4	✗	✗	✗	✗
		N2O	✗	✗	✗	✗

WSP undertook a high level analysis of both the baseline and project activity emissions linked to the scenarios proposed for the EBtP Project. The objective of this estimation is to provide an indication of the carbon offsets associated with each scenario, a more detailed emissions analysis will need to be undertaken if carbon credits are sort.

3.1 Baseline

There are two primary avenues in which GHG emission will be avoided as a result of the EBtP Project, namely:

- I. The generation and use of renewable energy as opposed to more carbon intensive electricity if the project were not implemented (CO₂); and
- II. The removal of harvested biomass from the system where, in the absence of the project, encroacher bush would be treated using herbicide and standing biomass cleared using fire (CH₄).

The establishment of a project baseline will be more complex than that indicated above. In reality, baseline emissions will comprise a mix of bush clearing followed by use of wood as a rural fuel source, conversion of wood into charcoal and then used as a fuel source, in field burning and in-field decay. **Determining the project baseline is likely to be one of the biggest challenges in securing carbon credits for the EBtP project.**

3.1.1 Grid Emissions Displacement

Namibia currently generates electricity for national consumption at its three existing power stations as well as exporting electricity from the South African (ESKOM), Zambian (ZESCO), Zimbabwean (ZESA) and Swaziland

(EDM) grids. For the purpose of this assessment the baseline electricity operating margin offset was calculated using information provided by Carbon and Energy Africa 2012 (Table 9).

Table 9: Namibian electrical supply operating margin (2010)

Source	MWh / year (Net)	Weight (%)	Emissions Factor (tCO ₂ e/MWh)	Overall Emissions Factor
Ruacana Power Station	1 312 069	34.5	0.00	0.00000
Van Eck Power Station	20 616	0.5	1.44	0.00782
Paratus Power Station	4 493	0.1	0.82	0.00097
Imports (ZESA)	891 00	23.5	0.35	0.08258
Imports (Eskom)	1 429 000	37.6	1.06	0.39836
Imports (EDM)	95 000	2.5	0.00	0.00000
Imports (Zesco)	47 000	1.2	0.002	0.00003
Total				0.4898

GHG emissions avoided by the EBtP Project were therefore estimated by calculating the difference in emissions resulting from the project (discussed further in Section 3.3). An alternative method may be to identify the marginal energy source in Namibia today and to then compare the GHG emissions associated with this source to the project emissions.

3.1.2 Removal of biomass residue from the system

For the purpose of this analysis it is assumed that in the absence of the EBtP Project encroacher bush would be cleared following a regime comprising arboricide and fire. Following guidance provided by the IPCC 2006 it was estimated that a fire through one hectare of bush encroached land (mass of above ground biomass equal to 10t/ha) would result in 0.36 tCO₂e of methane. Using this estimate the resultant methane emissions offset by the project were calculated for each scenario (Table 10).

Table 10: Methane emissions offset by the EBtP Project

Unit	Tonnes CO ₂ / MWh				
	Scenario 1	Scenario 2a	Scenario 2b	Scenario 2c	Scenario 2d
Area corresponding to 1MWh (ha)	0.11	0.09	0.09	0.09	0.09
CH ₄ emissions from burning of the equivalent area to generate 1MWh (tCO ₂ e)	0.040	0.032	0.031	0.033	0.033

3.2 Project Activities

Modelling the Scope 1 emissions generated as a result of direct non-renewable fuel combustion was undertaken for each supply chain scenario, taking into account the varying harvesting, transport and conversion technology options. For each scenario the amount of carbon dioxide equivalent (CO₂e) emitted per MWh of electricity produced was calculated (Table 11).

When calculating GHG emissions in the supply chain carbon dioxide emissions resulting from the combustion of woody biomass are not included. The carbon dioxide released during this process is termed biogenic carbon,

and as it forms part of the short carbon cycle, is not considered to have a significant impact on long term carbon stocks.

Table 11: GHG emissions per 1 MWh of electricity generated

Unit	Tonnes CO ₂ e / MWh				
	Scenario 1	Scenario 2a	Scenario 2b	Scenario 2c	Scenario 2d
Harvesting	0.002	0.008	0.008	0.009	0.009
Infield Transport	0.002	0.001	0.001	0.001	0.001
Handling	0.002	0.002	0.002	0.002	0.002
Road Transport	0.003	0.005	0.004	0.005	0.005
Conversion	0.018	0.014	0.010	0.015	0.010
Total	0.026	0.031	0.025	0.032	0.027

3.3 Estimated Offsets

A high-level estimate of GHG offsets resulting from the project can be calculated by subtracting the Project Activities from the Baseline. For simplification purposes the emissions boundary prescribed by ACM0018 was employed for each scenario (Table 12).

Table 12: Offsets generated by the various scenarios

Boundary	Details	Tonnes CO ₂ e / MWh				
		Scenario 1	Scenario 2a	Scenario 2b	Scenario 2c	Scenario 2d
Baseline	Grid Emissions Displacement	0.4898	0.4898	0.4898	0.4898	0.4898
	Removal of biomass residue	0.040	0.032	0.031	0.033	0.033
Baseline Total		0.530	0.522	0.521	0.523	0.523
Project Activities	Supply chain	0.009	0.016	0.016	0.017	0.017
	Combustion of biomass residues	0.018	0.014	0.010	0.015	0.010
Project Activities Total		0.027	0.03	0.026	0.032	0.027
Offsets / MWh		0.503	0.492	0.495	0.491	0.496
Electricity generation per year (MWh)		40 500	162 000	162 000	162 000	162 000
Total offsets per Year (tCO₂e/yr)		20 371	79 704	80 190	79 542	80 352

4 Conclusions

The above demonstrates a relatively optimistic assessment of potential carbon credits. Substantial uncertainties remain, particularly in terms of making an accurate determination of baseline emissions (Table 13). Additional work will need to be undertaken to establish the GHG emissions against which to measure the project (marginal or average grid emissions factor) in line with the proposed methodologies.

Table 13: Summary of high level carbon market analysis

Scenario	Additionality	Methodologies		Carbon Offsets
		CDM	Voluntary	
1	Expected to be easy to establish additionality based on the preliminary Commercial Assessment	Dependent on biomass meeting UNFCCC 'renewable biomass' requirements and an adequate determination of the baseline.	Dependent on CDM & carbon pool requirements for CCX	~20 000
2	Scenario is potentially not additional based on preliminary Commercial Assessment. More work will need to be undertaken to establish additionality.	Dependent on biomass meeting UNFCCC 'biomass residue' requirements and an adequate determination of the baseline.	Dependent on CDM & carbon pool requirements for CCX	~80 000

The option for CDM credits may be viable by the time the EBtP project commences, however at present there is no viable option for obtaining CDM credits (post 2012). Therefore, an assumption of voluntary carbon credits, possible Gold Standard, can be used for future analysis. The potential earnings from the carbon offsets calculated by this assessment are provided in Table 14.

Table 14: Indicative carbon credit earnings based on current prices

Mechanism	Price (N\$)*	Crediting Period (Max period without renewal)	Lifetime Earnings (N\$)**	
			Scenario 1	Scenario 2
CDM CER	27.71	10	5 000 000	22 000 000
GS	74.40	10	15 000 000	59 000 000
VCS	16.40	10	3 000 000	13 000 000
CCX	8.20	6	1 000 000	3 936 000

*Mean current price obtained from the Carbon Trade Exchange and CCX website

**Earnings have been rounded down to the nearest million N\$

WSP Group Africa (Pty) Ltd

Block A, 1 on Langford
Langford Road, Westville
Durban
3629
South Africa
Tel: +27 31 240 8820
Fax: +27 33 347 5391
www.wspgroup.co.za

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