Sustainable Charcoal Value Chain Mozambique

Feasibility Study
on climate financing
for a
Sustainable Charcoal Production Chain

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Disclaimer

This report has been prepared in the context of an assignment by the Climate Change Service of the Belgium Federal Government. The Government of Mozambique endorsed this assignment. The findings are the result of fieldwork and literature research by the authors and are meant to serve as a basis for further discussion with the different stakeholders in the charcoal value chain.

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Acronyms

ANB	Biomass Energy Agency (non-existent yet)
BEST	national Biomass Energy Strategy
CBNRM	Community-Based Natural Resource Management
CER	Certified Emissions Reduction credit
CDM	Clean Development Mechanism
CIB	Inter-ministerial Commission on Bioenergy
CIFOR	Center for International Forestry Research
CoP	Conference of Parties
CPA	CDM Component Programme Activity
CPAs	Charcoal Producers Association
CPI	Investment Promotion Centre
DUAT	land rights, Direito de Uso e Aproveitamento da Terra
DNRE	National Directorate for New and Renewable Energy
ESA	European Space Agency
EUEI	European Union Energy Initiative
EIA	environmental impact assessment
FAO	Food and Agriculture Organization
FDI	foreign direct investment
FUNAE	National Energy Fund - Fundo Nacional de Energia
GIS	Geographic information system
GIZ	German Gesellschaft für Internationale Zusammenarbeit
GNI	Gross National Income
GoB	Belgian Federal Government
GoM	Government of Mozambique
Kg	Kilogram
LDC	Least Developed Countries
MCLT	Mozambique Carbon Livelihoods Trust
ME	Ministry of Energy
MICOA	Ministry of Coordination of Environmental Action, Ministério para a Coordenação da Ação Ambiental
MINAG	Ministry of Agriculture, includes Forest Department
MRV	measurable, reportable and verifiable
NAMA	Nationally Appropriate Mitigation Action
NGO	Non-governmental organization
NLP	National Land Policy
ODA	official development assistance
PoA	Program of Activities of CDM
PROBEC	Program for Basic Energy and Conservation in Southern Africa.
REDD	Reduced Emissions from Deforestation and forest Degradation
SB	Standardized Baseline
SFM	Sustainable Forest Management
SNV	Netherlands Development Organization
UNFCCC	United Nations Framework Convention on Climate Change
VER	Verified or Voluntary Emission Reduction unit
WISDOM	Woodfuels Integrated Supply-Demand Overview Mapping
WB	The World Bank

Preface

The Belgian federal government is committed to supporting least developed countries' participation in the Clean Development Mechanism (CDM) and to supporting their efforts in contributing to climate change mitigation in general.

After a scoping study on opportunities for programmatic CDM and further consultations with Mozambican stakeholders, the Belgian Federal Government decided to support the identification of opportunities for the charcoal production sector in Mozambique to benefit from climate financing, either through the Clean Development Mechanism or the Nationally Appropriate Mitigation Action (NAMA) framework.

The activities to be developed should be in line with and contribute to the goals of Mozambique and to the Energy and Environment Policies of the Mozambican Government.

Sumário executivo

O presente relatório faz parte de uma iniciativa que tem por objetivo a identificação de oportunidades no setor de produção do carvão vegetal em Moçambique para que este possa beneficiar de financiamento climático, quer através do Mecanismo de Desenvolvimento Limpo (MDL) quer através do quadro de Medidas de Mitigação Adequadas a Nível Nacional (NAMA).

O presente relatório apresenta os resultados das discussões com as partes interessadas na cadeia de valor do carvão vegetal de Moçambique sobre os vários modelos de negócio possíveis para tornar a produção de carvão vegetal em Moçambique mais sustentável. Estes modelos de negócio foram identificados com base em pesquisa bibliográfica e investigação no terreno: 1) briquetagem de resíduos de carvão vegetal; 2) introdução de fornos modernos e gestão sustentável das florestas; 3) plantações de florestas privadas com espécies nativas; 4) resíduos de plantações de florestas; 5) carvão vegetal proveniente de outras fontes; 6) torrefação pelo setor privado. Com base nas discussões entre as partes interessadas que participaram num *workshop* realizado em Maputo, foram selecionados três projetos para análise posterior, com vista a eventual financiamento climático:

(1) Briquetagem de resíduos de carvão vegetal: o processo atual de produção de carvão vegetal deixa uma quantidade significativa de pequenos pedaços e poeira de carvão vegetal no solo. Uma estimativa aproximada sugere uma perda de 200 kg de materiais por forno de produção de carvão vegetal, que podem ser utilizados para briquetagem.
(2) Fornos modernos e gestão sustentável das florestas: fornos modernos e eficientes permitem uma produção de carvão vegetal mais eficiente: um forno de tijolos tem um rácio de 3:1 (madeira/carvão vegetal) em vez do rácio de 7:1 dos fornos de terra atuais. Os produtores encaram a degradação florestal como uma limitação à sua produção, por conseguinte, a introdução de fornos eficientes deve ser combinada com uma Gestão Sustentável das Florestas (GSF).
(3) Torrefação pelo setor privado: a torrefação pode ser uma opção comercial viável nas regiões com a) um elevado nível de produção de carvão vegetal com produtores que produzem já a quantidade máxima permitida pelas suas licenças, e b) com níveis baixos de capacidade de organização e, por esse motivo, com menos oportunidades para os projetos acima mencionados.

A «produção de carvão vegetal a partir de plantações de florestas com espécies nativas» não foi aprofundada, uma vez que esta opção exigirá a elaboração de legislação específica. No âmbito da atual legislação, as empresas privadas optam por plantações de pinheiro e eucalipto, que são vendidos noutros segmentos de mercado, uma vez que estas espécies não são apreciadas para a produção de carvão vegetal.

Atualmente, o financiamento climático pode ser conseguido através do mercado do carbono (Mecanismo de Desenvolvimento Limpo: projetos individuais ou programas no âmbito do MDL) ou através do quadro de Medidas de Mitigação Adequadas a Nível Nacional (NAMA) que direta ou indiretamente conduzem a reduções mensuráveis, notificáveis e verificáveis (MNV) das emissões de gases com efeito de estufa no contexto do desenvolvimento sustentável. O potencial do MDL foi avaliado com base em três metodologias aprovadas relacionadas com a produção de carvão vegetal. A análise técnica concluiu que nenhuma das metodologias se aplicava integralmente, por vários motivos. Assim, a menos que seja desenvolvida e aprovada uma nova metodologia do MDL, o financiamento climático através do mercado do carbono não é uma opção viável para a produção sustentável de carvão vegetal em Moçambique. O desenvolvimento de uma nova metodologia do MDL não se insere no âmbito deste estudo.

A possibilidade de financiamento no quadro de uma NAMA está, em grande medida, dependente da possibilidade de criar um sistema que permita a medição, a notificação e a verificação das reduções das emissões dos gases com efeito de estufa e dos benefícios do desenvolvimento sustentável. Foram desenvolvidos nos documentos pertinentes vários critérios para avaliação do potencial das atividades/políticas no âmbito das NAMA. Os quadros seguintes aplicam esses critérios aos três projetos propostos. No caso dos projetos 1 e 2, a análise quantitativa refere-se ao impacto para três associações de produtores de carvão vegetal, com um total de 75 membros. No caso do projeto 3, esta análise diz respeito apenas a uma unidade de torrefação. As NAMA visam, evidentemente, alargar as atividades a todos os setores de produção de carvão vegetal pertinentes. Se considerarmos apenas os três principais mercados urbanos em Moçambique (Maputo, Matolo e Beira), teremos já uma população de 2 773 000 pessoas. Tendo por base um agregado familiar médio de 5 pessoas, tal implica aproximadamente 554 000 agregados familiares. Estima-se que 75 % destes agregados familiares (ou seja, 416 000) utilizem carvão vegetal como principal combustível (um saco de 70 kg por mês), mesmo que disponham de outro tipo de fogões nas suas residências (BEST 2012). No total, esses agregados familiares utilizam 29 120 toneladas de carvão vegetal por mês ou 349 440 toneladas por ano. Se a mesma quantidade de carvão vegetal fosse produzida utilizando fornos de tijolo e com base na gestão sustentável das florestas (projeto 2; o projeto 3 é muito semelhante), tal implicaria:

- *Utilização de madeira*: substituir os fornos de terra por fornos de tijolos significaria 2,5 vezes menos madeira para a mesma quantidade de carvão vegetal, ou seja, passar de 2,4 milhões de toneladas de madeira para 1 milhão de toneladas de madeira, o que se traduziria em 3,3 milhões de árvores poupadas anualmente.
- Gestão sustentável das florestas (GSF): atualmente, o carvão vegetal é proveniente de áreas que são utilizadas de forma não sustentável e se degradam. Para produzir a quantidade acima mencionada utilizando fornos de tijolo, teríamos 354 000 ha de terra (tendo em conta uma rotação quinquenal) sob práticas de GSF.

Critérios	Projeto 1 – Tijolos	Projeto 2 – Fornos eficientes e GSF	Projeto 3 – Torrefação
Benefícios do desenvolvimento sustentável	Moderados. Efeitos positivos na produção sustentável de carvão vegetal (375 toneladas por ano), nos resíduos, nas florestas (menos 2 756 toneladas de madeira utilizada anualmente) e nas receitas das associações de produtores de carvão vegetal.	Fortes. Efeitos positivos na produção sustentável de carvão vegetal (5 590 toneladas por ano), nos resíduos, nas florestas (menos 17 612 toneladas de madeira utilizada anualmente), na GSF, na saúde e nas receitas das associações de produtores de carvão vegetal.	Fortes. Efeitos positivos na produção sustentável de carvão vegetal (50 000 toneladas por ano), nos resíduos, nas florestas (menos 350 000 toneladas de madeira utilizada anualmente), na GSF, na saúde e nas receitas das associações de produtores de carvão vegetal/setor privado.
Potencial de mitigação dos gases com efeito de estufa (GEE)	Baixo (842 tCO2eq/ano)	Moderado (11 475 tCO2eq/ano)	Forte (112 362 tCO2eq/ano)
Redução a baixo custo[1]	Elevada, 1140 USD/tCO2eq/ano	Moderada, 261 USD/tCO2eq/ano	Moderada, 106 USD/tCO2eq/ano
Apoio necessário	Pequeno, investimentos iniciais para prensas para briquetes (155 000 USD), reforço da capacidade	Moderado, investimentos iniciais para fornos eficientes (840 000 USD), reforço da capacidade	Grande, investimento inicial para unidades de torrefação (4 000 000 USD), bem como custos de funcionamento
Calendário	Curto, viabilidade a 2 anos	Moderado, 4 anos para plena implementação	A produção pode ser iniciada no primeiro ano com funcionamento pleno no quarto ano
Âmbito geográfico	No início, limitado à região Maputo/Matola, dado que nesta área a pressão para a desflorestação é mais grave (mas também nas cercanias da Beira).	Início na região Gaza/Maputo, dado que as associações de produtores de carvão vegetal estão mais bem organizadas nesta região, possível extensão a todo o território de Moçambique.	Será implementado na região de Maputo ou de Gaza, dado que o mercado é constituído pelas cidades de Maputo e Gaza.
Capacidade para medidas MNV	Fácil, aplica-se a metodologia MAS-III.BG. O único parâmetro de monitorização seria a quantidade de	Fácil, aplica-se a metodologia AMS-III.BG. A monitorização envolve a quantidade de carvão vegetal produzida e a garantia	Fácil, aplica-se a metodologia AMS-III.BG. Fácil de monitorizar devido à conservação de registos e à

[1] Apenas são calculados os custos diretamente relacionados com as reduções das emissões, como fornos eficientes e GSF.

	briquetes produzida.	de utilização de biomassa renovável através da GSF.	capacidade organizacional do promotor do setor privado. A GSF também deve ser monitorizada.
Verificação adicional	Forte, dado que são utilizados resíduos	Forte, desde que sejam aplicadas as tecnologias que são introduzidas automaticamente no âmbito de uma norma de base a desenvolver para Moçambique	Forte, uma vez que são utilizados resíduos e será implementado um programa de replantação
Ligações à política climática nacional	Enquadra-se no NAPA de 2009 (Plano de ação nacional de adaptação às mudanças climáticas) e na nova estratégia de energia a partir da biomassa		
Nível de risco do país associado à situação política e em termos de segurança	Risco médio: embora a situação esteja a melhorar, existe ainda um risco de governação relacionado com corrupção, conflitos por questões de terra e direitos sobre as terras pouco claros.	Risco médio: embora a situação esteja a melhorar, existe ainda um risco de governação relacionado com corrupção, conflitos por questões de terra e direitos sobre as terras pouco claros.	Risco médio-elevado: uma vez que os investidores do projeto podem exigir estabilidade a longo prazo para garantir o retorno dos investimentos.
Prova de compromisso político	O Ministério para a Coordenação da Ação Ambiental (MICOA) é o organismo governamental responsável pelas NAMA. Contudo, a gestão sustentável das florestas é da competência do Ministério da Agricultura, o que poderá suscitar discussões políticas (como é atualmente o caso das atividades no âmbito da REDD). Por conseguinte, a Comissão Interministerial de Biocombustíveis e Biomassa (CIB), que inclui todos os ministérios pertinentes, deve ser envolvida e aprovar os desenvolvimentos. *Na reunião de fevereiro de 2014 entre o MICOA e o governo belga, o MICOA confirmou o seu compromisso. O CIB manifestou o seu interesse, mas ainda não assumiu um compromisso.*		

Com base no quadro supra, é claro que todas as três opções têm potencial para uma NAMA, mas o impacto na redução das emissões de GEE, os benefícios do desenvolvimento sustentável e os custos variam significativamente. As condições para NAMA bem-sucedidas podem ser resumidas do seguinte modo:

- ✓ Um organismo governamental responsável pelo desenvolvimento das NAMA, que será realizado em conjunto com outras partes interessadas do governo, da sociedade e do setor privado.
- ✓ Apoio ao sistema de licenciamento pelo organismo e criação jurídica de novas associações de produtores de carvão vegetal noutras regiões, a fim de alargar o âmbito das NAMA.
- ✓ Desenvolvimento de um sistema de monitorização e notificação para indicadores fundamentais, tais como a quantidade de briquetes ou de carvão vegetal sustentável produzida pelas associações de produtores, as emissões, a cobertura florestal e outros benefícios do desenvolvimento sustentável.

Os resultados desta avaliação de viabilidade serão ainda discutidos com o governo moçambicano, com vista a determinar o interesse no desenvolvimento de uma proposta completa de NAMA que possa ser apresentada a eventuais financiadores. É ainda necessário proceder à recolha de mais dados e ao ensaio das tecnologias no terreno. Devem ser elaboradas propostas de investigação específicas para este trabalho.

Executive summary

This report is part of an initiative that aims at the identification of opportunities for the charcoal production sector in Mozambique to benefit from climate financing, either through the Clean Development Mechanism (CDM) or the Nationally Appropriate Mitigation Action (NAMA) framework.

The reports presents the outcome of discussions with stakeholders in the Mozambican charcoal value chain on various potential business models to make charcoal production in Mozambique more sustainable. These business models were identified after literature and field research: (1) briquetting charcoal residues; (2) introducing modern kilns and sustainable forest management; (3) private sector plantations with native trees; (4) forest plantation residues; (5) charcoal from other sources: (6) torrefaction by the private sector. Based on the stakeholder discussions at a workshop held in Maputo, three projects have been retained for further analysis with respect to climate financing potential:

(1) Briquetting charcoal residues: The current process of producing charcoal leaves a significant volume of small pieces and charcoal dust in the field. A rough estimate would suggest a loss of 200 kg material per kiln production, which can be used for briquetting.
(2) Modern kilns and sustainable forest management: Efficient and modern kilns allow for more efficient charcoal production: a brick kiln has a 3 :1 (wood / charcoal) ratio instead of 7 :1 by the current earth kilns. Producers experience forest degradation as a limitation to their production and the introduction of efficient kilns should therefore be combined with Sustainable Forest Management (SFM).
(3) Torrefaction by the private sector: torrefaction can be a commercial viable option in regions with (a) high level of charcoal production with producers that already produce the maximum amount allowed by their licenses, and (b) lower levels of organization capacity and thus less opportunities for the above-mentioned projects.

The 'Production of charcoal from Forest Plantations with native species' has not been researched in more detail since this will require the development of specific legislation. Under the current legislation, private companies opt for pine and eucalyptus that are sold in other market segments as these species are not appreciated for charcoal production.

Climate financing can at present be delivered via the carbon market (Clean Development Mechanism: individual projects or CDM programmes) or under the framework of Nationally Appropriate Mitigation Actions (NAMA) that directly or indirectly lead to measurable, reportable and verifiable (MRV) greenhouse gas emission reductions in the context of sustainable development. The CDM potential has been assessed on the basis of three approved CDM methodologies related to charcoal production. The conclusion from the technical analysis is that none of the methodologies fully applies, for various reasons. So, unless a new CDM methodology is developed and approved, climate financing via the carbon market is not a feasible option for sustainable charcoal production in Mozambique. The development of a new CDM methodology is beyond the scope of this assignment.

The potential for financing under a NAMA framework is largely dependent on the potential for setting up a system that allows for monitoring, reporting and verification of GHG emissions reductions and of sustainable development benefits. In literature a number of criteria have been developed to assess the NAMA potential of activities/policies. The following table applies these criteria to the three project opportunities. The quantitative analysis in case of project 1 and 2 refers to the impact for three Charcoal Producer Associations having a total of 75 members and to one torrefaction unit only in case of project 3. The purpose of the NAMA would be of course to scale up the activities to all important charcoal production areas. If one would consider the three main urban markets in Mozambique alone (Maputo, Matolo and Beira) this already entails 2,773,000 people. With an average household size of 5 persons this implies approximately 554,000 households. An estimated 75% of these households (i.e. 416,000 households) use charcoal as their main fuel (one 70 kg bag per month) even though they also have other stoves at home (BEST 2012). In total they now use 29,120 tons charcoal per month or 349,440 tons/year. If the same amount of charcoal would be produced using brick kilns and SFM in forests (project 2. Project 3 is rather similar) this would imply:

- *Wood use*: moving from earth kiln to brick kiln means 2.5 times less wood for the same amount of charcoal: From using 2.4 million t wood to 1 million t wood. This means 3.3 million trees saved on an annual basis.
- SFM: Currently the charcoal comes from areas that are unsustainably used and degrade. In order to produce the above amount with brick kilns 354,000 ha of land (assuming a 5 yr rotation) would be under SFM practices.

Criteria	Project 1 – Briquettes	Project 2 –Efficient kilns and SFM	Project 3 – Torrefaction
Sustainable development benefits	Moderate. Positive effects on sustainable charcoal production (375 ton per year), waste, forests (2,756 ton less wood used per year) and income for CPA's.	Strong. Positive effects on sustainable charcoal production (5,590 ton per year) waste, forests (17,612 ton less wood used per year), SFM, health and income for CPA's.	Strong. Positive effects on sustainable charcoal production (50,000 ton per year), waste, forests (up to 350,000 ton less wood used per year), SFM, health and income for private sector/CPA's.
GHG mitigation potential	Low (842 tCO2eq/yr)	Moderate (11,475 tCO2eq/yr)	Strong (112.362tCO2eq/yr)
Low cost abatement[2]	High, 1140 USD/tCO2eq/yr	Moderate, 261 USD/tCO2eq/yr	Moderate, 106 USD/tCO2eq/yr

[2] Only costs directly related to the emission reductions are calculated here, like improved kilns and SFM.

Required support	Small, upfront investments for briquetting presses (155,000 USD), capacity building	Moderate, upfront investments for improved kilns (840,000 USD), capacity building	Big, upfront investment for torrefaction units (4,000,000 USD) as well as running costs.
Time frame	Short, 2 years feasible	Moderate, 4 year for full implementation	Can initiate production from year 1 with full operation in year 4
Geographical scope	At first limited to Maputo/Matola region as here pressure from deforestation is most severe (but also around Beira)	Start with Gaza/Maputo region as CPAs are best organized, extension possible to rest of Mozambique	Will either be implemented in Maputo or Gaza region as market is Maputo city and Matola city
Ability to MRV actions	Easy, AMS-III.BG applies, only monitoring parameter would be the produced quantity of briquettes	Easy, AMS-III.BG applies, monitoring involves the produced quantity of charcoal, and the safeguarding of use of renewable biomass through SFM	Easy, AMS-III.BG applies. Easy to monitor due to book keeping and organizational capacity of private sector developer. SFM should be monitored as well
Additionality check	Strong, because residues are used.	Strong, as long as technologies which are automatically additional under a to-be-developed Standardized Baseline for Mozambique are applied.	Strong, as residues are used as well as replantation program shall be implemented
Links to national climate policy	Fits under 2009 NAPA and the new biomass energy strategy		
Level of country risk associated with the political and security situation	Medium – risk: Although the situation is improving there is still a governance risk related to corruption, conflicts over land and unclear land rights.	Medium – risk: Although the situation is improving there is still a governance risk related to corruption, conflicts over land and unclear land rights.	Medium-high: as investors to the project may require long term stability as to guarantee return on investments
Evidence of political commitment	MICOA is the lead government organization on NAMA, however, sustainable forest management is under the Ministry of Agriculture, which might lead to political discussions (as is now the case for REDD activities). Therefore the CIB - Interdepartmental Commission on Biofuels and Biomass -(which includes all relevant Ministries) should be involved		

	and endorse the developments. *In the February 2014 meeting between MICOA and the Belgium government, MICOA confirmed its commitment. The CIB has stated their interest but are not yet committed.*

From the table above, it is clear that all three options have NAMA potential but GHG emission reduction impact, sustainable development benefits and costs differ largely. conditions for a successful NAMA can be summarized as:

- ✓ A lead government organization for development of the NAMA together with other relevant government, society and private sector stakeholders
- ✓ Support the licensing system by organisation and legal establishment of new Charcoal Producer Associations in other provinces in order to enlarge the scale of the NAMA.
- ✓ Development of a monitoring and reporting system for crucial indicators such as for the produced quantity of briquettes or sustainable charcoal by the CPAs; emissions, forest cover and other sustainable development benefits.

The results of this feasibility assessment will be further discussed with the Mozambican government with a view of determining the interest for the development of a full NAMA proposal that can be submitted to potential financiers. At the same time, some further data collection and field-testing of technologies is needed. Specific research proposals need to be developed for this work.

1 Introduction

1.1 Introduction to this report

The ultimate objective of the initiative is to identify opportunities for the charcoal production sector in Mozambique to benefit from climate financing, either through the Clean Development Mechanism (CDM) or the Nationally Appropriate Mitigation Action (NAMA) framework.

The report is the second report of the initiative following the Literature and Field research (final report of January 2014). The current report is the Climate Financing Feasibility Study, which describes some potential charcoal projects – based upon the Literature and Field research and discussions with stakeholders (workshop February 2014) – and describes their climate financing potential.

1.2 Main research question of the study

The ***charcoal value chain*** is comprised of five components: forest management, production, transportation, retail and consumption. Sustainable production of charcoal is not a new discussion within Mozambique. Key for this assignment is to use this existing knowledge and to take it to the next practical level. Based upon the objective of this initiative the main research question is:

"How could the charcoal production sector in Mozambique evolve in order to benefit from climate financing, either through the Clean Development Mechanism (CDM) or the NAMA framework".

A sound methodology consists of several elements. An important and fundamental element is to use clear definitions in order to avoid multiple interpretations. The definitions used are presented in annex 2.

1.3 Climate financing

In general, as presented in the study on the Charcoal Value Chain (EES, January 2014), significant emission reductions can be achieved by introducing improved kilns and forest management principles and such emission reductions may be eligible for carbon market financing.

Implementing a project in the charcoal sector of Mozambique with UNFCCC related climate financing faces several serious obstacles however, which are described further. Establishing a feasible and adequate Project – with measurable, reportable and verifiable (MRV) results for the charcoal sector would ideally entail the following steps (UNDP, 2013):

- *Assessment*: Knowing the scale of the problem in order to provide a solution at a sufficient or at least meaningful scale.
- *Analysis:* Presenting the value chain that links the consumption of charcoal as cooking energy to deforestation.
- *Formulation of response:* On the basis of the value chain, identifying and selecting the most appropriate scope of intervention to address the problem (e.g. deployment of improved production technologies; switch to alternative sources).

Followed by the actual MRV:

- *Defining verifiable outputs:* Defining, calculating and monitoring the results achieved by the activities.
- *Evaluation of cost-effectiveness:* Economic indicators on the cost effectiveness of the problem should be included in order to check the cost of avoided emissions against initial assumptions. In the case of a NAMA other sustainable development benefits will be important progress indicators.
- *Evaluation of the impacts):* The MRV of the results should enable an evaluation of the impacts.

Two major opportunities for climate financing have been identified in the previous study and 2014 workshop[3]: Clean Development Mechanism Program of Activities (CDM-PoA) and a Nationally Appropriate Mitigation Action (NAMA). The following table summarizes the key differences between CDM-PoA and a NAMA:

Table 6: Differences between a CDM PoA and a NAMA.

	CDM PoA	**NAMA**
Aim (I)	Contribute to sustainable development in the host country	Contributes to sustainable development in the host country
Aim (II)	Assist developed countries to meet their reduction targets through actions in developing countries	Developing countries contribute to global GHG reductions
Type of action / scale	A bundle of individual projects or a programme with a bundle of activities	Policies, programmes and projects ⇒ Scaled up mitigation
Initiator of activity	Mostly private sector	Mostly public sector
Financing	Via sales of carbon credits: ⇒ Mostly ex-post ⇒ Depends on carbon market	Different sources (public, international and domestic), private, national and international financial institutions ⇒ Mostly up-front ⇒ Financial support obligations for developed countries (as well as for capacity building and technology transfer)
Host country involvement	Designated National Authority needs to approve the project, stakeholders shall be consulted	By definition
Requirements	• Additionality, i.e. not take place without the revenue from the sale of carbon credits or other factors preventing the project to happen without CDM • Applicable UNFCCC registered methodology	Depending on funding source some requirements may be asked by international donors, such as 'transformational changes'
Measuring,	• Focus on GHG reductions	• Important for internationally supported

[3] Climate Finance in Mozambique - Identifying and prioritizing appropriate mitigation actions and interventions in the municipal waste and charcoal production sectors' organized by the Mozambican Ministério para a Coordenação da Acção Ambiental (MICOA) and the Belgian Federal Directorate-General for the Environment on February 18th, 2014 in Maputo. Workshop report and presentations are available on http://www.climat.be/fr-be/mediatheque/presentations/workshop-climate-finance-mozambique

Reporting and Verification (MRV)	• Methodology for calculation of GHG reduction and for monitoring needs to be approved • Verified by accredited auditor (DOE) • Issuance of Certified Emission Reductions (CERs)	NAMAs: donors may want to have a say • Progress indicators (quantitative but also qualitative) • For benefits and co-benefits • National systems, procedures and authorities
Duration	• CDM: 10 years non renewable or 7 years, twice renewable (max. 21 years) • PoA: max. 28 years; individual CPAs (1 X 10y or 4 X 7y)	No limitation
UNFCCC body in charge	CDM Executive Board and its panels	No specific regulation Countries can voluntarily submit NAMA to the NAMA Registry for recognition or for matching financial, technical and capacity building support[4]

Source: Belgian Federal Public Service for the Environment (2014)

The previous report presented the first steps including Assessment, Analysis, and Formulation of a potential response.

This report describes the potential response - a description of desired and promising actions by the stakeholders in the value chain - in more detail based upon the discussion with stakeholders in the 2014 workshop. This response is assessed on the feasibility for climate financing. Lastly an evaluation of the cost-effectiveness is provided.

The actions should in any case be feasible and adequate from a sustainable development perspective (economic, social and environmental) first and from the climate financing perspective second. This will make it possible to identify promising actions regardless from what source financing will become available to tackle obstacles.

[4] http://unfccc.int/cooperation_support/nama/items/7476.php

2 Potential business models identified in first phase

This chapter describes first (par. 2.1) the potential business models identified in the previous phase, which were discussed with stakeholders (mainly workshop). The findings of the workshop are presented in paragraph 2.2.

2.1 Potential business models

In the report Charcoal Value Chain (EES, January 2014), several key actors and models for co-operation were considered. A concise overview is presented here. In Mozambique you can only export biomass – including charcoal - if you can prove it comes from a renewable source (i.e. managed plantations with replanting). Currently, no charcoal is exported and charcoal is sold in large quantities on the domestic (urban) market. Sustainable Forest Management (SFM) is non-existent in charcoal producing areas. Further information can be found in the previous report. Discussed opportunities are:

1. Production from native trees – Briquetting charcoal residues

Main actor: Established Charcoal Producer Associations (CPAs).

Current charcoal production is done by using traditional earth kilns. The current practice of charcoal making leaves a high amount of small charcoal in the field. Charcoal producers also discard of smaller branches and logs when preparing the wood for carbonization. This is because such wood would result in more smaller and non-desirable (by consumers) pieces of charcoal. These small pieces could either be collected and marketed at lower prices targeting poorer urban consumers or could be used to produce briquettes. Consumer preference testing (pilot project) should be able to demonstrate the desirability of briquettes.

2. Production from native trees – Modern kilns and SFM;

Main actor: Established Charcoal Producer Associations (CPAs).

High efficiency gains can be made by improving existing earth kilns as well as establishing a highly efficient kiln in a fixed location. This should be combined with SFM. The interviewed charcoal producers in the CPAs – especially those experiencing forest degradation - showed an interest in these modern kilns. The interviewed producers stated they wanted to be individually responsible, which would mean one modern kiln per licensed producer and allocated forest block.

Certain pre-conditions have to be met before a project can be attempted. Modern, fixed kilns can be introduced under the following conditions:

1. Each individual member should have legal, inheritable **land rights** according to DUAT.
2. A project needs to have a certain scale to be cost-efficient: reach a sufficient amount of producers holding a significant amount of land, meaning producers need to be organised. A crucial element therefore is that an established level of organisation is already present showing producers want to co-operate with each other i.e. **Charcoal Producer Associations have to exist**. They also have to be legally established with a functioning Chair, Board members and perform tasks such as administration and monitoring. The Association has to show that it has allocated exploitation blocks to its members and that it monitors implementation and licenses.

The members show accountability towards each other and government through monitoring and reporting.

3. The members have to show that they run an already **financially viable** charcoal making business (by using a balance sheet incl. forest stock and sales figures).
4. The forest is currently degrading and producers feel the pressure of **un-sustainable forest use** and the viability of their business. They accept that SFM practices and re-planting is needed.
5. The resource is/can be limited by a government licence (DUAT licence by MINAG) for the exploitation blocks to individual license holders and the license should be inheritable.
6. Improved kilns should not be a communal operation but rather the responsibility of individual members with one fixed kiln per exploitation block, In addition they can use some traditional earth kilns whose performance can be improved as well by chimneys. The CPAs can assist their members and facilitate training, construction and exchange of experiences. The CPAs may also be needed to manage developments as some individuals will fail to maintain the operations and others will thrive (probably those who are more entrepreneurial).

3. Production from native trees – Private sector plantations

Main actor: forest plantation companies.

There are no commercial forest plantations with native trees in Mozambique. The plantations all plant eucalyptus and pine trees (fast growing species) for paper and construction industry. Eucalyptus and pine seem not suitable for consumer-oriented charcoal production in Mozambique, as consumers strongly prefer other tree species (i.e. native trees). If a plantation company is to produce charcoal for the Mozambican market from native trees specific legislation and enforcement is needed to avoid them to plant other species and shift to other market segments. Secondly, the competition from the informal sector that does not pay any fees (many do not pay license fees and they do not pay Value Added Tax) is a major obstacle to be addressed.

4. Forest plantation residues

Main actor: forest plantation companies.

Mozambican government and companies have experience with industrial-size plantations. The large forest plantations are all located in the center and north of the country. According to the forestry department of the Ministry of Agriculture, no significant forest plantations are planned for the South of the country. This is largely due to climate conditions and lack of available land for such developments. The waste from forest plantations is not used in a commercial manner. The plantations burn the sawdust or leave it to rot. Briquetting from production residues might be a commercial option but so far companies have not shown an interest (Mozambican consumers seem not to be interested in charcoal from eucalyptus). At the moment, building a market chain on this resource seems un-viable but can be discussed in more detail with industrial plantation owners.

Another option is that the forest companies allow villagers to collect waste materials from their plantations and use this to produce charcoal. This has not yet been discussed but the plantations will probably be hesitant to allow this. They are already struggling with illegal logging and would not be able to distinguish a legal entry from an illegal entry. That means they would have to collect waste material and bring it to one central point. Whether they are willing to do so is not discussed.

5. Charcoal from other sources

Main actor(s): Companies, often with outgrower schemes

Charcoal can also be produced from other species such as Bamboo, cotton stalks and from agro-forestry and agriculture residues. This has been tried before and initiatives have so far not been very successful. Various projects have tried briquetting of forest and agriculture residues. So far, no project has become commercial as they are faced with various constraints in relation to the source and type of waste material:

1. *From smallholders*: this waste stream is not organised, which means a lot of effort has to be put into the development phase. This has been tried in various projects that all failed because it proved difficult to organise the producers at scale, collect the waste in an affordable manner, and as a consequence the 'production' proved volatile.
2. *From industry*: most waste streams from large agricultural companies already have a value. For example, bagasse from sugar cane is very valuable for co-generation and ethanol production, and banana residues are used for the production of biogas (which will also be high potential for other industries). The briquette producer cannot compete with these uses.

In general, projects were not successful because it is difficult to organise feedstock; there is strong competition from the existing legal and illegal charcoal production; and consumers strongly prefer other tree species (i.e. native trees). Our conclusion is that briquetting of agriculture residues as a stand-alone commercial activity is not viable in Mozambique.

6. Torrefaction

Main actor: a commercial company.

Currently several modern carbonization technologies exist, which work through the process of torrefaction. Torrefaction units can be designed to the specifications of the local context, and may vary in size as well as be fixed or mobile. With the correct technology, it is also possible to integrate methane abatement within the process. A torrefaction unit is currently outside the reach of charcoal producers (financially and skill-wise). Secondly, many producers currently sell 'at the gate'. This creates a commercial opportunity for a company to integrate itself within the charcoal value chain.

The following implementation models can be identified:

1. One large central torrefaction plant is established within the community grounds. Charcoal producers may bring their feedstock (from their individual forest blocks) to this location for torrefaction. There are two sub-options:
    a. The producer pays per load torrefied, and may package and sell the charcoal from this centralised location. The prospects for reduced feedstock requirements, as well as a faster carbonization process (from 2-4 weeks using traditional kilns – to just a couple of hours using torrefaction) could make this option attractive.
    b. Another option is that a company buys the raw material from the producers and retails the torrified product in the urban areas. This is the most attractive option for companies. Producers would accept this option only if the company pays more

than they would otherwise earn 'at the gate' (more field-transport needed, but less labour present in the field to manage the earth kilns).

2. Small torrefaction units are set-up on individual producer blocks. The producer can hire this unit from a company and is trained on how to use the technology, and is responsible for its operation. Another option is if the producer takes a loan for this unit and a payment system of instalments cover the unit costs over time. Because the producer is limited to a certain legal amount it means he/she saves time that can be used for other purposes. He/she may not produce more. The first option seems therefore more realistic.

2.2 Stakeholder response

2.2.1 Introduction to the 2014 stakeholder workshop

The results of the earlier study – as presented in the previous chapter – were used as input to organise a stakeholder workshop. The Mozambican Ministry for Coordination of Environmental Action (MICOA) and the Belgian Federal Directorate-General for the Environment organized on February 18th, 2014 a workshop on 'Climate Finance in Mozambique - Identifying and prioritizing appropriate mitigation actions and interventions in the municipal waste and charcoal production sectors'. The morning session introduced climate finance, its tools and the Mozambican context. Thereafter the participants were divided into two separate groups – one focused on the municipal waste sector and the other on the charcoal production sector. Information from the workshop can be found at: http://www.climat.be/climatefinance-mozambique.

In preparation of the workshop, potential stakeholders related to the business models (presented in section 2.1) were approached:

- Charcoal producers are getting increasingly organized and representatives of seven CPAs were invited. Six persons representing five different organizations attended the workshop and showed a great interest.
- Also representatives of potential technology providers attended the workshop.
- Eight identified plantation owners were invited. Only Lurio Green Resources attended the workshop but in an earlier email they stated that they will focus for the moment on producing charcoal from Eucalyptus in another country. The company Envirotrade has run into financial problems with their carbon trading project in Sofala province (according to Friends of the Earth) and its implementation is criticised by local people (the contract they signed).

The purpose of the discussion of the production of charcoal in the afternoon was to identify specific context (design) activities. To structure the discussion the 2MW model (Annex 3) developed by Ricardo Martins[5] was used. This model was developed to structure discussions on energy systems (charcoal) and allowed the comparison (and then the combination of) the results of the different sessions. The groups were organized based on an assessment of their capacity.

[5] ricardo.martins09@imperial.ac.uk

2.2.2 Workshop results

The results of the workshop sessions are presented below and these will be used to identify feasible project activities. Session 1 involved members of associations of charcoal producers that were well organized, session 2, the less organized producers and their associations and group 3 a mixture of good and less organized producers. The groups were formed by Rui Mirira, who has direct experience with these CPAs, and Ricardo Martins. The Groups were completed with a random mixture of other participants including policy makers at the national level, local officials, researches, NGO representatives, donors, etc.

The 2MW model was the starting point of each group but each group was free to discuss different options.

Session 1: well organized producers

Participants identified the use of carbon residues left on the field as a market opportunity. Connected to this opportunity is the current lack of appropriate technology for making briquettes. Participants would make use of equipment that has multiple uses (chip-carbonization briquetting). If this opportunity is pursued, more analysis needs to be done on the necessary technology, training, and marketing conditions. An important element was the introduction of a regulation for use and sale of charcoal waste. Secondly, it would require proper attention to develop the market and to convince urban consumers. The most important markets would be the urban markets and supermarkets and / or gas stations.

More information on potential measures is presented in annex 3.

Box 1: Medicinal charcoal.

The producers showed an interest in using charcoal dust for medicinal purposes. Charcoal is known to bind certain poisons so it can be used in acute poisonings. It can however not adsorb for example strong acids, alcohols and most hydrocarbons (gasoline, kerosene, fuel oil, cleaning fluids, paint thinners, pine oil, etc.). On the other hand it can adsorb medication. Charcoal for medicinal purposes should therefore be used carefully but is an attractive low-cost option. The charcoal dust may need to be purified to remove harmful substances and reach the appropriate grade. The charcoal dust also has to be pressed into tablets and not sold as dust to avoid inhalation. Starch can be used to bind the dust and produce the tablets. Medicinal charcoal is mostly 'activated' charcoal meaning the active surface area has been increased. "Activation" requires a controlled burning of the wood that is then subjected to an oxidizing gas, such as steam or air, at elevated temperatures. This process cleans soot and small particles out of the cracks and crevices thereby allowing more surface area. Pyrolysis and torrefaction can be used to produce activated charcoal. Some strict market regulation might apply, that could limit this opportunity.

Session 2: less organized producers

The session started with the identification of three main problems in the sector: (1) The shortage of forest resources (wood), (2) much waste from the tree and inefficient charcoal production; and (3) high fuel prices (for use in chainsaw, transport).

The most serious problem perceived was the scarcity of forest resources and the on-going forest degradation. The discussion focused on this subject and resulted in a model along the value chain that includes the management of raw materials and their collection (logging) to marketing to multiple audiences. It also includes the use of waste as a source of energy and additional income.

More information on potential activities is presented in annex 3.

Session 3: mixture of organizations
The main problem identified was the lack of knowledge and skills related to efficient charcoal making technology. The participants discussed the whole value chain and how to enhance its efficiency including making full use of the tree, collection of charcoal residues for briquetting, introduction of new technologies, etc. This means training and capacity building on various aspects of efficient resource management to efficient production to transport and marketing. An important element discussed was that the government should implement the Land Law and implement the 20% payment system to local communities under the Forestry and Wildlife legislation (i.e. this is the return to communities from the tax charged for forest exploitation). The government could also create the right fiscal incentives and re-invest in the charcoal sector.

More information on potential activities is presented in annex 3.

2.3 Organisation assessment of the charcoal producer associations

In the previous study phase, two charcoal producer associations were visited and several key persons interviewed. This provided some basic information on the capacity and manner of organization of several charcoal producer associations. The day after the workshop the capacity and level of organization of the seven charcoal producer associations was discussed with them directly.

From the discussion the project team concludes that the number of actual members previously reported was not correct. Each community does have numerous people engaged in charcoal production. Many however do not produce charcoal on a regular basis but only when there is a financial need. They have not become members of the producer association yet. Others can be considered professional producers, which are engaged in charcoal production throughout the year. They have formed the producer associations and they often employ people in the field. On average each professional producer has 5 to 8 kilns and employs 2 persons per kiln.

Table 1: Some Charcoal Producer Associations in Mozambique.

Name production region	Contact person	Name CPA	Province	Members	Persons employed	Capacity
Mapai-chicualacuala	Pedro Laice	Mapai	Gaza	33p	165 - 528	Good
Hochane	Rosa Maposse, Alberto Chauque	Mabalane	Gaza	20p	200 - 320	Good
Chicualacuala	Arlindo Mondlate	Pfucane	Gaza	20p	200 - 320	Medium
Jabula	Albino Tembe	Jabula	Maputo	9p	90 - 144	Low
Goba	Rafael Mathe	Goba	Maputo	30p	300 – 480	Low

Criteria used to assess capacity: (1) Chair and board members established; (2) regular meetings; (3) some form of administration; (4) some form of monitoring members; (5) legal status; (6) some form of reporting. None of the CPAs meet all these criteria. Those 'qualified' good meet at least criteria 1-4 and can be a partner in a project. The one qualified as 'medium' only meets criteria 1-3 and those qualified *as 'low' meets criteria 1 and/or 2. Please note the qualification is based on an interview with representatives at the workshop meeting and did not entail a proper organization assessment.*

In the table a first impression is provided of the capacity of the contact persons and the professional members of the associations (based on the feedback from the contact persons). This varies considerably (see table 1). Each producer association has a commission (10 persons is common) with a chairperson. The level of organization and administration seems low although they exert a certain level of control over production by their members and seem capable of monitoring the production performance of their members.

2.4 Assessment of private sector opportunities

The charcoal market is estimated at 400 million dollar a year for Mozambique (BEST 2012). Charcoal continues to be consumed by the large share of urban households as their primary cooking fuel. It is estimated that more than 80% of urban households rely on charcoal on a daily basis (Atanassov, B) This growing demand coupled with limited forestry resource near the urban centers has exponentially increased the price of charcoal over the past several years. At the level of the producer, the price for charcoal is 3.6 Meticais per kg (250 Mt for a 70kg bag)[6]. Within the markets of Maputo city, this same charcoal is sold at a market price of 12 Meticais per kg when in the form of a 70 kg charcoal sack (total 840 Mt). This large difference in prices is to account for the margins earned by the intermediaries within the value chain such as transporters and charcoal wholesalers. With such large margins to be made (between production and retail), it becomes commercially attractive for companies within part of, or the entire, value chain.

As said, transporting and wholesale services are already known market opportunities.

The most important production-related opportunities have been discussed in the previous report and presented in paragraph 2.1. The last years, companies entering the market have shown mostly interest in piloting organizing waste materials from third parties and using modern torrefaction and/or briquetting technologies for the production of charcoal. Recently, the AECF-REACT fund approved such a project piloting using torrefaction. Another interesting opportunity might be to establish a native tree plantation or agroforestry plantation that produce native trees for charcoal production. Together with small-scale farmers with woodlots a sufficient scale can be organized. This concept has been tested by Solidaridad Southern Africa (www.solidaridadnetwork.org) in Sofala province. small-holders were given native tree species to plant on their land. This was a pilot project to stimulate community based biomass plantations on private land. 5000 small-holder farmers were involved in these trials. The project initially distributed eucalyptus plantings, but later changed to native tree species such as the acacias for experimentation purposes. The intention of this project was to organize small-holder farmers to produce biomass as feedstock for sustainable charcoal production through torrefaction. The torrefaction machine was to be operated by a private entity. This project remained at pilot level as the local charcoal prices were too low to compete with. It was concluded that a similar initiative would have been economically viable if it was located near the markets of Maputo and Matola cities.

Lastly, retail of 'green charcoal' including packaging and marketing might be an interesting opportunity for a company. However, given the low income of the majority of consumers

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[6] This is the standardized price amongst producers in Combomune and Mabalane districts (Oct. 2013).

they can probably not charge a premium but rather can distinguish themselves in the market as ‘sustainable’ and ‘pro-poor’ to create a positive sentiment.

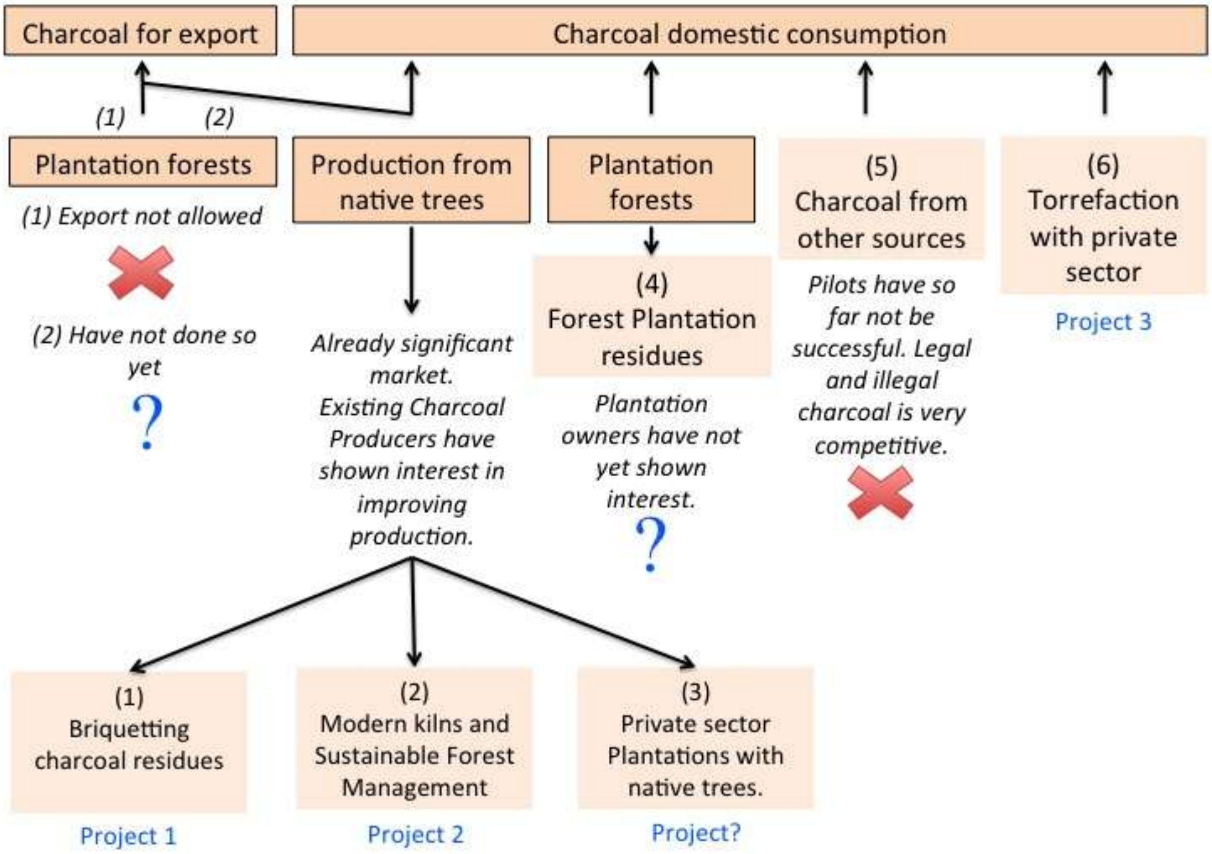
In general, if a company takes full advantage of the entire value chain, it stands to generate the largest profit. However due to the dimension of such an activity, the following considerations need to be taken into account:

1. Availability of enough land for forested plantation in the vicinity of urban market;
2. Types of land use licenses and taxes applicable to the industry;
3. Community consultation and acceptance requirements;
4. Potential social and environmental impacts caused by the project (maybe relocating some community members, clearing native vegetation, wildlife habitat destruction);
5. Risk assessment (wild fires, animal grazing of young trees, theft)
6. Market acceptance for the new product (in the case of briquettes or different tree species used for charcoal making).

2.5 Conclusions of study and workshop

Based upon study findings and the stakeholder discussion the social, environmental, technical and commercial feasibility for charcoal production has been assessed (see previous study and chapter). The summarized result is shown in the figure below:

Figure 1: Options for charcoal production.



The charcoal projects are described in more detail in the chapter 4. Recently, briquetting of municipal waste was also suggested as an option but this option has not been researched or discussed yet with stakeholders.

The potential project "Private sector plantations with native trees"

There are several forest plantations in Mozambique but no commercial forest plantations with native trees. If a plantation company is to produce charcoal for the Mozambican market from native trees specific legislation is needed to avoid them to plant other species (eucalyptus or other agricultural crops) and shift to other market segments. Such a charcoal plantation can be very efficient and competitive in the Mozambican market (e.g. briquettes from South Africa are sold in Mozambique).

It should be discussed with the Mozambican government first whether they are willing to develop such legislation. If not, the current legislation and practices apply and forest plantation will very likely opt for pine and eucalyptus. Because development of legislation will take significant time, we suggest not to go into detail yet. This is however an option that can be discussed with the government to assess their interest and willingness.

3 Climate-financing

In this chapter the identified potential projects in chapter 2 are assessed on their potential to be (partially) financed from climate-related sources.

3.1 Potential of using REDD+ for Sustainable Forest Management

A potential climate-financing option is REDD+: Reduction of Emissions from Deforestation and Forest Degradation. REDD implementation is the responsibility of the host countries and their national laws. Various non-governmental organizations criticize the REDD mechanism for infringing on the rights of local and indigenous peoples. Therefore, land and tenure have to clearly established and supported by local communities before a REDD+ project can be implemented.

At the 2013 Conference of Parties seven decisions in relation to REDD were taken[7]:

1. REDD+ finance: Result-based finance for country action may come various sources, including the Green Climate Fund.
2. Coordination of finance (in the joint SBI/SBSTA): Interested parties are invited to design a national entity or focal point.
3. National Forest Monitoring Systems (SBTA): Governments decide how they define 'forests'. The system should be based on the available methodological guidance.
4. Summary of information on safeguards: To be provided on a voluntary basis.
5. Forest reference emission levels: Countries may (voluntary) submit a forest reference and/or forest emission reference level to be technically assessed in the context of results-based payments.
6. Measuring, reporting and verification of forest-related emissions. The system should be transparent and consistent over time. Parties should report every two years.
7. Drivers of deforestation and forest degradation: Encourages parties to take action.

A major REDD-related initiative in Mozambique was the South-South REDD, a co-operation between Brazil and Mozambique with financing from Norway.[8] The purpose of the project was to create the conditions under which Mozambique is able to implement a REDD-project. The initiative ended in 2012. A major result was the development of the REDD+ readiness preparation proposal (RPP). Mozambique's RPP was formally submitted to the FCPF in January 2012 and approved in March the same year. Mozambique has now approved REDD-regulation. Currently, JICA finances an MRV-GIS capacity-building project with two pilot projects in the Provinces of Gaza and Tete.

Potential financing mechanisms for Sustainable Forest Management are:

- Climate Investment Fund, Forest Investment Program (CIF-FIP):
  https://www.climateinvestmentfunds.org/cif/Forest_Investment_Program
- Global Environment Facility (GEF):
  http://www.thegef.org/gef/SFM
- Althelia Climate Fund
  http://www.ecospherecapital.com/about-althelia-ecosphere/our-esg/

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[7] http://www.redd-monitor.org/2013/11/25/what-came-out-of-warsaw-on-redd-part-1-the-redd-decisions/

[8] http://www.iied.org/south-south-redd-brazil-mozambique-initiative

3.2 Potential for a CDM-PoA

3.2.1 The Clean Development Mechanism Programme of Activities (CDM PoA)

Under the CDM a facility has been developed called PoA (Programme of Activities), which aims to bundle a large amount of small scale emission-reduction activities with the purpose to create such a scale that the activity can earn carbon credits in a cost-effective way. Next to the benefit of cost-effectiveness, an important benefit is that not all activities have to be known at the time of registration, but can be added later on. This allows for a small-scale start of the project, adding more activities while the charcoal sector is developing. Essential elements of a PoA are:

- Concrete GHG reducing activities
- An entity that manages and co-ordinates the CDM related actions (the CME).

The purpose of this section is to explore the feasibility of the three options identified above, within the existing framework of the CDM. This framework is basically determined by the registered methodologies.

3.2.2 Objective of a sustainable charcoal CDM-PoA

The objective of a sustainable charcoal production CDM PoA would be to make sustainable production of charcoal financially viable through the sales of carbon credits resulting from the greenhouse gas emission reductions realized, while safeguarding the sustainable development goals.

3.2.3 Charcoal project opportunities and CDM PoA

The selected project opportunities described in paragraph 2.5 can all (theoretically) be developed as a CDM-PoA:

- *Project 1 - Briquetting of charcoal residues*

  In general, only the product, charcoal briquettes, leads to emission reductions. As for the second potential product, medicinal charcoal, no emission reductions occur, this product is therefore left out of the analysis.

  Briquetting of charcoal residues substitutes charcoal production, thereby reducing the emissions occurring when producing the same amount in traditional (baseline) kilns, including emissions related to the use of non-renewable biomass.
- *Project 2- Introducing efficient kilns SFM*

  It became clear in the research and workshop that methane destruction is a step too far. The charcoal producers interviewed prefer individual, (partly)self-constructed kilns.

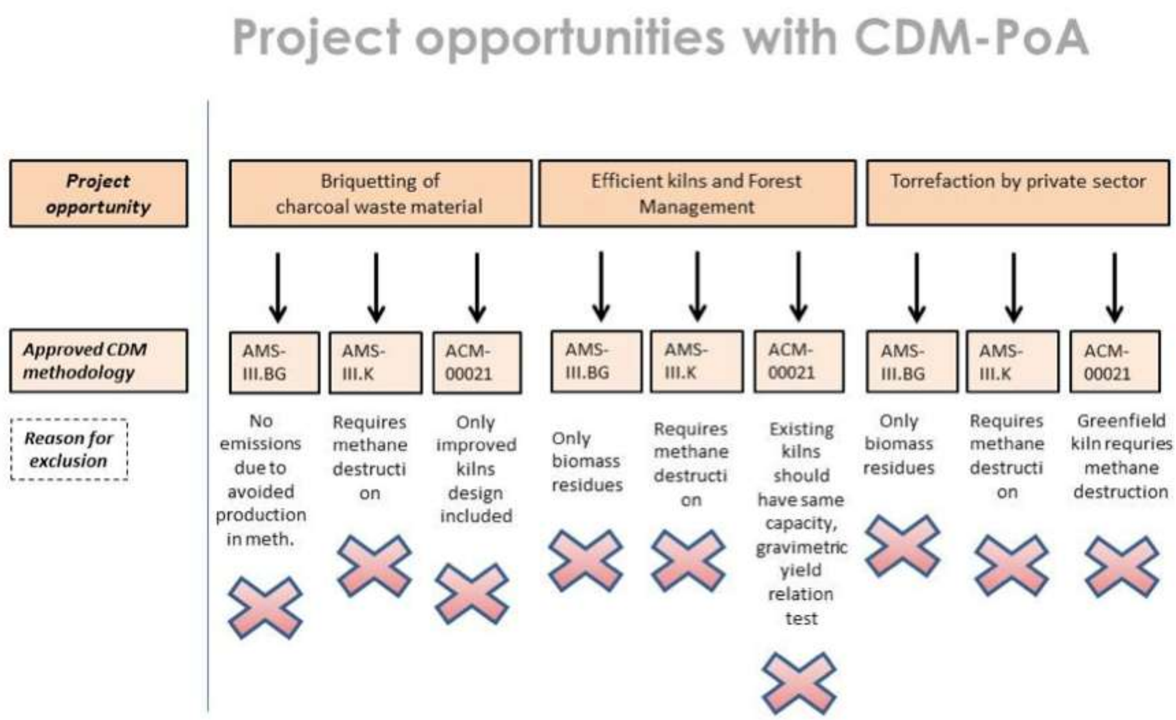
  The project opportunity includes two sources of emission reductions, (1) less emissions because of avoided deforestation due to reduced wood consumption and replanting of trees and (2) less CO_2 and CH_4 emissions resulting from more efficient kilns , needing less quantities of wood to produce the same amount of charcoal.
- *Project 3 – Torrefaction by private sector and SFM*

  The last potential project opportunity is to introduce torrefaction technology in areas with lower levels of producer organization and thus less opportunities for the above-mentioned projects. Combined with SFM and re-planting significant CO_2 and CH_4 emissions can be achieved via avoided deforestation (see above) and avoidance of methane emissions.

A CDM PoA involves the application of a CDM methodology approved by the UNFCCC.

A number of UNFCCC approved methodologies for sustainable charcoal production exist. Each methodology is applicable under certain conditions. A technical analysis of the three identified activities/projects against the criteria included in the existing methodologies leads to the conclusion that either none of the existing methodologies fully applies (see Annex 4 for the details of the technical analysis), or, in case of the briquetting opportunity, no methodology accounts for avoided production of charcoal (with the related emissions). Unless, a new CDM methodology is developed and submitted to the UNFCCC for approval – which is a long and expensive process and therefore beyond the scope of this assignment -, none of the identified project opportunities qualifies for climate financing via a CDM-PoA. The figure below summarizes the conclusions:

Figure X: Project opportunities with CDM-PoA



3.3 Potential for a NAMA

3.3.1 The option of a Nationally Appropriate Mitigation Action (NAMA)

Whereas the CDM provides a way for developed countries to help meet their emission reduction targets through purchase of additional project-based emission reductions from developing countries, Nationally Appropriate Mitigation Actions (NAMAs) are primarily conceived as a way for developing countries - with financial, capacity building and technological support from the international community - to make progress in reducing their own domestic emissions.

So far, 57 countries, plus the African Group, have expressed to the UNFCCC their interest to implement one or more NAMAs. Most of the NAMAs proposed have a timeframe up to 2020.

NAMAs show a large diversity as they include quantified emission reductions below a 'business as usual' scenario, intensity targets, sectoral policies and programmes, investment projects, and others. Some developing countries have also provided information on context, conditions and need for finance, technology and capacity building[9]. Mozambique has not yet communicated a NAMA proposal to the UNFCCC. During a meeting with representatives of the Ministry of Environment (MICOA) of Mozambique, these representatives expressed their eagerness to develop a NAMA proposal before the next Conference of Parties meeting (December 2014). A NAMA on sustainable charcoal was considered an interesting option.

The UNFCCC has set up a registry where Developing Country Parties can submit NAMAs and indicate the support needs and where Developed Country Parties can submit their offer for support. As of April 2014, the NAMA registry contained 44 NAMAs at different stages of development. The web-based NAMA registry was deployed in October 2013[10]. Another NAMA database is deployed by Ecofys. The objective is to share information on these activities so that countries and other participants are able to learn from these experiences and gain insights into how mitigation activities can be undertaken within the NAMA framework. This webpage is not a registry, it is a collection of publicly available data. It does not represent official submissions and may not reflect the priorities of the country governments. In March 2014 this database contained 95 NAMAs and 37 feasibility studies in 35 countries[11].

3.3.2 Objective of a charcoal NAMA

The key objective for a NAMA is that it directly or indirectly leads to measurable, reportable and verifiable (MRV) emission reductions activities by developing countries in the context of sustainable development.

In practice, there are three types of NAMAs:

- Unilateral NAMAs: which are implemented using only domestic resources and finance
- Supported NAMAs: which are implemented with use of international support such as grants, loans and capacity building programmes
- Credited NAMAs: which are implemented with use of international support under the UNFCCC through the carbon markets by creating and selling carbon credits to industrialised countries[12].

The vagueness of the NAMA concept extends also to the responsibility for their implementation. Under the Cancun Agreements, supported NAMAs are meant to be inscribed in the UNFCCC NAMA registry, and are expected to request and be given both (at least partial) financial and technical support, whereas unilateral NAMAs are only subjected to domestic MRV.

[9] http://unfccc.int

[10] More information is available at http://unfccc.int/7476.

[11] More information is available at http://www.nama-database.org

[12] *Although the framework for the third option does not exist yet, it is possible to register NAMA's under the UNFCCC and it might become a credible option for donors, even without use of the credits for their Kyoto targets.*

Table 3 Overview of NAMA MRV requirements

Characteristics	**Unilateral**	**Supported**	**Credited**
Type of finance	To be financed domestically	To receive international finance, capacity building or technology transfer	To receive payment in return for carbon credits
MRV requirements	Domestic MRV in accordance with guidelines developed under the UNFCCC. "National standards" appropriate for NAI	MRV according to international guidelines - yet to be developed under the UNFCCC	MRV according to international guidelines - yet to be developed under the UNFCCC Likely to draw upon CDM methodologies
Level of stringency and scrutiny	Lower Depends on national standards adopted	Higher Designed to provide confidence to financiers	Highest To provide confidence to the carbon markets and ensure environmental integrity

Although the use of a UNFCCC registered methodology is not obligatory, it is argued here that **the use of a registered methodology enhances the transparence and accountability and therefore the MRV-system of a NAMA**. Secondly our argumentation is that **the more stringent the MRV-system, the greater confidence to financiers can be provided** which is positive for the possibilities to finance of the NAMA and therewith for the success of the NAMA implementation.

There are several approaches that could be used for identifying and developing a NAMA: (1) top-down - on the basis of national commitments, strategies and policies; or (2) bottom-up - on the basis of experience with existing CDM projects, specifically PoA projects. A combination of the two approaches is also conceivable[13]. According to a UNDP study, a third (3) would be to start a NAMA from scratch. Within the NAMA framework existing standardized approaches and PoA' experiences can be used and adapted to the Mozambican context and the NAMA concept[14]. A crucial consideration is MRV.

In line with this third approach we have selected bottom-up project opportunities which both include emission reductions in the charcoal production sector, which can be turned into NAMA programmes (with use of the CDM methodologies), but which will be adapted to specific conditions of the NAMA concept in order to increase the probability for financing. Perspectives developed a range of practical selection criteria, which can be applied here in order to get well-developed NAMAs, to which some criteria are added by the authors of this report.

[13] *Perspectives, Mobilizing NAMAs and new carbon market mechanisms in RCREEE Member States post 2012, November 2011.*
[14] http://www.unep.org/urban_environment/PDFs/UNEP_UrbanCDMreport.pdf

Table 4: Selection criteria for NAMA opportunities

Criteria	**Explanation**
Sustainable development benefits	"strong" actions would reduce household fuel costs, or create for example local manufacturing opportunities as these can improve the livelihood of citizens and would be more appealing to donors Also, SFM practices should be present, to avoid deforestation or land degradation.
GHG mitigation potential	"high" suggests emissions reductions > 500ktCO2e per year
Low cost abatement	lower cost abatement activities are more likely to be implemented, - activities with negative costs (Energy Efficiency) will score particularly well
Required support	The type of support as well as the scale of the upfront investments needed might influence the choice of the donors
Time frame	Shorter time frame needed for design, implementation and achievement of actions might be more appealing to donors
Geographical scope	A NAMA which can be implemented through the host country might better serve the needs of the population
Ability to MRV actions	"easy" is if the NAMA approach can theoretically be based on an existing CDM methodology or for which sustainable development indicators can be easily monitored; more complex NAMAs involving many different actions will score lower
Additonality check	Measures or activities for which the additionality is proven in a structured manner do raise more confidence among donors and might in future become a prerequisite for credited NAMAs
Links to national climate policy	"strong" links are considered to exist where the country has clearly articulated climate policies and/or sectoral policies with a GHG emission reduction co-benefit and the NAMA is linked to these (e.g. stated in its submission in response to the Copenhagen Accords), as this suggests a higher chance of successful implementation
Level of country risk associated with the political and security situation	lower country risk enhances the likelihood of successful implementation and would also be more appealing to donors
Evidence of political commitment	higher political commitment increases the likelihood for a successful implementation

Source: Adapted from Perspectives, Mobilizing NAMAs and new carbon market mechanisms in RCREEE Member States post 2012, November 2011.

4 PROJECT 1: Briquetting of charcoal residues

4.1 Primary process activities (business case)

The current process of producing charcoal leaves a significant volume of small pieces and charcoal dust in the field. The producers see a strong potential market value for these residues. However, at the moment the sale of briquettes will probably fall within the limit of the 1,000 bags charcoal license. If this would remain the case only producers that do not fully produce at the moment can earn more money. Others that produce 1,000 bags would need less wood resources to produce the maximum allowed amount of 70,000 kg of charcoal per charcoal license. For them the incentive to produce briquettes would be strongest if they experience forest degradation and shortage of trees on their exploitation blocks. The government could however also decide to allow a maximum number of bags of briquettes on top of the current charcoal license. This would mean more income for the producers and a strong incentive for all.

Biomass briquettes are currently only sold at retail stores for middle and high income consumers for leisure purposes (barbeque). These briquettes are usually imported from South Africa (made from wood from Namibia) and sold at a premium price. The average price for these briquettes is calculated at 670 USD/ton. The average price of conventional charcoal in Maputo city is at 430 USD/ton. If local production of briquettes is to target the low-income household, it should therefore be price competitive to conventional charcoal.

Picture 1: Charcoal waste in the field, Gaza Province 2013.

The volume in charcoal residues is significant enough to allow briquetting (See picture). There are no exact figures on the volume (subject for a next phase). From the field study interviews the following information was derived: The charcoal producers stated they use approximately 70 Mopani trees of 25 cm diameter for one kiln. This equals roughly 21 tons wood. With the average earth kiln efficiency of 7:1 they would be able to produce 3,000 kg charcoal. The producers however also stated they can collect approximately 40 bags of 70kg per kiln which equals 2,800 kg charcoal. This rough estimate would suggest a loss of 200 kg material per kiln production, which can be used for briquetting. One producer may produce 1,000 bags for which he/she will need 25 earth kilns. This could mean 5,000 kg of charcoal residues per producer per year. The three best-organized CPAs mentioned on page 10 include app. 75 members (employing 570-1,170 people), which combined would mean 375,000 kg of charcoal residues.

The charcoal producers see chip-carbonization briquetting technology[15] as the most appropriate technology. The costs of this technology varies with the volume and carbonization time needed. The technology allows the charcoal producer to also use the smaller pieces of the trees as well. In a future dialogue with the CPAs it is important to determine whether a manual or an automated briquetting machine is required: A manual briquetting machine (which is generally just a manual press) can cost a few hundred US dollars, while the more advanced automated machines include components such as grinders, dryers and briquetters and can add up to cost anything from 10 thousand US dollars up to a hundred thousand US dollars (depending on scale of production and manufacturer). Such prices make it difficult for individual charcoal producers to become owners of automated briquetting machines. A Chinese based manufacturer best illustrates the different briquetting technologies available (http://charcoalbriquettemachine.com/).

An option for this model might be a centrally operated automated briquetting machine, owned and operated by the CPA, or another interested investor. Manual briquetting machines (or presses) may be further used by individual charcoal producers. The briquetting of charcoal residue does not need further carbonization. The simple press together with a binding agent will suffice.

Assumptions: *A small machine-powered briquetting machine can handle 200 kg per hour, which is equivalent to the amount of waste material per kiln rotation. If all producers would turn up in the same week with their 200 kg of charcoal residues each, approximately 30-35 production hours in total are needed. We assume it is acceptable for producers to wait 1-2 days on their turn, which means 1 machine per 10 producers would be acceptable. In addition each producer would want a manual briquetting machine as an alternative if the cost of petrol becomes too expensive or its production is too low. So, for the three best-organized CPAs mentioned on page 10, this means:*

Costs:	*7 machine-powered briquetting machines (10,000 USD each)*	*70,000 USD*
	75 manual briquetting machines (1,000 USD each)	*75,000 USD*

4.2 Enabling environment activities

For briquetting of charcoal waste materials, specific NAMA conditions to be met are:

- ✓ Enforcement of current legislation and government monitoring of production and transport in order to safeguard the additionality

The following activities are needed to create the right enabling environment for the project to become successful.

[15] They could also use this technology for residues from sawdust and other agriculture residues such as crop straws, rice husks, bamboo shavings, etc.

1) Governance

As stated earlier, the sale of briquettes will probably fall within the limit of the 1,000 bags charcoal license. The producers stated a strong preference for the government to develop regulation to allow briquette production above the current limitation of 1,000 bags. If the government would allow the sale of briquettes above the 1,000 bags charcoal license 'leakage' is an important consideration. How can be avoided that producers whom have reached their limit do not continue producing briquettes with additional wood resources. The government of Mozambique has two options:

- Include briquettes in the current charcoal license (in order to avoid leakage);
- Allow a maximum of 70 bags of briquettes on top of the charcoal license of 1,000 bags of charcoal (based upon 200kg of residues per kiln production x 25 kilns = 5,000 kg = app. 70 bags of 70 kg), which roughly means 17,500 Mt per year additional revenue per producer. The number of bags to be allowed in the license has to be verified by field research and a base line (now it is only based upon assumptions).

2) Marketing

The briquettes do not require different stoves. The target group of the charcoal briquettes – as identified by the workshop participants - are households (of all socio-economic levels), restaurants, kiosks and street vendors of cooked food. In addition institutional consumers like schools, prisons, hospitals etc. might be interested as well. The charcoal can be sold directly to the institutional client or through the regular outlets (at municipal markets, from shops, supermarkets and petrol stations). The producers found it important to communicate the products as of "certified quality" and brand it accordingly. The briquettes should be packaged in sacks different from the traditional charcoal bags under a specific brand name in order for the consumer to be able to make a clear distinction. The product brands can be communicated through specific packaging, flyers, posters and other means.

3) Monitoring and verification

At the workshop the monitoring of results was not discussed in-depth although it was clear to everyone that a sound monitoring system has to be developed. The MRV system to be developed for this project should:

1. Establish a sound baseline of average earth kiln production, volume of trees and tree branches used, and volume of charcoal residues
2. Monitoring production
3. Monitoring forest developments
4. Monitoring or CPA' capacity and performance as an organisation and outreach to members (e.g. peer-to-peer training).
5. Verification that the achieved results – GHG emissions reductions - are real through all of the above and independent auditing.

The monitoring system to be developed should be such that it can be internalised and financed by the charcoal value chain stakeholders without long-term dependency on external subsidies. During the set-up phase the need for subsidy is unavoidable. Given the economic context of the individual charcoal producer any monitoring system should be low-cost. Sending an auditing team into the field to check producer organisations and individual producers is too expensive. However, some external auditing of this self-monitoring system is still needed for legal control and if external / climate financing is used.

Establishing a baseline: Together with local producers and government authorities a baseline of charcoal production has to be established to determine an average volume of trees and tree branches used, charcoal residues per charcoal production cycle. This would also allow to make a proper calculations of the rough estimates presented earlier such as the quantity of bags of briquettes that can be produced annually. This is also needed to underpin a government decision on the license.

Monitoring production: The only way to establish a low-cost system is if the producers themselves do the monitoring and report to one central focal point, which reports to the authorities. Producers should introduce a balance sheet that notes the needed production information and they can take picture with their mobile phones. Climate-financed projects require strict MRV and when the CPA is a project partner the balance sheet could to be signed by the producer and counter-signed by the chair and treasurer of their CPAs to build a transparent and trustworthy MRV-system. Briquette bags should also be 70 kg and counted as part of the overall production (within or above the current license). The government can monitor charcoal production and marketing as it does now with the licensing system although improvements are necessary. The system itself has to be checked at regular intervals by an independent auditor with random field checks.

Monitoring forest development: By using the charcoal residues one producer can in theory produce 2-3 bags of 70kg with briquettes per production cycle or 50-75 bags on an annual basis. This means he/she needs to produce 3,500-5,250 kg <u>less</u> charcoal from trees, or 24.500-36,750 kg less wood is needed to produce the same amount of 1,000 bags. At app. 0.3 ton per tree this would mean 6,123 – 9,186 less trees have to be cut. This has to have a positive impact of the forest resources, which should be monitored (# trees, forest cover). For those experiencing forest degradation and thus a shortage of resources (and maybe already hamper their total production) this is a strong incentive.

Monitoring of capacity: The organisations and stakeholders involved need the appropriate capacity to implement a charcoal briquette program. Some – like the producers and local officials – need additional training. Monitoring and evaluating their capacity and performance can be part of the regular program-monitoring framework.

4.3 Costs and benefits, stakeholder commitment

Costs, for implementation in three CPAs, consisting of a total of 75 charcoal producers

Project / measure	Outputs	Outputs 4 yrs	Est. budget USD (4yr)
1. Briquetting			
Briquette units	7 briquette machines 75 manual briq. Machines (petrol paid for by producers)		155,000
Charcoal briquetted	375 ton / year	1,500 t	
Wood use	1,837 - 2,756 ton less / year	7,348 – 11,024 t	
Forest Management	6,123 – 9,186 less trees cut / year	24,492 – 36,744 less trees	
Governance	Control 'leakage' or improve enforcement		200,000
Marketing	Branding and sale		120,000
MRV	Baseline		85,000
	Monitoring system		200,000
Project management			200,000

			960,000

Benefits

In order to claim "Additionality" under climate financing, briquettes cannot be produced on top of the maximum amount of charcoal, thereby leading to more charcoal produced than in the baseline situation. In this case, briquetting of charcoal residues substitutes the production of charcoal and the emissions related to this substituted production are avoided. As mentioned earlier, this is an attractive option for producers, whom experience severe pressure from deforestation as they need less wood resources. The option is especially attractive for producers who cannot produce the full amount allowed and who would earn more money.

Per producer this leads to yearly emission reduction of 11.23 ton CO_2eq per year (see Annex 5 for the calculation of these emission reductions). In the three best-organized CPAs there are 75 members, which combined would lead to an emission reduction of 842 ton CO_2eq per year.

In addition there would be some significant co-benefits:

- Waste: 375,000 kg less charcoal residues in the forest per year from the 75 producers.
- Forest: If within the current license, 24,500 – 36,750 kg less wood is needed per year by one producer. This means 6,123 – 9,186 less trees to be cut per year for all 75 producers. If the briquette production falls outside the current license the amount of wood used remains the same.
- Income:
  - Option 1: If producers - incl. women - are allowed to produce additional to their license they could make an additional income of 17,500 Mt/year/producer or 1.3 million MT/yr for all 75 producers.
  - Option 2: If the briquettes are included in the current license, producers would only earn more money if they cannot fully produce at the moment, or, if they do, they save on wood resources and avoid forest degradation. In addition, the charcoal briquettes might also benefit poorer households if it is sold at a lower price.

Stakeholder commitment

As stated, the strongest motivation for charcoal producers to successfully use briquetting is when they would gain more income, the second factor would be less forest degradation. Various producer' profiles can be identified:

1. Producers do not reach their full 1,000 bags: they can produce more and gain more income. Pressure on the resource base will remain the same.
2. Producers do not reach their full 1,000 bags and experience degradation: they can gain more income. Pressure on the resource base will remain the same.
3. Producers reach their full 1,000 bags but experience no degradation: they would want a permit to produce above the current license and gain more income.
4. Producers reach their full 1,000 bags and experience degradation: they would have to use less wood to reach the full amount and would reduce degradation.

4.4 Sustainable development assessment

A preliminary assessment of the contribution to sustainable development of the proposed project activity, briquetting of charcoal waste material, is as follows.

Environmental impact

	Impact
Water *e.g. quality/quantity*	Neutral
Air *e.g quality, local pollutants*	Briquetting of charcoal residues partially substitutes for regular charcoal. Therefore less trees will be logged and less CO_2 will be emitted, while producing the same amount of charcoal.
Soil Condition *e.g. pollutants, erosion, land use.*	Charcoal residues and charred biomass left on kiln sites improve soil fertility. If the residues are removed for charcoal briquetting, this positive side-effect could be limited. The charcoal residues are however centered on the location of the kilns. The soil improvement properties are therefore localized. Because mainly the small chunks will be collected (which take a long time to degrade) and the charcoal dust will remain behind the soil fertility may not be affected. Within the communities visited there are no known practices of using charcoal residues to improve soil conditions on farm lands.
Biodiversity improvement *e.g. local species, habitat conservation*	Because less trees will be logged to produce the same amount of charcoal, the biodiversity of production areas will be better conserved.

Economic impact

	Impact
Financial benefits to local entities *e.g. energy efficiency, competitiveness, creation of new jobs, useful by products, touristic attractiveness*	• The project contributes to energy efficiency by making use of charcoal residues which otherwise would not be used and left in the field. • The project can have a positive effect on the competitiveness of the industry by introducing a new product, namely briquettes, a product that has potential to be competitive. • If producers - incl. women - are allowed to produce additional to their license they could make an additional income. But if briquette production will be add up to the total of produced charcoal, which is restricted to a limit, the project will not up-scale the charcoal production. The nr. of jobs will remain roughly the same. The nr. of jobs will only be affected if briquette making proves to be significantly more or less labour intensive than current production practices.
Sustainability of balance of payments e.g.	The use of charcoal for cooking is widely used in Mozambique, resulting in a relatively low use of fossil fuels for cooking. The project will contribute to a sustainable and long-term supply of charcoal, securing this type of energy supply.

dependency on fossil fuels, security of energy supply	
Technology transfer and self-reliance *e.g. new technology, replicable*	New technology regarding kilns and briquetting will be introduced to the charcoal producing communities based on their capacity to use these techniques and work methods. Thus the aim is that the communities themselves will be using this technology, resulting in technology transfer and self-reliance.

Social impact

	Impact
Poverty alleviation *e.g. poverty line, access to essential services*	Because of SFM practices and more efficient charcoal production, forests are better conserved and long term business generation within the sector is secured. Work opportunities may arise for those gathering the charcoal residues in the field as well as possible briquette machine operators.
Improved quality of life *e.g. quality of employment, access to affordable clean energy services*	• The project secures long term energy supply of charcoal and has a positive impact on clean energy access. In addition, it intends to introduce a cheaper type of charcoal (namely briquettes) targeting at the poorer people within Mozambique, making charcoal for cooking more accessible. Poorer households mainly use charcoal and firewood currently. • Work opportunities may arise for those gathering the charcoal residues in the field as well as possible briquette machine operators. Quality of employment will not be affected much however.
Improved equity *e.g. distribution to local stakeholders, participation in decision making*	The benefits of the project will completely be distributed to local stakeholders, namely the local charcoal producing communities. They will be owner of the project and its activities, possible with institutional support from the Mozambican government and with international support through de NAMA system (during the start-up phase). If the project will work with the private sector, there should be attention for a balanced decision making process, making sure that the stakes of local charcoal producer communities are sufficiently included.

Impact saving energy sources

	Impact
Saving of non-renewable primary energy sources	The use of charcoal for cooking is widely used in Mozambique, resulting in a relatively low use of fossil fuels for cooking. The project will contribute to a sustainable and long-term supply of charcoal, saving non-renewable primary energy sources.

4.5 Overall feasibility of project 1

Social feasibility
The charcoal producers themselves proposed this project during the workshop.

Environmental feasibility
The project will lead to less charcoal residues in the production area. If the producers have to produce within their current license they will need to use less wood, which helps to reduce the pressure on forest resources. Because mainly the small chunks will be collected (which take a long time to degrade) and the charcoal dust will remain behind the soil fertility may not be affected. The project is as such ecologically feasible.

In addition, the producers will use petrol for their briquette machines. It is assumed that the additional emissions from burning petrol is balanced by the wood savings but the carbon balance has to be calculated when a full proposal is drafted for climate financing.

Technical feasibility
The briquetting technology is easy to use.

Commercial feasibility
The project is commercially feasible. The initial costs for the briquette machines are just out-of-reach for the majority of charcoal producers: They do however currently gain a substantial income from charcoal production and have stated their interest to invest themselves. They are financially capable to pay for operation and maintenance of the machines.

If the charcoal producers are currently not producing the maximum amount or if they would be allowed to produce above the current license, they will gain more income. If the producers produce the maximum amount and experience forest degradation (as often the case in the vicinity of the major cities), this option is commercially attractive as it reduces pressure on the wood resources (long-term viability).

Organizational feasibility
The project as such is not difficult to organize or implement. The only difficult organizational aspect is governance. Already it is not easy to monitor charcoal production and forest developments. Depending on the licensing option chosen by the government, the monitoring and enforcement will require attention to avoid illegal production and 'leakage' (see paragraph 4.2 'governance').

5 PROJECT 2: Introducing efficient kilns and Sustainable Forest Management

5.1 Primary process activities (business case)

In general, the goal of the charcoal producer associations is to get access to forest resources and promote production of charcoal. Because most producers produce the maximum amount, higher revenues by increasing production from this project are not foreseen as long as the license limits production to 1,000 bags of charcoal per producer[16]. However, producers seem to experience forest degradation as a limitation to their production and they are aware of the increasing competition by other energy sources. Some also mentioned the increasing risk of droughts hampering forest recovery and increasing impact of forest fires. Therefore, the introduction of efficient kilns should be combined with SFM and a project should include the following elements:

1) *Efficient charcoal production including farming.*

For all kiln types, efficiency and quality of the charcoal increases with wood with lower moisture contents. Efficient and modern kilns would allow for more efficient production (see annex 6). Less raw material would be needed and less CO_2 and CH_4 would be emitted. This would also positively influence the sustainable management of the forest (less area needed, less logging, more potential for re-growth). The produced charcoal would also be better (higher calorific value i.e. higher energy content) and there would be less waste material. It is feasible and acceptable to the charcoal producers to introduce efficient earth kilns with chimneys and modern kilns on fixed locations (the general preference seems to be individual kilns rather than community kilns). Earth kilns with a chimney are an easy first step. All producers would like to learn more about various kiln options and would like to receive training on those kilns they prefer. Producers showed a preference for kilns they can make themselves from local raw materials. Methane abatement by flaring might be too technological for these producers.

Table 2: Kiln types and their efficiency (see also annex 6 on kiln types).

Kiln Technology	Average conversion	Efficiency	Life expectancy	Additional User requirements
Earth kiln	7 : 1	8 -15%	1 rotation	-
Earth kiln with chimney	5 : 1	14 -25%	Chimney lasts	-
Casamance kiln	4 : 1	20 - 30%	Materials last	Construction skills
Brick kilns	3 : 1	30-40 %	Years	Construction skills, wood cut to fit in the kiln
Retort kilns	2.5 : 1	>40%	Years	Construction skills, wood cut to fit in the kiln

Information is based upon field research and Energypedia.

[16] In theory, each member of a household can register as a producer and request an exploitation block from the Provincial forestry department. To some extent this is probably held in check by the communities themselves.

If one would assume the three best-organized CPAs would be involved in this project, the project would entail 75 CPA members (employing 570-1,170 people) or 75,000 bags of charcoal. At first, each producer would probably have either one Casamance kiln or construct one brick kiln and between 4-6 earth kilns with a chimney. All charcoal produced would be more sustainable than compared to current production. With the project the producers would introduce SFM practices and in time construct 1 or 2 other fixed kilns (brick or retort kilns) and no longer use earth kilns. At that time the whole production or 75,000 x 70 kg = 5,250,000 kg = 5,250 ton of charcoal would be produced in a sustainable manner.

Assumptions*: A brick kiln can produce the charcoal in 14 days and the capacity depends on the size, which is yet unknown. It is assumed for now that the capacity will be similar to a current earth kiln: 40 bags of 70kg charcoal. The second assumption is that each producer would use the brick kiln 12x and produce 33,600 kg charcoal with it. The producer would need 100,800 kg wood for this. In addition the producer would use improved earth kilns (i.e. a chimney) to produce the remaining 36,400 kg charcoal (13 kiln) for which he/she needs 182,000 kg wood. In total a producer would need 282,800 kg wood instead of 490,000 kg wood: a reduction of 207,200 kg wood per producer or 15,540 ton for the 3 CPAs (75 producers). At app. 0.3 ton per tree this would mean 51,800 less trees have to be cut.*
A brick kiln can be produced from local materials. Traditional mud bricks however will probably be not strong enough so some special attention to brick production and the mortar used is needed. Construction would entail oversight by an experienced mason, labour, bricks and mortar and training of the producer to operate, maintain and repair the brick kiln.

Costs:	*75 brick kilns (10,000 USD each)*	*750,000 USD*
	450 improved kilns (6 chimneys per producer, 200 USD each)	*90,000 USD*

2) *Sustainable Forest Management (SFM)*

The producers stated that they prefer larger forest areas to allow re-growth of trees (both through natural regeneration and re-planting). On the areas that have been used for charcoal production by earth kilns the land can be used for agriculture. Long-term legal rights (DUAT) to the land were considered crucial. Re-planting of native trees (Mopani and Terminalia were mentioned as attractive species) would mean a tree nursery has to be established in the vicinity of each CPA. As yet there is not much experience in re-planting native trees, more research and pilot-experience is needed.

Table 3: Forest area needed per license (70,000 kg charcoal).

Kiln Technology	Average conversion	Kg wood needed	Average Sustainable Forest Management area needed depending on re-growth		
			5 yrs	**10 yrs**	**15 yrs**
Earth kiln	7 : 1	490,000	165 ha	331 ha	495 ha
Earth kiln with chimney	5 : 1	350,000	118 ha	236 ha	354 ha
Casamance kiln	4 : 1	280,000	95 ha	190 ha	285 ha
Brick kilns	3 : 1	210,000	71 ha	142 ha	213 ha
Retort kilns	2.5 : 1	175,000	59 ha	118 ha	177 ha

- The retort kilns include all types of retort kilns: carbon twin retort, pyro-7 retort, Adam retort.

- The charcoal producers use mainly Mopani trees and the calculations are based on the assumption that only these species are used. The Mopani trees are cut at 25 cm diameter.
- There is little information on growth rates of Mopani under various conditions, which is a major limitation in the ability to manage and utilize Mopani. Cunningham (1996) estimated the wooden biomass available for charcoal production at 14,787 kg/ha for Mopani woodland.
- Assuming re-growth of the Mopani tree takes 4 to 5 years (**this still has to be researched carefully!)**, this means a legal, sustainable Exploitation Block with current technology could be 165 ha. In case re-growth takes 15 years however, the Exploitation Block would need to be 495 ha. According to local producers they would need 150-200 ha (field study interviews), which points towards a re-growth of around 5 years unless the block management is yet unsustainable and degrading fast.

The figures in the table show that with a more efficient kiln production the size of the Exploitation block could be reduced significantly. The development context of Mozambique and increasing forest degradation also indicate that if the re-growth of the trees used for charcoal is around 15-20 years, the introduction of modern kilns should be a short-term priority to ensure future production.

There is also room for improvements in mode of operation and selective logging (e.g. avoid cutting of young trees and trees with a small trunk diameter). Also the choice of the location for logging and the earth kiln might improve forest re-growth. The survival of the Miombo forest depends much on its root system. Excavating the topsoil to cover the earth kilns destroys the root system and fastens forest degradation. As yet there is no information on this subject.

5.2 Enabling environment activities

For the introduction of more efficient kilns and Forest Management, specific NAMA conditions to be met are:

- ✓ Establishment of sustainable rotation exploitation blocks and management system for charcoal producers in order to safeguard the use of renewable biomass
- ✓ Support the forest use planning and zoning of charcoal producer areas by the government and prohibition and enforcement (also through satellite monitoring) in other forest areas.
- ✓ Additionality of the technologies to be used for improved kilns should be determined ex ante i.e. a baseline has to be defined (e.g. by using the list of the standardized baseline of Uganda and adapt this to the Mozambican situation)

Activities in support of the primary process activities are:

1) Governance

The role of government was perceived as very important regarding implementation of the law, enforcement and taxation.

- Conditional to any progress towards sustainable production is the allocation of land rights (DUAT. See for an explantation the previous report).
- Participants also wanted the government to implement the Land Law and the 20% payment system to local communities under the Forestry and Wildlife legislation (i.e.

this is the return to communities from the tax charged for forest exploitation) as an incentive for SFM.

- The government was also asked to prohibit or limit logging for other applications. Participants discussed and concluded that part of the revenues from the licensing system should be re-invested in the charcoal production sector to become more sustainable and to support financing activities to make production sustainable (e.g. training, re-planting).
- Producers also indicated they could invest themselves in activities of the cooperative. Ideally the charcoal activities and climate financing, in order to create future financial sustainability, would pay for capacity building and other recurring costs. Thus, it is important to reform the licensing scheme and all charcoal-related organizations so that it facilitates sustainable production.
- Proper government capacity needs to be built to monitor forest resources, control illegal logging, and enforce licenses. This would lead to accreditation of producer organizations and a positive product differentiation.
- The government could also consider a specific license for charcoal produced in modern kilns which is closely linked to SFM in the exploitation block. This would allow both a higher production as well as stimulates SFM and re-planting. Enforcement would of course be key and has to be area-based.

2) Marketing

The target group of the sustainable charcoal – as identified by the workshop participants - are households (of all socio-economic levels), restaurants, kiosks and street vendors of cooked food. In addition institutional consumers like schools, prisons, hospitals etc. might be interested as well. The users would also have to resort to more efficient practices, such as using improved stoves. The producers found it important to communicate the product as of "certified quality" and brand it accordingly (e.g. "Chanatse" which is the local name for the Mopani tree associated with good quality charcoal). The certified brand can be communicated through specific packaging, flyers, posters and other means. Various cooperatives showed an interest in distribution and marketing through the acquisition of a truck and to establish presence in local sales outlets such as along the main road, at local markets and in urban supermarkets.

3) Monitoring and verification

At the workshop the monitoring (and verification) of results was not discussed in-depth although it was clear to everyone that a sound Monitoring, Reporting and Verification system has to be developed. The monitoring and evaluation system to be developed has different purposes:

1. Establish a baseline
2. Monitoring of kiln performance to be eligible for climate financing
3. Monitoring of forest cover and resources (deforestation, re-growth and re-planting)
4. Monitoring or organisations' capacity and performance
5. Verification that the achieved results – GHG emissions reductions - are real through all of the above and independent auditing.

The monitoring system to be developed should be such that it can be internalised and financed by the charcoal value chain stakeholders without long-term dependency on external subsidies. During the set-up phase the need for subsidy is unavoidable. Given the economic context of the individual charcoal producer any monitoring system should be low-cost. Sending an auditing team into the field to check producer organisations and individual producers is too expensive. However, some external auditing of this self-monitoring system is still needed for legal control and if external / climate financing is used.

Establish a project baseline: For the CPAs that want to participate in the project a baseline has to be established that include number of members, annual production, current number of earth kilns, volume of wood used, volume of charcoal produced and some measurement of CO_2 and CH_4 emissions (or by estimation through calculated carbon content of material used).

Monitoring of kiln performance: The only way to establish a low-cost system is if the producers themselves do the monitoring and report to one central focal point, which reports to the authorities. In addition the government can monitor charcoal production and marketing as it does now with the licensing system although improvements are necessary. The system itself has to be checked at regular intervals by an independent auditor with random field checks.

Potentially, monitoring of kiln performance by producers can be done by using a specific smart phone application, which include type and location of the kiln, amount of wood used, amount of charcoal produced, etc.. Such an application does not exist yet and has to be developed. Data transfer has to be organised because sending data through the phone network is too expensive (and there is not enough rural coverage anyway). If and how such a system can be paid for or commercialised has to be determined.

Monitoring of forest cover: In general, the 75 producers would have approximately 12,500 ha of forest under sustainable management. In order to track forest cover developments satellite images and remote sensing are the most appropriate tools. Until recently images were very expensive but NASA has decided to make them available at low cost. Also Google Earth can provide high-quality landscape images. This made the Global Forest Watch (by the World Resources Institute) possible, which was launched last year. The GFW can be used to monitor forest cover developments around the globe, including Mozambique. In combination with some 'ground truthing' this could be used in a low-cost effective way to track forest cover development and whether sustainable forest management goals are achieved.

Monitoring of capacity: The organisations and stakeholders involved need the appropriate capacity to implement a charcoal program. Some – like the producers – need additional training. Monitoring and evaluating their capacity and performance can be part of the regular program monitoring framework. One example can be the National System for the elaboration of the National GHG inventories that could entail the National Forestry Inventory and monitor the expansion/retreat of charcoal production areas and, ultimately, of the NAMA.

5.3 Costs and benefits, stakeholder commitment

***Costs*, for implementation in three CPAs, consisting of a total of 75 charcoal producers**

Project / measure	Outputs	Outputs 4 yrs	Est. budget USD (4yr)
2. Efficient kilns			
Brick kilns	75 brick kilns		750,000
Earth kiln + chimney	450 improved kilns		90,000
Sustainable charcoal	5,250 ton/year	21,000 t	
Wood use	25,540 ton less per year	62,160 t	
Forest Management	75 exploitation blocks or SFM on 12,500 ha		500,000
	Tree nursery for replanting		90,000
Governance	DUAT, land law		600,000
	Control illegal logging		
	Enforce licenses		
	Re-invest revenues		
Marketing	Branding and sale charcoal		120,000
MRV	Baseline		250,000
	Monitoring system		200,000
Project management			400,000
			3,000,000

Benefits

Since a NAMA is not a PoA, the limitation (described in chapter 4) to only biomass residues does not apply here. This makes the use of CDM methodology AMS III BG suitable for this project opportunity under a NAMA framework. The inclusion of Forest Management in the NAMA should safeguard the applicability criterion of renewable biomass feedstock. Following the application of a registered CDM methodology, project kilns not equipped with capture and destruction of the pyrolysis gases are not eligible to claim emissions reduction on account of avoidance of methane emissions from the project activity under this methodology. This amount is however minor, compared to the emission reductions due to the application of SFM.

The additionality of the projects should be safeguarded by a list of brick and improved kilns which can be used in the NAMA for which the additionality has been checked. An example of such a list can be found in the Standardized Baseline[17] of Uganda, this positive list includes:

- Casamanca kiln,
- Adam retort sedimentary kiln
- Carbo twin retort
- Pyro 7 retort sedimentary kiln with or without briquetting process.

This list can be adopted for the NAMA in Mozambique, or an alternative list of positive technologies can be registered at the UNFCCC as a standardized baseline or as part of the NAMA.

[17] Standardized baseline: Fuel switch, technology switch and methane destruction in the charcoal sector of Uganda Version 01.0

The calculation of emission reductions achieved in this project opportunity can be found in annex 5. The calculated emission reductions are due to SFM. The potential emission reductions from methane production associated with charcoal production are not accounted for as the methane in the project is not flared, which is a prerequisite for this in the methodology. Since this source of emission reductions is small (around 9 tCO_2eq per producer), the possibilities for inclusion in a NAMA are not investigated into detail. The baseline scenario set in the methodology would be the future use of fossil fuels for meeting similar thermal energy needs. If the methodology is properly applied, the calculated yearly emission reduction is 153 tCO_2eq per producer. For the three best organized CPAs with the mentioned 75 members, this would result in *11,475 ton CO_2eq less emitted into the atmosphere*.

In addition there would be some significant co-benefits:

- Waste: the amount of charcoal residues in the field would go down from 375,000kg to 175,500 kg (nothing from brick kilns, rest from the remaining earth kilns with chimney);
- Forest: If, within the current license, all exploitation blocks or 12,500 ha would come under a SFM-regime, combined the producers would need 15,540 ton less wood (with app. 0.3 ton per tree this would 51,800 less trees to be cut). They would use 62,160 ton less wood = 207,200 less trees in 4 years.
- Income: if restricted to the current license, the producer would not directly make more money but gain time they can spend on other income generating activities. Because less kilns need to be managed per year this can either lead to (a) concentration of production in certain months for which the same amount of people are needed; or (b) spreading production throughout the year for which less people are needed thus less employment (please note most of the employed people are seasonal migrants).
- Health: the brick kilns would also reduce smoke inhalations by the producers and their employees.

Stakeholder commitment

The strongest motivation for charcoal producers to successfully use modern kilns and apply forest management practices is when they foresee more income. The second factor would be less forest degradation. As stated before, an important pre-condition for this project is that the charcoal producer experience forest degradation. If not, they will not apply SFM practices and re-plant. Given this pre-condition two producer' profiles can be identified:

1. Producers do not reach their full 1,000 bags and experience degradation: they can significantly reduce the pressure on the resource base and start re-planting so can produce more in the future.
2. Producers reach their full 1,000 bags and experience degradation: they can significantly reduce the pressure on the resource base and secure their full production for the coming years.
3. Producers reach their full 1,000 bags but experience no degradation: they would the least motivated to apply SFM but with the modern kilns they would gain time to start other activities.

It is assumed from the above reasoning and discussions with producers in the field and at the workshop that producers with profile a1 and 2 are willing to invest themselves in improved kilns and re-planting.

5.4 Sustainable development assessment

A preliminary assessment of the contribution to sustainable development of the proposed project activity, efficient kilns and sustainable forest management, is as follows.

Environmental impact

	Impact
Water *e.g. quality/quantity*	Neutral
Air *e.g quality, local pollutants*	• Through the use of more efficient kilns, less CO_2 will be emitted during the production process of charcoal. • Through the use of more efficient kilns and sustainable forest management practices, less Co2 will be emitted because of the prevention of deforestation.
Soil Condition *e.g. pollutants, erosion, land use.*	Currently only traditional earth kilns are used, for which top soil is excavated. Through the use of modern and fixed kilns the use of top soil will be limited, which has a positive effect on the general soil condition and on the root system of trees.
Biodiversity improvement *e.g. local species, habitat conservation*	The proposed SFM practices focus on the re-growth of native species, reducing forest degradation and improving local biodiversity. In addition, through the use of more efficient kilns, less trees are logged, impacting the conservation of biodiversity positively.

Economic impact

	Impact
Financial benefits to local entities *e.g. energy efficiency, competitiveness, creation of new jobs, useful by products, touristic attractiveness*	• The project contributes to energy efficiency by introducing more efficient kilns. • The project can have a positive effect on the competitiveness of the industry by introducing charcoal of certified quality and brand it accordingly, a product that has potential to be competitive. • Because charcoal production is restricted to a limit, the project will not up-scale the total production. The aim is to produce the same amount of charcoal, but with less trees. This has a positive effect on the sustainability and security of the sector (and jobs), due to higher forest conservation (and regeneration). But on the short run it is likely that less employees are needed to produce the same amount of charcoal and some jobs will be lost. However, this could be compensated if forest management practices are applied and new jobs are created, such as for tree nurseries and for tree re-planting.
Sustainability of balance of payments *e.g. dependency on*	The use of charcoal for cooking is widely used in Mozambique, resulting in a relatively low use of fossil fuels for cooking. The project will contribute to a sustainable and long-term supply of charcoal, securing this type of energy supply.

fossil fuels, security of energy supply	
Technology transfer and self-reliance *e.g. new technology, replicable*	New technology regarding kilns and briquetting will be introduced to the charcoal producing communities based on their capacity to use these techniques and work methods. Thus the aim is that the communities themselves will be using this technology, resulting in technology transfer and self-reliance.

Social impact

	Impact
Poverty alleviation *e.g. poverty line, access to essential services*	Because of SFM practices and more efficient charcoal production, forests are better conserved and long term business generation within the sector is secured.
Improved quality of life *e.g. quality of employment, access to affordable clean energy services*	• If restricted to the current license, the producers would not directly make more money but gain time they can spend on other income generating activities. Depending on the concentration of activities some of the migrant employees would no longer be needed. • The brick kilns would also reduce smoke inhalations by the producers and their employees. • The project secures long term energy supply of charcoal and has a positive impact on clean energy access.
Improved equity *e.g. distribution to local stakeholders, participation in decision making*	The benefits of the project will completely be distributed to local stakeholders, namely the local charcoal producing communities. They will be owner of the project and its activities, possible with institutional support from the Mozambican government and with international support through de NAMA system (during the start-up phase). If the project will work with the private sector, there should be attention for a balanced decision making process, making sure that the stakes of local charcoal producer communities are sufficiently included.

Impact saving energy sources

	Impact
Saving of non-renewable primary energy sources	The use of charcoal for cooking is widely used in Mozambique, resulting in a relatively low use of fossil fuels for cooking. The project will contribute to a sustainable and long-term supply of charcoal, saving non-renewable primary energy sources.

5.5 Overall feasibility of project 2

Social feasibility

The charcoal producers themselves proposed this project during the workshop. Also government stakeholders were interested in this option.

Environmental feasibility
The project will lead to a very substantial decrease in the use of forest resources. The reduction will make sustainable forest management in the current exploitation blocks feasible. SFM practices need to be integral part of the project, which include natural re-growth, logging rotation, and replanting. Introduction of modern kilns is the only charcoal-related option to avoid further forest degradation. In addition other renewable energy sources should be used.

Technical feasibility
Depending on the modern kiln technology chosen, the producers can build the kiln themselves or need one-time support from a mason or technician. Maintenance of the brick and retort kiln is limited. The operations need some training. The essence of the training is however more on explaining <u>why</u> a certain practice has to be conducted (to get the efficiency needed) rather than the technology is complicated to understand.

Commercial feasibility
The project is commercially attractive. Given the current and increasing constraints with availability of land in the vicinity of the major cities, this is a commercially attractive option because less forest resources i.e. land is needed.

The initial costs for the kilns are out-of-reach for the majority of charcoal producers: they do however currently gain a substantial income from charcoal production and have stated their interest to invest themselves. They are financially capable to pay for operation and maintenance of the kilns.

This option is commercially attractive for the producers who produce the maximum amount and experience forest degradation (as often the case in the vicinity of the major cities), as it reduces pressure on the wood resources (long-term viability).

Organizational feasibility
The project as such is not difficult to organize or implement but it does need careful preparation with the major stakeholders. It is strongly recommended to implement the project with the charcoal producer that experience severe forest degradation becomes this will determine the success of the project. If the government of Mozambique decides this project becomes part of a NAMA some organizational aspects need to be considered: lead organization, legislation and governance. Already it is not easy to monitor charcoal production and forest developments. Some additional area-based monitoring is needed. This effort can be considered in the National System for GHG inventories, to maximize synergies and promote the coherence of the used methodologies.

6 PROJECT 3: Torrefaction and SFM by the private sector

6.1 Primary process activities (business case)

The third project opportunity is to *introduce torrefaction technology in regions with (a) high level of charcoal production with producers that already produce the maximum amount, and (b) lower levels of organization capacity and thus less opportunities for the above-mentioned projects.* Especially in regions close enough to urban markets but too far for producers to transport charcoal to the market at this moment. Companies might be very interested to integrate themselves in the value chain. In order to have a climate-relevant impact and reduce emissions, support to the private sector should include absorbing responsibility for organizing producers as suppliers to torrefaction unit as well as organizing sustainable forest management and re-planting.

Torrefaction is a thermochemical process whereby biomass is exposed to temperatures of 200 to 400 degrees Celsius under atmospheric pressure and in the absence of oxygen. Torrefaction is typically used as a technique to produce higher energy fuel from biomass. The process produces a solid, dry material, which displays similar characteristics to coal. The process of torrefaction is similar in efficiency to the retort kin (in terms of wood to coal ratio: 2.5 to 1), however is able to produce charcoal with a higher calorific value. Torrefaction technology has an additional advantage of scalability. The size of the chamber can be much larger compared to the retort kiln's design, which increases production capacity.

For torrefaction to be economically viable, it should be used at an industrial production scale. An average commercial viable scale for a company is estimated at 50,000 tons charcoal per year. This implies 125,000 tons of wood or 412,500 trees. For a Sustainable Exploitation Block with a rotation scheme of 5 years 42,142 ha of supply area would be needed. This amount of land is not available in the Maputo region for a single company. Therefore the supply area includes both the company land as well as individual suppliers (outgrower-plantation model). It should be noted that the more the company has to source from external suppliers (and thus organize this supply chain) the higher the transaction costs will be.

To assess this project in more detail several questions/concerns have to be answered in the future dialogue with government (next step):

1. If the private company which owns the torrefaction unit is also bound to 1,000 charcoal bags per year industrial production scale is not feasible?
2. Will the individual producers who deliver the wood to the private company be bound to 1,000 bags per year?
3. Will the producers continue making charcoal using their traditional kilns (up to their 1,000 bag limit) and provide additional wood to the torrefaction unit (therefore adding to the deforestation problem)?
4. Is there land available for large scale plantation based biomass sourcing?

These are questions, which need to be addressed together will Mozambicanauthorities. Additional regulations have to be developed based on the interest/need for private sector intervention in the charcoal value chain. Some possible solutions may be:

1. All wood to be used by the torrefaction units is directly linked to a licensed plantation with fixed boundaries and SFM (incl. mandatory replanting). <u>The production limitation is set to the plantation area and not to the number of bags</u>;

2. Charcoal producers can be given a limit to the quantities of wood supplied to the torrefaction center;
3. Charcoal producers could be financially encouraged by the torrefaction company not to produce charcoal in the traditional manner, if they chose to be suppliers to the torrefaction unit. This can be achieved by establishing a wood price, which is competitive to what the producers would otherwise earn selling charcoal at the gate. Since torrefaction is a more efficient technology, the amount of charcoal produced is more than three times the original amount (if produced in a traditional manner).

6.2 "Enabling environment" activities

Government policies and regulations must be updated to support private sector industrial level production of charcoal. Policies and regulations are currently targeted at small-scale charcoal production at community level or individual license holders. These policies are to regulate the existing charcoal value chain. Industrial production of charcoal, which brings about efficient technology, forest plantation, and large-scale production should be governed by industry-specific regulations. Such do not exist in Mozambique yet. Sustainability criteria for the industry should also be developed to avoid negative impacts of the industry. It is recommended that the countries' sustainability criteria for the biofuels industry be used as reference.

A public private partnership should be established for tree plantations/replantation programme. Local producers should participate actively in the sustainable charcoal value chain and would benefit from capacity building activities. If the project is established in an area with an organized CPA this CPA could become shareholder (including technology transfer.

For torrefaction by the private sector, specific NAMA conditions to be met are:

- ✓ According to the UNFCCC registered methodology to account for the emission reductions in the NAMA (AMS-III.BG, version 02), the renewable raw material supplies used in the project activity should originate from sustainable sources of biomass. Biomass is "renewable" if the biomass is originating from land areas that are forests where:
    - a) The land area remains a forest; and
    - b) Sustainable management practices are undertaken on these land areas to ensure, in particular, that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and
    - c) Any national or regional forestry and nature conservation regulations are complied with.

1) Governance

In general, the role of government is very important regarding implementation of the law, enforcement and taxation. For torrefaction to succeed it is important that government policies and regulations are updated to support private sector industrial level production of charcoal.

2) Marketing

The company has to motivate producers to supply them with raw material by informing producers about this opportunity and making them a sound offer.

The target group of the torrefied charcoal is the same as for regular charcoal: Households (of all socio-economic levels), restaurants, kiosks and street vendors of cooked food. In addition institutional consumers like schools, prisons, hospitals etc. might be interested as well.

3) Monitoring and reporting

In general, a sound monitoring system has to be developed. The monitoring and evaluation system to be developed has different purposes:

1. Establish a baseline
2. Monitoring of performance of the torrefaction unit(s)
3. Monitoring of forest cover and resources (deforestation, re-growth and re-planting)
4. Monitoring or organisations' capacity and performance
5. Verification that the achieved results – GHG emissions reductions - are real through all of the above and independent auditing.

The monitoring system has to be developed by the company and become part of its overall business activities and budget. This should be developed together with the company's own monitoring and evaluations system.

Establish a project baseline: The company has to develop a baseline that include number of producers, annual production, volume of wood used, volume of charcoal produced and some measurement of CO_2 and CH_4 emissions (or by calculated carbon content of material used).

Monitoring of unit performance: The company has to measure performance i.e. CO_2 and CH_4 emissions.

Monitoring of forest cover: The regions in which the torrefaction unit is operational has to be monitored to track the forest cover and to allow for monitoring unwanted impacts. The Global Forest Watch (by the World Resources Institute) can be used to monitor forest cover developments. In combination with some 'ground truthing' this could be used in a low-cost effective way to track forest cover development and whether sustainable forest management goals are achieved.

6.3 Costs and benefits, stakeholder commitment

The investment for an industrial scale production of sustainable charcoal is considerable but also potentially commercially viable. The running costs for a 50,000 ton production facility is estimated at 11 million USD per year. This includes reforestation activities as well as purchasing the biomass from smallholders or large-scale forest plantations. The capital investment for the technology (torrefaction facility and other initial investment costs are estimated at 12.5 million USD. The potential revenues of a sustainable charcoal production business are however equally great. The market price for conventional charcoal in Maputo city is currently at 450 USD per ton. The value of 50,000 tons of sustainable charcoal is therefore estimated at 22.5 million USD. Investors and project developers stand to make a considerable margin within this market segment. The enabling conditions for such a business to occur are fundamental to the success. The political environment; consumer acceptance of this alternative fuel; as well as availability of large amounts of feedstock is paramount.

Costs

Project / measure	Outputs	Outputs 4 yrs	Est. budget USD (for 1yr in mature business)
3. Torrefaction			
Torrefaction unit	One 50,000 t torrefaction unit		4,000,000
Sustainable charcoal	50,000 ton/year	200,000 t	
Wood use	125,000 ton less wood[1]	500,000 t	
Forest Management	42,142 ha under SFM in an outgrower-plantation model		500,000
	Sustainable exploitation and replantation of existing forests		1,000,000
	Forest and agricultural residues		200,000
	Tree nursery for replanting		500,000
Governance	Regulations and licensing		100,000
Marketing	Branding and sale		300,000
MRV	Baseline		85,000
	Monitoring system		200,000
	Total investment costs private sector		***12,505,000***
Wood feedstock purchased	125,000 t/yr bought at 50 USD/t		6,250,000
Running costs	Worker salaries		250,000
	Transport to sales point		250,000
	Tax		4,300,000
	Total running costs		**11,050,000**

[1] It is assumed that the charcoal will replace unsustainable charcoal in the market because the torrefaction unit will be introduced in a region with (a) high level of charcoal production with producers that already produce the maximum amount, and (b) lower levels of organization capacity and thus less opportunities for the above-mentioned projects.

The project is commercially viable. However because the torrefaction project needs approximately 42,142 ha of supply area, which is not available in the Maputo region for a single company, many outgrowers are needed. It is likely that for this part of the project subsidy is needed to make the project viable. Also some replanting might be needed on degraded areas. These costs cannot be estimated yet because they depend upon the exact location.

Benefits

Since a NAMA is not a PoA, the limitation (described in chapter 4) to only biomass residues does not apply here. This makes the use of CDM methodology AMS III BG suitable for this project opportunity under a NAMA framework. The inclusion of Forest Management in the NAMA should safeguard the applicability criterion of renewable biomass feedstock. The calculation of emission reductions achieved in this project opportunity can be found in annex 5. The calculated emission reductions are due to SFM and, to a lesser extent, due to avoidance of methane production. The baseline scenario set in the methodology would be the future use of fossil fuels for meeting similar thermal energy needs. If the methodology is properly applied, the calculated yearly emission reduction is 112,362 tCO_2eq per year for a torrefaction unit producing 50,000 tons of charcoal per year from renewable biomass.

In addition there would be some significant co-benefits:

- Waste: Agricultural and forestry waste streams can be used as feedstock for torrefaction. This allows for further reduction of deforestation.
- Forest: It is assumed that the 50,000 tons of torrefaction-based briquettes will replace at least the same quantity of production (torrefaction needs less wood so SFM can be established on the same amount of land now used with earth kiln production). When considering the current efficiency level of traditional kilns, this translates to a saving of approximately 125,000 tons of wood. With approximately 0.3 tons of wood per tree, this would be 412,500 less trees to be cut.
- Income: Besides the market opportunities for the private sector, community members may be engaged as workers and suppliers of biomass to the project. This directly impacts upon household income in the region. Furthermore, if agro-forestry models are introduced, a further income opportunity with the sale of food crops can be generated. It is believed that the torrefaction facility will stimulate other market opportunities in the region.
- Health: If the communities would be engaged as suppliers of biomass and not produce their own charcoal, they would not inhale smoke anymore from the traditional kilns.

Stakeholder commitment

Industrial scale sustainable charcoal production has not yet been developed in Mozambique. Initial consultation with government, local communities and civil society points favorably towards the development of such initiatives.

For government this business model brings about an opportunity to achieve policy targets of reducing deforestation as a result of unsustainable charcoal production. Furthermore, the prospects of a private public partnership (PPP) within sustainable forest plantations are of interest to the Ministry of Agriculture and the state run agriculture fund (FDA).

Initial discussion with charcoal production communities points towards the establishment of favorable business opportunities between these communities and private sector. Employment opportunities as well as prospects for a supply chain establishment for biomass are direct benefits. Furthermore, communities may be engaged in agro-forestry business models, which not only contribute towards reforestation, but also stimulate food production in the region.

This model also gives an opportunity for environmental and development organizations to become integrated and support communities to become better integrated in a sustainable biomass supply chain. The introduction of agro-forestry models which foster reforestation and food production are such examples.

6.4 Sustainable development assessment

A preliminary assessment of the contribution to sustainable development of the proposed project activity, torrefaction and sustainable forest management by the private sector, is as follows.

Environmental impact

	Impact
Water *e.g. quality/quantity*	In the case of a plantation that is owned by a private company, it should be checked if water resources are situated within this area where local communities make use of. If access would be denied to them this could have a negative impact on the water quantity access for local communities.
Air *e.g quality, local pollutants*	• Through the use of torrefaction, less CO_2 will be emitted during the production process of charcoal. • Through the use of torrefaction and sustainable forest management practices, less CO_2 will be emitted because of the prevention of deforestation.
Soil Condition *e.g. pollutants, erosion, land use.*	• Currently only traditional earth kilns are used, for which top soil is excavated. If the CPAs would limit their activities to supplier for torrefaction and not built earth kilns anymore, this would have a positive effect on the general soil condition and on the root system of trees. • If accessible land would be converted to a forest plantation, this could have a big impact on the land use of that area if it is used by communities for practices of agriculture, cattle, collecting fuel wood etc. Denied access could be beneficial from an ecological point of view, but undesirable from a social point of view. This should be assessed case by case.
Biodiversity improvement *e.g. local species, habitat*	The proposed forest management practices focus on the re-growth of native species, reducing forest degradation and improving local biodiversity. In addition, through the use of torrefaction, less trees are logged, impacting the conservation of biodiversity positively.

Economic impact

	Impact
Financial benefits to local entities *e.g. energy efficiency, competitiveness, creation of new jobs, useful by products, touristic attractiveness*	• The project contributes to energy efficiency by introducing more efficient kilns. • The project can have a positive effect on the competitiveness of the industry by introducing charcoal of certified quality and brand it accordingly, a product that has potential to be competitive. • If the production limit will be maintained, the project will not up-scale the total production of charcoal (because the project focusses on more organised CPAs that already produce the allowed maximum of charcoal). Then the same amount of charcoal would be produced, but with less trees. This has a positive effect on the sustainability and security of the sector (and jobs), due to higher forest conservation (and regeneration). But on the short run it is likely that less employers are needed to produce the same amount of charcoal and some jobs will be lost. In addition, if

	the CPA's would only have a role as supplier to torrefaction, this could implicate that less man-power is needed. However, this could be compensated if forest management practices are applied and new jobs are created, such as for tree nurseries and for tree re-planting. And also, new jobs could be created at the private companies for torrefaction activities and within the plantations.
Sustainability of balance of payments *e.g. dependency on fossil fuels, security of energy supply*	The use of charcoal for cooking is widely used in Mozambique, resulting in a relatively low use of fossil fuels for cooking. The project will contribute to a sustainable and long-term supply of charcoal, securing this type of energy supply.
Technology transfer and self-reliance *e.g. new technology, replicable*	• New technology regarding torrefaction will be introduced to private companies. If the CPA's only will function as supplier to the private companies, limited technology transfer will be realised and also the self-reliance of the CPA's with regards to charcoal production will be reduced. • On the other hand, a local business successfully producing and selling briquettes (through torrefaction process) might foster the replication of briquette production by local communities (using efficient kilns and manual briquetting technology). This may in turn have a positive ripple effect for community based sustainable charcoal production.

Social impact

	Impact
Financial benefits to local entities *e.g. energy efficiency, competitiveness, creation of new jobs, useful by products, touristic attractiveness*	• Because of forest management practices and more efficient charcoal production, forests are better conserved and long term business generation within the sector is secured. • Besides the market opportunities for the private sector, community members may be engaged as workers and suppliers of biomass to the project. This directly impacts upon household income in the region. Furthermore, if agro-forestry models are introduced, a further income opportunity with the sale of food crops can be generated. It is believed that the torrefaction facility will stimulate other market opportunities in the region. • Partnering with the private sector can provide interesting economic opportunities, such as an expansion of business and creation of jobs. However if in practice will have a positive impact on the involved CPA's and surrounding communities, depends on the conditions that private companies will set, for example will CPA's get good prices for their wood as supplier or will labourers of plantations receive a good wage? If these are favourable, this can have a positive impact on poverty alleviation. • If the communities would be engaged as suppliers of biomass and not produce their own charcoal, they would not inhale smoke

	anymore from the traditional kilns, impacting their health positively.
Sustainability of balance of payments *e.g. dependency on fossil fuels, security of energy supply*	The project secures a long term energy supply of charcoal, resulting long-term affordable access to clean energy services. Depending on what conditions the private sector will set, the quality of employment can be impacted either positively or negatively.
Technology transfer and self-reliance *e.g. new technology, replicable*	Because the CPA's will work with the private sector, there should be attention for a balanced decision making process, making sure that the stakes of the CPA's and surrounding communities of plantations are sufficiently included.

Impact saving energy sources

	Impact
Saving of non-renewable primary energy sources	The use of charcoal for cooking is widely used in Mozambique, resulting in a relatively low use of fossil fuels for cooking. The project will contribute to a sustainable and long-term supply of charcoal, saving non-renewable primary energy sources.

6.5 Overall feasibility of project 3

Social feasibility
This option was not discussed at the workshop with companies. The private sector has shown interest in torrefaction (e.g.one project will be implemented in the nearby future, financed by AECF-REACT) but a major constraint is the availability of land area and whether a company is allowed to produce more than 1,000 bags. Whether this option is socially acceptable depends on how the company deals with local villagers (respect contracts, employment, correct payment of wood suppliers).

The potential work related opportunities for community members as well as the development of out-grower models will have a positive impact on poverty alleviation. It is also possible to develop a model whereby the local community has a stake in the investment. In this manner they will not feel excluded from the development. This can be set up whereby a percentage of the revenue earned is channelled into a community fund and used for social infrastructure or further forest management practices.

Environmental feasibility
The project will lead to a very substantial decrease in the use of forest resources. The reduction will make sustainable forest management in the exploitation blocks feasible. SFM practices need to be integral part of the project, which include natural re-growth, logging rotation, and replanting. Introduction of modern kilns (of which torrefaction is one option) is the only charcoal-related option to avoid further forest degradation. In addition other renewable energy sources should be used.

Technical feasibility
The use of torrefaction technology requires careful attention. A company with its trained staff and strict protocols is the most suitable entity for operations of the torrefaction technology combined with SFM practices on a large scale. Maintenance and operations are technically feasible.

Commercial feasibility
The torrefaction technology is too expensive for charcoal producers and can only be made viable with a company and with scale. The project is expensive but also has high returns. The project is in itself commercially viable if the full amount of land is available to a company. If the company has to enter into an agreement with a large number of small wood suppliers this will require additional expenses and make the project commercially less attractive. In that case government support is needed to organize the producers (these projects are often in the form of public-private partnerships). Given the current and increasing constraints with availability of land in the vicinity of the major cities, such a PPP is a commercially attractive option because less forest resources i.e. land is needed.

Organizational feasibility
A PPP on torrefaction with many suppliers is rather complicated and has high transaction costs. Because monitoring, verification and reporting is linked to one entity – the company – monitoring is actually less difficult for the government to organize.

7 Conclusions and recommendations

7.1 NAMA project opportunities

When applying the NAMA criteria to the three project opportunities, the following analysis can be made. The quantitative analysis refers to the impact for the described 3 CPAs with 75 members in case of project 1 and 2 and the described torrefaction unit only. The purpose of the NAMA would be of course to scale up the activities to all important charcoal production areas. If one would consider the three main urban markets in Mozambique alone (Maputo, Matolo and Beira) this already entails 2,773,000 people. With an average household size of 5 persons this implies approximately 554,000 households. An estimated 75% of these households (i.e. 416,000 households) use charcoal as their main fuel (one 70 kg bag per month) even though they also have other stoves at home (BEST 2012). In total they now use 29,120 ton charcoal per month or 349,440 t/yr. If the same amount of charcoal would be produced using brick kilns and SFM in forests (project 2) this would imply:

- *Wood use*: moving from earth kiln to brick kiln means 2.5 times less wood for the same amount of charcoal: From using 2.4 million t wood to 1 million t wood. This means 3.3 million trees saved on an annual basis.
- SFM: Currently the charcoal comes from areas that are unsustainably used and degrade. In order to produce the above amount with brick kilns 354,000 ha of land (assuming a 5 yr rotation) would be under SFM practices.

Table: Overview table of projects

Criteria	Project 1 – Briquettes	Project 2 –Efficient kilns and SFM	Project 3 –Torrefaction
Sustainable development benefits	Moderate. Positive effects on sustainable charcoal production (375 ton per year), waste, forests (2,756 ton less wood used per year) and income for CPA's.	Strong. Positive effects on sustainable charcoal production (5,590 ton per year) waste, forests (17,612 ton less wood used per year), SFM, health and income for CPA's.	Strong. Positive effects on sustainable charcoal production (50,000 ton per year), waste, forests (up to 350,000 ton less wood used per year), SFM, health and income for private sector/CPA's.
GHG mitigation potential	Low (842 tCO2eq/yr)	Moderate (11,475 tCO2eq/yr)	Strong (112.362tCO2eq/yr)
Low cost abatement[18]	High, 1140 USD/tCO2eq/yr	Moderate, 261 USD/tCO2eq/yr	Moderate, 106 USD/tCO2eq/yr
Required support	Small, upfront investments for briquetting presses (155,000 USD),	Moderate, upfront investments for improved kilns (840,000	Big, upfront investment for torrefaction units (4,000,000 USD) as well

18 Only costs directly related to the emission reductions are calculated here, like improved kilns and SFM.

	capacity building	USD), capacity building	as running costs.
Time frame	Short, 2 years feasible	Moderate, 4 year for full implementation	Can initiate production from year 1 with full operation in year 4
Geographical scope	At first limited to Maputo/Matola region as here pressure from deforestation is most severe (but also around Beira)	Start with Gaza/Maputo region as CPAs are best organized, extension possible to rest of Mozambique	Will either be implemented in Maputo or Gaza region as market is Maputo city and Matola city
Ability to MRV actions	Easy, AMS-III.BG applies, only monitoring parameter would be the produced quantity of briquettes	Easy, AMS-III.BG applies, monitoring involves the produced quantity of charcoal, and the safeguarding of use of renewable biomass through SFM	Easy, AMS-III.BG applies. Easy to monitor due to book keeping and organizational capacity of private sector developer. SFM should be monitored as well
Additionality check	Strong, because residues are used.	Strong, as long as technologies which are automatically additional under a to-be-developed Standardized Baseline for Mozambique are applied.	Strong, as residues are used as well as replantation program shall be implemented
Links to national climate policy	Fits under 2009 NAPA and the new biomass energy strategy		
Level of country risk associated with the political and security situation	Medium – risk: Although the situation is improving there is still a governance risk related to corruption, conflicts over land and unclear land rights.	Medium – risk: Although the situation is improving there is still a governance risk related to corruption, conflicts over land and unclear land rights.	Medium-high: as investors to the project may require long term stability as to guarantee return on investments
Evidence of political commitment	MICOA is the lead government organization on NAMA, however, sustainable forest management is under the Ministry of Agriculture, which might lead to political discussions (as is now the case for REDD activities). Therefore the CIB - Interdepartmental Commission on Biofuels and Biomass -(which includes all relevant Ministries) should be involved and endorse the developments. *In the February 2014 meeting between MICOA and the Belgium government, MICOA confirmed its commitment. The CIB has stated their interest but are not yet committed.*		

From the table above, conditions for a successful NAMA can be summarized as:

- ✓ A lead government organization for development of the NAMA together with other relevant government, society and private sector stakeholders

- ✓ Support the licensing system by organisation and legal establishment of new Charcoal Producer Associations in other provinces in order to enlarge the scale of the NAMA.
- ✓ Development of a monitoring and reporting system for crucial indicators such as for the produced quantity of briquettes or sustainable charcoal by the CPAs; emissions, forest cover and other sustainable development benefits (see previous chapters).

7.2 Conclusions and recommendations

The study presented and discussed with stakeholders various potential business models: (1) briquetting charcoal residues; (2) introducing modern kilns and sustainable forest management; (3) private sector plantations with native trees; (4) forest plantation residues; (5) charcoal from other sources: (6) torrefaction by the private sector. From the stakeholder discussions three feasible projects have been defined further: (1) briquetting charcoal residues; (2) modern kilns and sustainable forest management; and maybe (3) torrefaction by the private sector.

Another potential project 'Production of charcoal from Forest Plantations with native species' has not been researched in more detail. If a plantation company is to produce charcoal for the Mozambican market from native trees specific legislation is needed to avoid them to plant other species and shift to other market segments. It should be discussed with the Mozambican government first whether they are willing to develop such legislation. If not, the current legislation and practices apply and forest plantation will very likely opt for pine and eucalyptus.

Contact was established with seven CPAs from the Gaza and Maputo provinces, which have different levels of organizational capacity. It is recommended to start with three Associations - those preliminary assessed as well-enough organized with app. 75 members employing 570-1,170 people – in future project developments. Other Associations can be added at a later stage, if the pilot project proofs successful.

The potential of a CDM-PoA has been assessed based upon the accepted methodologies. The conclusion from the technical analysis is that none of the methodologies are fully applicable. Major reasons are that one potential methodology requires solely use of biomass residues, whether another requires that the construction of the modern kilns will <u>all</u> be the same in terms of capacity and design and a final methodology requires methane destruction, which is not feasible given the current capacity of the charcoal producers in Mozambique.

The feasibility of a NAMA has been assessed as well. The key objective for a NAMA is that it directly or indirectly leads to measurable, reportable and verifiable (MRV) greenhouse gas emission reductions by developing countries in the context of sustainable development. <u>From the analysis it can be concluded that the main emissions reductions will be achieved by Sustainable Forest Management and only secondly by introducing modern kiln technology</u>.

7.3 Follow-up process

The follow-up process on this report mainly entails discussing the described project options with the main stakeholders.

First, the project team will engage in consultations with the Mozambican government to find out if the government is interested in pursuing activities to make the charcoal production sector more sustainable and if so, which project options it finds most feasible and attractive. Ideally, the option would be endorsed by the Inter-departmental Commission on Biomass, ensuring buy-in from all relevant Ministries. Secondly, the project team can assist the Mozambican government – if so desired - in formulating the selected project options in such a way that they can benefit from climate financing opportunities. This means that it will especially work on the MRV-aspect of the project options. The team can also assist the stakeholders in submitting the project proposals to potential financiers.

The charcoal producers also can be engaged to discuss the feasibility of options and their on-going interest. The producers have also stated their worry that the whole process would take very long and they experience problems now. Therefore, we suggest to consider some Fast Track pilot activities or studies to keep stakeholders involved and motivated:

1. *CPA-capacity analysis:* During the study and based upon interviews it became clear that there are still many un-clarities about the actual organization-level and capacities of the charcoal producer associations which need further study to assess the actual and up-scaling potential e.g.: how many are there in the Maputo and Gaza provinces?, how many members and employees to they have?; how is the CPA organized?, what is their legal status? Do they have administration and MRV capacities?, how much land falls under their CPA?
2. *Pilot kiln construction*: construct in each of the regions near the three CPAs some modern kilns together with local producers with local materials and local technicians to assess this potential, and to assess all local implications and constraints;
3. *SFM study*: map the wood resources, wood cutting practices and level of forest degradation and assess the potential re-growth rates of the wood species used (to assess the rotation scale).

These suggested options will also provide valuable baseline information that can be used to assess the commercial feasibility, social acceptability and ecological sustainability better.

It is advised to also consult some private sector stakeholders and for example the African Enterprise Challenge Fund on if and how charcoal production from torrefaction can be taken forward under a NAMA.

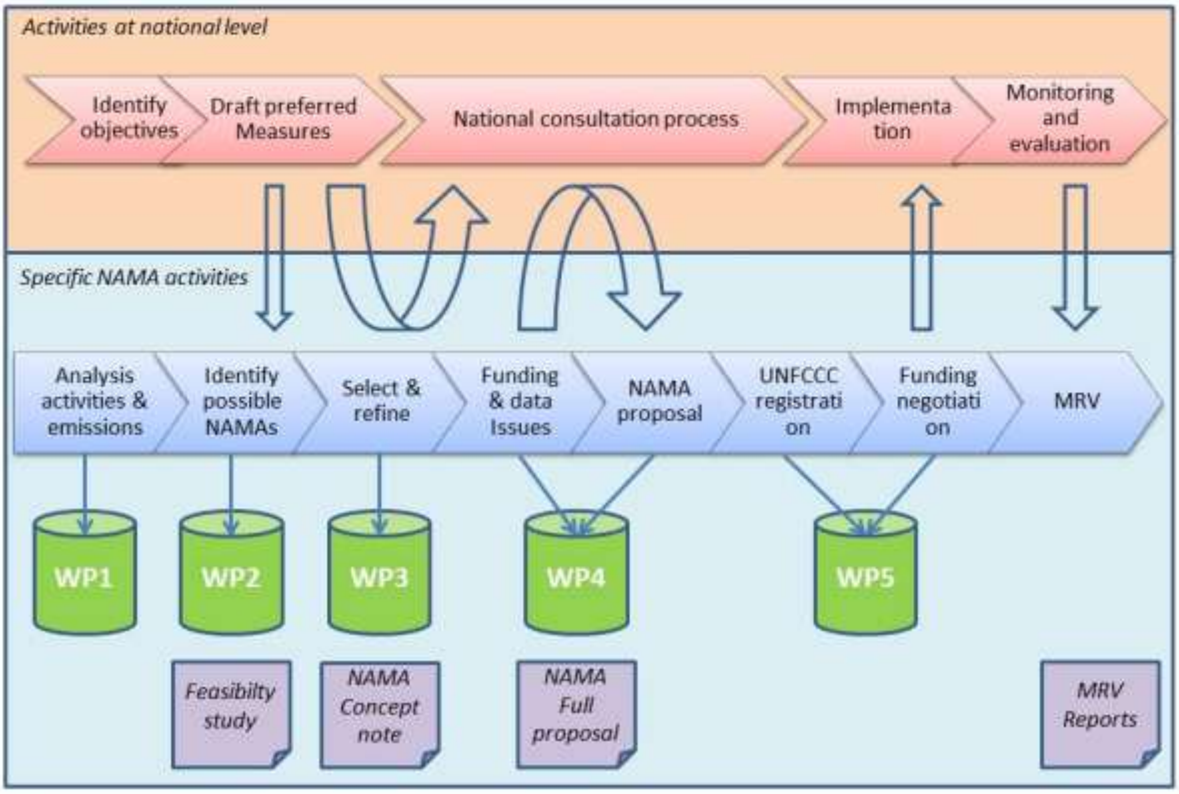
7.4 Steps to be taken

Now three potential project opportunities are selected as being a potential NAMA in the charcoal sector of Mozambique, the NAMA itself can be developed. This process is reflected in the figure below.

Figure – NAMA development process[19]

[19] Based on: Sterk, Presentation at COP17 side event, 2011, Wuppertal Institute

NAMA development process



Steps already taken are:

- ✓ objectives have been defined (make the charcoal production sector more sustainable)
- ✓ activities and emissions have been analysed (in the previous Work Package)
- ✓ preferred measures have been drafted based on the Workshop
- ✓ Possible NAMA's are identified and selected (in this Work Package)

After consultation among stakeholders of this report, NAMA concept notes can be developed (in the next Work Package), which can undergo a national consultation process. Meanwhile, funding issues and data issues can be worked out and a full NAMA proposal can be drafted as part of Work Package 4. Registration in the UNFCCC registry by the Mozambican government and funding negotiations will be part of Work Package 5.

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Annex 2: Definitions

Biomass is non-fossilized and biodegradable organic material originating from plants, animals and micro-organisms. This shall also include products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes. Biomass also includes gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material.

Briquette. A block of compressed charcoal, coal dust, saw dust, wood chips or any other flammable biomass (agricultural waste). In this study used for fuel or kindling.

Carbonization is the process whereby charcoal is produced through the pyrolysis of woody biomass in charcoal kilns. Through the carbonization, complex carbonaceous substances contained in wood or agricultural residues, mainly cellulose, hemicelluloses and lignin, are broken down by heating into elemental carbon and chemical compounds which may also contain some carbon in their chemical structure. The end products of carbonization under controlled conditions are pyroligneous acid, tar, residual gas and charcoal.

Carbonization cycle. The time needed by a kiln to manufacture charcoal. It is expressed in hours, begins with ignition of the kiln and finishes when the kiln is sealed for cooling.

Charcoal. Charcoal is a solid biofuel obtained from biomass by means of a thermo-chemical process known as "pyrolysis" or "carbonization process", which consists of the thermal decomposition of biomass. Charcoal may be in the form of blocks or can take the form of charcoal briquettes (agglomeration of small carbonized particles or agglomeration of particles that are carbonised).

Existing kiln. A kiln is considered to be existing, if it has been in operation for at least a year prior to the implementation of the project activity. At existing charcoal kilns, the project activity shall avoid or abate methane emissions by the installation of charcoal kilns of enhanced design, and/or by the installation of methane abatement units.

Fuel wood / fire wood. Any wooden material used as fuel for cooking and heating. Typically the wood is collected as logs and branches and used as such.

Informal charcoal sector - is characterized by the use of traditional kilns such as earth mound kilns, pit kilns or equivalent open-end technologies, which require no investment besides labour. Individuals or a group of individuals involved in charcoal production, but are not formally registered or formally charged with production and supply of charcoal products or related service by the authorities. Newly established formalized organization by such individuals, e.g. cooperative, can also be considered as the informal sector for the purpose of this methodology;

New kilns. At new kilns constructed to provide capacity additions to existing charcoal kilns, or at Greenfield kilns, the project activity shall mitigate methane emissions by the installation of methane abatement units.

Pyrolysis is a thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen (or any halogen). It involves the simultaneous change of chemical composition and physical phase, and is irreversible.

Renewable biomass[20] **-** Biomass is "renewable" if:

1. the biomass is originating from land areas that are **forests, croplands and/or grasslands** under sustainable management
2. the biomass is a **biomass residue**
3. the biomass is the non-fossil fraction of an **industrial or municipal waste**.

Torrefaction of biomass, e.g. wood, can be described as a mild form of pyrolysis at temperatures typically ranging between 200 and 320 °C. During torrefaction, the biomass properties are changed to obtain a much better fuel quality for combustion and gasification applications. Torrefaction leads to a dry product with no biological activity like rotting. Torrefaction combined with densification leads to a very energy-dense fuel carrier of 20 to 25 GJ/ton Lower Heating Value.

[20] Based on EB 23 Report, Annex 18. http://unfccc.int

Annex 3: 2-MW model used for the workshop discussions (by R. Martins).

REDE DE ACTORES
- Que Instituições e Pessoas podem ajudar, participar ou prejudicar?
- Como podem esses Actores ajudar/prejudicar?

CANAIS DE COMUNICAÇÃO E RELACIONAMENTO
- Como comunicar com a rede de Actores?
- Como comunicar com os "Utilizadores"?
- Que tipo de relação ter com os Actores? E com os "Utilizadores"?

UTILIZADORES & SEUS HÁBITOS ENERGÉTICOS
- Quem vai usar o carvão?
- Como é que esses utilizadores usam o carvão? Para quê?
- Como esses utilizadores gostam do carvão?

PROBLEMA-MOTIVAÇÕES
- Qual é o grande problema?
- Porque temos de resolver esse problema?

PROPOSTA-OBJECTIVOS
- Como resolver esse problema?

LEGISLAÇÃO, REGRAS E CAPACIDADES
- Que regras e leis devemos usar, conhecer ou criar?
- Que capacidades devemos ter ou criar?
- O que precisamos saber, conhecer ou aprender?

RECURSOS & TERRA
- Que madeira usar para carvão?
- Há alternativas a essa madeira? Quais?
- Qual a melhor terra para produzir essa madeira?
- De quem é essa terra?

PRODUÇÃO
- Como produzir? (tipo de forno...)
- Quanto produzir? Todo o ano?
- Como comprar e manter equipamento?

DISTRIBUIÇÃO
- Que tipo de transporte usar?

FORNECER ENERGIA
- Como fazer o nosso carvão mais desejado pelos utiizadores?
- Fornecemos só carvão ou algo mais?

CUSTOS, IMPACTOS, RISCOS & COMPETIÇÃO
- Qual o maior custo, risco e impacto com o carvão?
- O que pode correr mal com o carvão?
- O que pode competir com o carvão? (recursos, alternativas energéticas)

GANHOS, BENEFÍCIOS, OPORTUNIDADES & SINERGIAS
- Qual o maior ganho, benefício e oportunidade do carvão?
- O que podemos ganhar com o carvão?
- Que outras actividades ou negócios podemos criar com o carvão?

INFRAESTRUTURAS & CONTEXTOS
- Que infraestruturas fazem falta?
- Fazemos só carvão ou temos outras actividades?

Annex 3: Workshop results: Activities from session I – Well organized producers.

Network of Actors

- Charcoal producer associations
- Individual charcoal producers
- Charcoal vendors in the city
- Technology providers
- Residue collectors from the field
- Climate financiers
- Expert consultants

Communication channels

- Special packaging with environmental seal
- New environmental brand
- Promotion and marketing of new brand in all sales points
- Brand name: Chanatse charcoal

Problems and motivations

- Under-utilization of forest and agri residues
- Lack of technology

Proposal and objectives

- Introduction of technology to utilise residues for charcoal
- Briquetting technology and improved kilns

Legislation and rules

- In this moment there are no laws governing charcoal making from residues
- Need to propose new legislation (not limiting production to 1000 bags/year)
- Add new law – with financial incentives

Users and energy practices

- Households (of all socio-economic levels
- Restaurants and kiosks
- Can be sold at the municipal markets
- Can also be sold from shops, supermarkets and petrol stations
- Packaged in sacks different from the current ones.

Biomass resources and land

- Agricultural residues
- Tree branches (Mopani)
- Charcoal pieces left as waste from production
- Other waste

Production

- Year round production
- Using briquette machine
- Improved kilns too
- Needs binding agent

Distribution

- Transport by train or truck
- The producer takes the briquetted to sale yard in the city themselves or works with intermediaries

Energy delivery

- The briquette should last longer
- Should have a high calorific value
- Should emit less smoke
- The briquette should be dense so it doesn’t wither away as fast

Costs, impacts, risks and competition

Opportunities, benefits and synergies

• Technology price (high?) • Existence of more desirable alternatives to customers • Maintenance risk (lack of spare parts or technicians) • Lack of local binding agent for briquettes	• Economic opportunity to producers (beyond the 1000 bag restriction) • An environmentally sustainable charcoal • The consultant who can help finance this initiative has guaranteed work

Annex 3: Workshop results: Activities from session II – less organized producers.

Network of Actors

- Financer
- Governent
- Bank/Micrcredit
- Private Sector
- Donors
- Project Desiner (to integrate and create inernal capacity)

Communication channels

- Publicity (leaflets, other)

Problems and motivations

- Lack of forestry resources (wood to produce charcoal)

Proposal and objectives

- Increase forestry resources to a level in which they are suffcient
- Planting/forest management
- increase kiln's efficiency
- improve the the use/cut

Legislation and rules

- Associativism
- System of licenses
- Resource's monitoring
- Certification/Regulation
- Enforcing capacity/fiscalization

Users and energy practices

- Families
- Bakeries
- Restaurants
- Improved cooking stoves

Biomass resources and land

- Other forest species (rapid growth)
- Land use rights (duration)
- More area for exploitation

Production

- Kilns more efficient
- More area for exploitation

Distribution

- Done by the Cooperative, including the comercialization

Energy delivery

- Through the creation of a Brand Label targeted at the various users (e.g., to sell at supermarkets but also near the road or in traditional markets)

Costs, impacts, risks and competition

- Costs: land use (2 MT.ha^{-1}.y^{-1}); management; concultatn(project designer), workers; tranports; certification; equipment's and transport's maintenance;
- Risks: climate change (drought), forest burning
- Competition: other sources of energy and technology

Opportunities, benefits and synergies

- Use waste to produce brickets (from the tress and kilns)
- use charcola poeder to medicine

Annex 3: Workshop results: Activities from session III – mixture of organized producers.

Network of Actors

- Academic and research institutions to support the introduction and implementation of new technologies.
- Private-sector promote and fund new technologies
- MOA, MICOA-promote and finance new technologies, conduct forest inventories, tax payments.
- Community and state: supervise and implement tax laws, prevent (illegal) logging.
- Extension services to assist charcoal producers.
- Micro-credit institutes and associations.

Communication channels

- Educate the coal producer that use low-yield technology
- Influence bakeries to use more coal
- Educate users to more profitable culinary practices

Problems and motivations

- Lack of knowledge of the exact amount of existing forest resources.
- Lack of knowledge of efficient technologies and the land productivity.

Proposal and objectives

- Introduce better technology coal production (identify, train, empower, raise awareness, mobilize, replicate).
- Create association with structure and accountability to improve performance.

Legislation and rules

- Prohibit logging for other applications (eg medical).
- Create fiscal incentives.
- Implement the Land Law and use the law to allocate 20% of the land for coal production.
- Train farmers in the use of improved technologies

Users and energy practices

- Urban Centers, Industries and Bakeries: ask for high-energy source.
- Urban centers, supermarkets: ask for briquettes (but clean).
- Urban consumers have bad energy habits (so don't just introduce improved cook stoves).

Biomass resources and land

- Make full use of the tree including twigs and leaves.
- Also use the coal residues.
- Also use non-timber species (eg sisal) and agricultural and municipal waste (eg paper)
- Make forest inventory, planning and management.
- Keep root system intact to allow

Production

- Introduce improved (Casamanca) kiln and brick kilns.
- Collect waste and charcoal residues for making briquettes.

Distribution

- Storage yard in the bush.
- Truck, train and cattle in areas where mechanical means are not enough.
- Truck to be bought.
- Cattle to be raised.

Energy delivery

- At Fuel Stations in the city.
- Joint sale with non-charcoal forest products (eg mushrooms).
- Sale of improved stoves to reduce consumption.

<table>
<tr><td>forest regeneration</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Costs, impacts, risks and competition
Major costs are the purchase and maintenance of: new technologies, warehouses, shipyards and service stations, and truck.
Possible uses of waste for other activities (eg agriculture).
Competition from other energy technologies.
Lack of political will or law enforcement (Mopane is class 1 tree).
Forest fires and poaching.</td><td colspan="2">Opportunities, benefits and synergies
Use less biomass resources increases the profitability of production.
More time available for other activities (eg livestock production).
Increased local beneficiaries of resources.
Casamanca kilns produce vinegar with pesticidal properties.
Accessing environmental subsidies (pay tax) or reinvest in coal / other business.</td></tr>
<tr><td colspan="4">Infrastructure and context
There is a lack of infrastructure (physical and institutional), but the concern is in making a more efficient / opportunistic use of existing infrastructure (eg trains).
Existence of entrepreneurs and rural middle-class with vision and financial capacity to make the coal business a profitable and integrated investment value chain and simultaneously realize that you have to play with legal, technological and environmental aspects in order to compete with new energy technologies in new social realities.</td></tr>
</table>

Annex 4: Technical analysis conditions for a CDM-PoA

As mentioned in the previous Work Package, under the CDM the following UNFCCC registered methodologies concern the charcoal production sector:

- AMS-III.BG: Emission reduction through sustainable charcoal production and consumption.
- AMS-III.K: Avoidance of methane release from charcoal production.
- ACM0021: Reduction of emissions from charcoal production by improved kiln design and/or abatement of methane.

In the previous Work Package, the general applicability and suitability for Mozambique has been assessed, showing that:

Project 1 - Briquetting of charcoal waste material

- *AMS-III.BG (version 02.0)*: this methodology states that a charcoal production facility may include briquetting facility for the agglomeration of smaller biomass particles. However, no emission reductions can be claimed under this methodology due to these avoided production of charcoal.
- *AMS-III.K (version 05.0)*: this methodology requires methane destruction with or without improved kilns in a facility equipped with recovery and flaring/combustion. As this is not the case with briquetting of charcoal waste materials, this methodology does not apply
- *ACM0021 (version1.0.0)*: this methodology focuses on the production of charcoal through improved kiln design as well as abatement of methane, which is neither the case when briquetting charcoal waste material. Therefore, this methodology does not apply.

As a conclusion, no methodology exists at this moment to account for avoided emissions due to use of charcoal residues. This rules out the use of a CDM-PoA for this project.

Project 2- Introducing efficient kilns and Sustainable Forest Management

- *AMS-III.BG (version 02.0):* This methodology only accounts for reductions of methane emission due to use of more efficient kilns <u>if the methane in the project situation is flared and/or gainfully used</u>. This is not the case in our project opportunity. Secondly, for PoA's, only CPA's for which biomass related leakages can be ruled out shall be included. In practice, this limits the use of biomass to biomass residues, which are not available in our project opportunity. Even if the project opportunity would be implemented as a bundled small scale CDM project (in order to avoid the PoA requirement), the use of renewable biomass feedstock is required and leakage due to competing use of biomass should be accounted for due to the following requirement:
    1. If it is demonstrated (e.g., using published literature, official reports, surveys etc.) at the beginning of each crediting period that the quantity of available biomass in the region (e.g., 50 km radius), is at least 25% larger than the quantity of biomass that is utilised including the project activity, then this source of leakage can be neglected otherwise this leakage shall be estimated and deducted from the emission reductions.

  This is not the case as there is deforestation. The inclusion of this source of leakage emissions leads to zero emission reductions. Therefore the general conclusion is that this methodology is not suitable for the project opportunity.
- *AMS-III.K (version 05.0)*: this methodology requires <u>methane destruction</u> with or without improved kilns in a facility equipped with recovery and flaring/combustion. As this is not the case, this methodology does not apply.
- ACM0021 (version1.0.0): The methodology focuses on the production of charcoal

through improved kiln design as well as abatement of methane. The destruction or gainfully use of methane is <u>not</u> required under the following conditions:

1. It shall improve the design and operations of the existing kilns through the adoption of technologies and processes for advanced kiln, which avoid or diminish the production of methane emissions in the carbonization process
2. All the existing kilns to be improved or replaced by the project activity shall have the same mechanical design (volume, insulation type, net capacity, flows of combustion gases, burner type) with a maximum deviation of 10%;
3. The project shall not result in the installation of capacity additions or Greenfield installation of kilns.

The first and third requirement are no problem, as most producers are already producing the maximum 1000 bags per year. The second requirement however is problematic. The earth kilns are similar but may deviate in capacity from each other as is most suitable for the available volume of wood. The brick kilns to be introduced may also deviate from each other unless only one type is promoted. Even if this would be the case, the following general requirement is problematic as well:

4. Only kilns for which a gravimetric yield relation was derived are used in the baseline and/or project situation;

This means for every earth kiln (or at least a representative sample) to be replaced and/or improved and the improved kiln, a third party certified test should be done per procedure as described in the methodology. As (partly) self-built brick kilns will be used, which all differ slightly in efficiency, a large amount of certified test to check the efficiency gains in methane emissions would be needed. This is not considered feasible for this project due to the scale and also in relation to the limited amount of emission reductions associated with the methane emissions from charcoal production.

Project 3 – Torrefaction by private sector (and replanting)

- *AMS-III.BG (version 02.0)*: In line with the reasoning of the second project opportunity, for PoA's, only CPA's for which biomass related leakages can be ruled out shall be included. In practice, this limits the use of biomass to biomass residues, which are not available in this project opportunity.
- *AMS-III.K (version 05.0)*: this methodology is about reducing emissions from charcoal production through destruction of the formed methane. As with torrefaction, no (or almost no) methane is formed, there is no destruction of methane either. Therefore, this methodology is not applicable to this project opportunity.
- *ACM0021 (version1.0.0):* As mentioned in the previous project opportunity reasoning, the methodology does not require methane destruction in case (among others) the project does not result in the installation of capacity additions or Greenfield installation of kilns. As the torrefaction unit would be a Greenfield installation, in areas where less CPAs are active, this methodology is not applicable to this project opportunity.

As a conclusion, no methodology fully applicable account for avoided emissions due to the implementation of improved kilns in combination with forest management. This rules out the use of a CDM-PoA for this project.

Annex 5: Technical analysis emission reductions of the project opportunities

Project 1 - Briquetting of charcoal waste material

As the briquetting of charcoal waste materials substitutes the production of other charcoal, the emissions related to these substituted production are avoided. The only applicable methodology to calculate for these emissions is AMS-III.BG.

Under the assumption made in chapter 3 of this report, a charcoal producer produces per kiln 200 kg waste material, next to 40 bags charcoal. When production is at the license maximum of 1000 bags, this means yearly 5 tons of charcoal waste material is available for briquetting.

The following equations and values apply here:

Equation (1)

$$\mathrm{ER_y} = \sum_i Q_{CCP,i\,y} \times \left[\left(\mathrm{f_{NRB,BL,wood}} \times \mathrm{NCV_{charcoal,i}} \times \mathrm{EF_{projected\_fossilfuel}}\right) + \left(\mathrm{SMG_{y,b}} - \mathrm{M_d}\right) \times \left(1 - \mathrm{f_{NRB,BL,wood}}\right) \times \mathrm{GWP_{CH4,y}}\right] - \mathrm{PE_{y,fugitive}} - \mathrm{PE_{y,flaring}} - \mathrm{PE_{FF,y}} - \mathrm{PE_{El,y}}$$

Where:

Parameter	*Definition*	*Value*	*Source / explanation*
ER_y	Emission reductions in year y[21] (t CO_2e/yr)	-	Calculated
$Q_{CCP,i,y}$	Quantity of charcoal type *i* produced and used in year *y* (t)	5 ton per producer	
$f_{NRB,BL,wood}$	Fraction of biomass of type *i* used in the absence of the project activity that can be established as non-renewable biomass; determined as per the procedure found in the latest version of "AMS-I.E: Switch from non-renewable biomass for thermal applications by the user" or on the basis of the published DNA endorsed default values available on the UNFCCC website[22]	91%	UNFCCC http://cdm.unfccc.int/ DNA/fNRB/index.html
$NCV_{charcoal,i}$	Net calorific value of the charcoal type *i* produced during the project (TJ/t). This shall be determined using one of the options provided in appendix 1	29.5 GJ/ton	Default value
$EF_{projected\_fossilfuel}$	Emission factor for the substitution of non-renewable woody biomass by similar consumers.	81.6 t CO_2/TJ	Default value
$GWP_{CH4,y}$	Global warming potential of methane applicable to the crediting period	21 t CO_2e/t CH_4	Default value

21 Project emissions on account of transport are assumed to be negligible.

22 Default values of fraction of non-renewable biomass can be retrieved at: <http://cdm.unfccc.int/DNA/fNRB/index.html>.

$SMG_{y,b}$	Specific methane generation for the baseline charcoal generation process in the year *y*	0.030 t CH_4/t charcoal	Default value
M_d	Factor to account for any legal requirement for capture and destruction of methane in the charcoal production facility (tonne of CH_4/tonne of raw material)	0	Policy context
$PE_{y,fugitive}$	Fugitive emission from operation of charcoal producing facility	0	No charcoal production
$PE_{y,flaring}$	If applicable, emissions due to the flare inefficiency in the project charcoal manufacturing plant in the year *y* (t CO_2e) determined in accordance with the procedure provided in AMS-III.K. In case captured pyrolysis gas is gainfully used (e.g. as fuel for pre-heating the facility, or for wood drying, or used for production of heat and/or power), then it can be taken as zero	0	No flare
$PE_{FF,y}$	Project emissions due to fossil fuel consumption in charcoal production facilities in year *y* (t CO_2)	0	No fossil fuel use
$PE_{El,y}$	Project emissions due to electricity consumption in charcoal production facilities in year *y* (t CO_2)	0	No electricity use

Per producer this leads to yearly emission reduction of 11.23 ton CO_2 per year.

Project 2- Introducing efficient kilns and Sustainable Forest Management

In the same logics as project 1, the simplest methodology AMS-III.BG will be used. Since a NAMA is not a PoA, the limitation (described in chapter 4) to only biomass residues does not apply here. This makes the methodology AMS.III.BG under a NAMA framework suitable for this project opportunity. The inclusion of Forest Management in the NAMA should safeguard the applicability criterion of renewable biomass feedstock, as per EB23, annex 18:

> *Biomass* is "*renewable*" if (among others):
> 1. The biomass is originating from land areas that are **forests** where:
> (a) The land area remains a forest; and
> (b) Sustainable management practices are undertaken on these land areas to ensure, in particular, that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and
> (c) Any national or regional forestry and nature conservation regulations are complied with.

Within the methodology AMS-III.BG a standardized baseline has been registered for Uganda[23]. Among others, this standardized baseline defines a positive list technologies which are automatic additional. This is very practical for a sector-wide NAMA as it avoids the demonstration of additionality for every improved kiln installed. The positive list includes the Casamanca kiln, the Adam retort, sedimentary kiln, the Carbo twin retort

[23] Standardized baseline: Fuel switch, technology switch and methane destruction in the charcoal sector of Uganda Version 01.0

and the Pyro 7 retort sedimentary kiln with or without briquetting process. This positive list can be adopted for the NAMA in Mozambique, or an alternative list of positive technologies can be registered at the UNFCCC as a standardized baseline or as part of the NAMA.

The following equations and values apply here:

For the project activity not equipped with capture and destruction of the pyrolysis gases, emission reductions are calculated as follows:

$$ER_y = \sum_i Q_{CCP,i_y} \times \left[\left(f_{NRB,BLwood} \times NCV_{charcoal,i} \times EF_{projected\_fossilfuel} \right) \right] - PE_{FF,y} - PE_{El,y} \qquad \text{Equation (2)}$$

Where:

Parameter	*Definition*	*Value*	*Source / explanation*
ER_y	Emission reductions in year y[24] (t CO_2e/yr)	-	Calculated
$Q_{CCP,i,y}$	Quantity of charcoal type *i* produced and used in year y (t)	70 ton per producer	
$f_{NRB,BL,wood}$	Fraction of biomass of type *i* used in the absence of the project activity that can be established as non-renewable biomass; determined as per the procedure found in the latest version of "AMS-I.E: Switch from non-renewable biomass for thermal applications by the user" or on the basis of the published DNA endorsed default values available on the UNFCCC website[25]	91%	UNFCCC http://cdm.unfccc.int/DNA/fNRB/index.html
$NCV_{charcoal,i}$	Net calorific value of the charcoal type *i* produced during the project (TJ/t). This shall be determined using one of the options provided in appendix 1	29.5 GJ/ton	Default value
$EF_{projected\_fossilfuel}$	Emission factor for the substitution of non-renewable woody biomass by similar consumers.	81.6 t CO_2/TJ	Default value
$PE_{FF,y}$	Project emissions due to fossil fuel consumption in charcoal production facilities in year y (t CO2)	0	
$PE_{El,y}$	Project emissions due to electricity consumption in charcoal production facilities in year y (t CO2)	0	

Emission reductions can be calculated as 153.34 ton CO2 per producer per year.

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24 Project emissions on account of transport are assumed to be negligible.

25 Default values of fraction of non-renewable biomass can be retrieved at: <http://cdm.unfccc.int/DNA/fNRB/index.html>.

Project 3- Torrefaction unit and private sector

In theory, the methodology ACM0021 can be applied to the project. However, this methodology does not account for avoided emission due to use of unsustainable biomass by the introduction of use of sustainable biomass. The possible emission reductions accounted by methodology ACM0021 are ex-ante calculated as 4,725 tCO2 per year for a production of 50,000 tones of charcoal per year. This is calculated with a default value of 0.030 tCH4/ton charcoal in the baseline and should be proven later with experimental analysis. It is however assumed that it will not be much higher than this (although conservative) default value.

The methodology AMS-III.BG however does account for emission due to use of unsustainable biomass.
When the following equation is applied:
The following equations and values apply here:

Equation (3)

$$\mathrm{ER_y} = \sum_i Q_{CCP,i\,y} \times \left[\left(\mathrm{f_{NRB,BL,wood}} \times \mathrm{NCV_{charcoal,i}} \times \mathrm{EF_{projected\_fossilfuel}}\right) + \left(\mathrm{SMG_{y,b}} - \mathrm{M_d}\right) \times \left(1 - \mathrm{f_{NRB,BL,wood}}\right) \times \mathrm{GWP_{CH4,y}}\right] - \mathrm{PE_{y,fugitive}} - \mathrm{PE_{y,flaring}} - \mathrm{PE_{FF,y}} - \mathrm{PE_{El,y}}$$

Where:

Parameter	*Definition*	*Value*	*Source / explanation*
ER_y	Emission reductions in year *y*[26] (t CO_2e/yr)	-	Calculated
$Q_{CCP,i,y}$	Quantity of charcoal type *i* produced and used in year *y* (t)	50,000 ton per unit	
$f_{NRB,BL,wood}$	Fraction of biomass of type *i* used in the absence of the project activity that can be established as non-renewable biomass; determined as per the procedure found in the latest version of "AMS-I.E: Switch from non-renewable biomass for thermal applications by the user" or on the basis of the published DNA endorsed default values available on the UNFCCC website[27]	91%	UNFCCC http://cdm.unfccc.int/ DNA/fNRB/index.html
$NCV_{charcoal,i}$	Net calorific value of the charcoal type *i* produced during the project (TJ/t). This shall be determined using one of the options provided in appendix 1	29.5 GJ/ton	Default value
$EF_{projected\_fossilfuel}$	Emission factor for the substitution of non-renewable woody biomass by similar consumers.	81.6 t CO_2/TJ	Default value

[26] Project emissions on account of transport are assumed to be negligible.

[27] Default values of fraction of non-renewable biomass can be retrieved at: <http://cdm.unfccc.int/DNA/fNRB/index.html>.

$GWP_{CH4,y}$	Global warming potential of methane applicable to the crediting period	21 t CO_2e/t CH_4	Default value
$SMG_{y,b}$	Specific methane generation for the baseline charcoal generation process in the year *y*	0.030 t CH_4/t charcoal	Default value
M_d	Factor to account for any legal requirement for capture and destruction of methane in the charcoal production facility (tonne of CH_4/tonne of raw material)	0	Policy context
$PE_{y,fugitive}$	Fugitive emission from operation of charcoal producing facility	0	No methane production associated with torrefaction
$PE_{y,flaring}$	If applicable, emissions due to the flare inefficiency in the project charcoal manufacturing plant in the year *y* (t CO_2e) determined in accordance with the procedure provided in AMS-III.K. In case captured pyrolysis gas is gainfully used (e.g. as fuel for pre-heating the facility, or for wood drying, or used for production of heat and/or power), then it can be taken as zero	0	No flare
$PE_{FF,y}$	Project emissions due to fossil fuel consumption in charcoal production facilities in year *y* (t CO_2)	0	Will be monitored during the project
$PE_{El,y}$	Project emissions due to electricity consumption in charcoal production facilities in year *y* (t CO_2)	0	Will be monitored during the project

For the torrefaction unit this leads to yearly emission reductions of 112,362 ton CO_2 per year.

ANNEX 6: Types of charcoal kilns

Information derived from FAO and Energypedia.

Earth mount kiln
This is the most common kiln used for charcoal production in sub-Saharan Africa. It can be constructed from locally available material. Wood is collected and stacked in the polygonal shape of the kiln. The wood is then covered with a layer of grass and the construction is sealed with soil excavated around the kiln. A small opening allows the control and monitoring of the process. The ignition area is exposed to wind until the pile begins to burn and the area is covered. The results are best if the charring process is closely monitored to ensure controlled air. The kiln requires continuous attention for 3 to 15 days depending on the size. After the kiln has cooled down charcoal can be harvested. The main advantage of this type of kiln is that it can be constructed easily without cost at the harvest site. Downsides are that carbonization takes rather long and the process requires continuous attention. In addition, charcoal quality and efficiency is rather low (between 8 and 15 %).

Improved traditional earth mount kiln with chimney

Adding a chimney to the traditional earth mount kiln improves its efficiency to some extent. The improved earth kiln includes wire mesh or metal sheet to reduce contamination of the charcoal and chimneys to enhance control of the carbonization process (Nelly et al 2006). The process: The process is similar to that of the traditional earth Kiln where the wood stack is tightly packed, covered with a thick layer of leafy green material followed by a heavy layer of soil. The advantage is that it produces less defiled charcoal and control of carbonization process is improved by the presence of chimneys. These are however achieved at an additional cost as both the mesh wire and chimneys cost money.

Casamance kiln

The Casamance kiln is an earth mound kiln equipped with a chimney. This chimney, which can be made of oil drums, allows a better control of air-flow. In addition, the hot flumes do not escape completely but are partly redirected into the kiln, which enhances pyrolysis. Due to this reverse draft carbonization is faster than traditional kilns and more uniform giving a higher quality of charcoal and efficiency up to 30 %. Comparative tests of the casamance kiln and traditional mound kilns confirmed the advantages in terms of efficiency and shorter carbonization times due to the enhanced hot flue circulation. Disadvantages of this kiln type are that it requires some capital investment for the chimney and it is more difficult to construct.

200-Liter Horizontal Drum Charcoal Kilns

Technical information about the drum kilns can be found at the Appropriate Technology Association (ATA; http://www.ata.or.th/th/Home.php).

Brick kiln
The brick kiln is stationary, unlike the traditional kilns or even the Casamance (which can be constructed anywhere). They have an efficiency of up to 30 % and are suitable for semi-industrial production of charcoal. One type is the truncated pyramid kiln, which is used in Chad mainly in the informal sectors. However, it has a lower efficiency than other brick kilns. The most notable type is the Argentine half orange Kiln (a brick kiln in the shape of an igloo), which has been adopted by the Malawi Charcoal Project. It is made entirely out of brick and mud as mortar. Loading and unloading is performed through two opposite doors, which are sealed before the kiln is ignited. The carbonisation cycle is much quicker and allows harvesting of charcoal after 13 – 14 days. Using a kiln of about 6 m diameter, up to 15 t of high quality charcoal can be produced per month. However, as brick kilns are stationary once built, they can only be used in areas with an easy supply of wood. Furthermore, the wood has to be cut with some precision and water supply is required for preparation of mortar. Kilns can also be produced using concrete instead of bricks; however, as their construction is very cost-intensive they have not succeeded in Africa.

Retort kiln
The retort kiln is one of the most efficient means of producing good quality charcoal. The kiln returns the wood gases back to the carbonisation chamber, burns the volatile a higher proportion of the tar components almost completely and uses the heat for the carbonisation process. The Improved Charcoal Production System (ICPS), also called Adam-Retort, may be presented as an example of retort technology. Efficiency can be as high as 40 % and noxious emission can be reduced by 70 %. In addition, the production cycle is completed within 24 to 30 hours. The retort is suitable for semi-industrial production. Disadvantges include that it's a stationary kiln, investment costs exceed 1,200 US$ and special skills are required for construction. Nevertheless, the Adam-retort has been introduced in several countries (Senegal, Madagascar, Peru etc.) on a pilot basis.