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Mozambique Biomass Energy Strategy

This study has been elaborated on behalf of the National Directorate of New and Renewable Energy to elaborate Mozambique's Biomass Energy Strategy.

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c/o Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ)
P.O. Box 5180
65726 Eschborn, Germany
E info@euei-pdf.org
I www.euei-pdf.org

Authors:
ECO-Consult and MARGE international team members:
Robert J van der Plas, Team Leader, Netherlands
Dr. Steve Sepp, Forest Economist, Germany
Maurice Pigaht, Household Energy Economist, Germany
António Malalane, Energy Specialist, Lawyer, Mozambique
Dr. Stefan Mann, Forestry, Germany
Gérard Madon, Energy Economist, France

With comments and contributions by:
Rosta Mate
Dr. Almeida Sitoe
Dirk van Eijk
Boris Atanassov

Photos: Steve Sepp

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Abbreviations and Acronyms

AGOA	African Growth and Opportunity Act
AIFM	*Avaliacao Integrada de Florestas de Moçambique* ,Integrated Assessment of Mozambican Forests – National Forest Inventory
AMODER	*Associação Moçambicano de Desenvolvimento Rural*, Mozambique Rural Development Association
APRONAF/ SUNAFOP	Support to the National Forest Programme by Finland
BAU	Business As Usual
BEST	Biomass Energy Strategy
CBNRM	Community Based Natural Resource Management
CBO	Community Based Organization
CDM	Clean Development Mechanism
CO2	Carbon Dioxide
DNFFB	*Direcção Nacional de Florestas e Fauna Bravia*, Notational Directorate for Forestry and Wildlife
DNTF	*Direcção Nacional de Terras e Florestas*, National Directorate for Land and Forests
DPTUR	*Direcção Provincial do Turismo*, Provincial Tourism Directorate
DUAT	*Direito de uso e aproveitamento da terra* - state-granted land right
FAO	Food and Agriculture Organization of the United Nations
FCFP	Forest Carbon Partnership Facility
FDD	*Fundo de Desenvolvumento Distrital*, District Development Fund
FEDESMO	*Fórum de Energias e Desenvolvimento Sustentável de Moçambique*-National Froum for Sustainable Energy
FUNAE	National Fund for Energy
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gas
GoM	Government of Mozambique
GTZ/GIZ	*Gesellschaft für Technische Zusammenarbeit*, German Agency for Technical Cooperation renamed in 2011 in Gesellschaft für Internationale Zusammenarbeit (GIZ) – German Agency for International Cooperation
IGF	*Inspecção Geral das Finanças*, General Inspection of Finance
ITC	*Iniciativa de Terras Comunitárias*, Community Land Initiative
IUCN	International Union for the Conservation of Nature
LOLE	*Lei dos Órgãos Locais do Estado*, Law on Local State Agencies.
MAI	Mean Annual Increment
ME	Ministry of Energy
MICOA	Ministry for Coordination of Environmental Affairs
MINAG	Ministry of Agriculture
MIS	Market Information System
Mt	Metical, Mozambican currency
NGO	Non-Governmental Organization
NORAD	Norwegian Agency for Development Cooperation
OIIL	*Orçamento de Investimento de Iniciativas Locais*, Local Initiatives Investment Budget
ORAM	*Organização Rural de Ajuda Mútua*, Rural Mutual Assistance Organization (NGO)
PEDSA	*Plano Estratégico de Desenvolvimento do Sector Agrário* - Strategic Plan for Agriculture Sector
REDD	Reducing Emissions from Deforestation and forest Degradation
RWEM	Rural wood-energy market
SADC	Southern African Development Community
SFM	Sustainable Forest Management
SPFFB	Serviço Provincial de Florestas e Fauna Bravia, Provincial Forest and Wildlife Service
TOF	Trees Outside Forests
UEM	Eduardo Mondlane University
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States' Agency for International Development
USD	US Dollar

UWEM	Urban wood-energy market
VAT	Value Added Tax
VCS	Voluntary Carbon Standard
WFP	World Food Program
WISDOM	Woodfuels Integrated Supply Demand Overview Mapping
WSMP	Woodfuels Supply Master Plans
WWF	World Wide Fund for Nature

1 Foreword

The Final report containing the proposed Biomass Energy Strategy consists of two separate parts: (i) a short version containing the Executive Summary including a limited number of annexes; and (ii) the long version with the detailed analysis and additional annexes. The long version therefore does not contain an additional executive summary. The short version can be read as a stand-alone document and is available in English and Portuguese.

The process to develop the strategy has been highly participative, with the following sequence used:

a) First round of discussions and fact finding in July 2011, which started with a meeting of the Biomass working group followed by a meeting with the Energy Consultative group; this was concluded by an Inception workshop, which presented the proposed approach for developing the strategy, outlined the principles to be used, and agreed on a Vision Statement based on which the strategy will be developed;
b) An agreement with the EU funded "Capacity Building in Energy Planning and Management" project was reached that a data collection effort would take place to complement available published information; recent and reliable information does not exist about the demand for biomass as well as supply chains of particularly charcoal in the various parts of the country. This would to a certain extent compensate this lack of information. It was decided that the data collection would take place in Matola/Maputo area, Beira town, and Nampula town. In addition, the last forestry inventory dates back to 2004/5 and new satellite data has not been acquired since. With the new data collection effort at least it would be possible to quantify the issues and define the problem, if any. However, the data collection itself introduced some delays because of various constraints such as availability of surveyors, best time to visit the area regarding the season, and approval of funds to start the work;
c) The second round of discussions and fact finding in February 2012 took place in Maputo, Matola, Beira, and Nampula. Meetings were held in these towns where stakeholder workshops were organized to discuss the elements of the proposed strategy in more details. This was concluded with a presentation for, and discussion with the Biomass Energy Working group chaired by the Director of the Department of Energy. Simultaneously, a working group under the lead of David Thierry started to collect all information needed to develop and update a national energy balance, a process that was new in the country;
d) The energy demand data collection was completed by August 2012 and the summary reports were presented in October; the results were used to fine-tune the analysis carried out by the BEST team;
e) The BEST team issued six "problem statements", presenting the biomass energy issues from the perspectives of the six ministries involved as well as suggested solutions; i.e., the National Department of Energy sees biomass quite different from the National Directorate of Lands and Forests, and solutions that are obvious to one may not be so obvious for the other. The GIZ funded AMES project gracefully agreed to discuss these problem statements in the districts as follows: a total of 23 districts including the provincial capitals in the central region (Manica, Sofala, Tete and Zambezia); 18 districts in the north (Nampula, Niassa and Cabo Delgado), and 14 district in the South (Maputo, Gaza and Inhambane). This work started in October 2012.
f) Although the process for developing a biomass energy strategy in Mozambique thus encountered quite a few delays compared to the same study in other countries, in the end the results are richer and based on more facts, and in addition, the opinions of future beneficiaries have been heard more thoroughly than elsewhere.
g) In fact, the final restitution workshop on December 7 showed strong leadership by the Directorate of Renewable Energies to start the political process leading to fine-tuning and Parliament adoption of the proposed biomass energy strategy in early 2013. It was attended by quite a few district officials as well as central government staff.

The authors are grateful to the Government of Mozambique for its contributions to the Strategy development process. Particular thanks are due to Marcelina Mataveia and Marta Susana Penicela of the Department for Renewable Energy and Yolanda Gonçalves and Darlindo Pechisso of the National Directorate of Lands and Forests, as well as Isac Tsamba of FUNAE. The team would also like to acknowledge Rosta Mate and Prof. A. Sitoe for their considerable support and provision of information in the early stages of the process. In addition to all others that have been consulted special thanks are extended to:

a) José Miguel Q. Nicolau, Consultor de Energia who gracefully included the energy demand and flow surveys under the Europe Aid project /127640/SER/MZ: Capacity Building in Energy Planning and Management;
b) Dirk van Eijk, Project Manager AMES/GIZ, who organized the stakeholder consultations in the districts;
c) Boris Atanassov for realizing the additional surveys in Maputo, Matola, Beira and Nampula; and
d) David Thiery for his work on the 2011 Energy Balance.

2 Introduction

2.1 National Biomass Energy Environment

Mozambique's energy security situation is relatively comfortable as the country is blessed with a large and varied energy resource base:

- Large hydroelectric resources, with only 2GW of 16 GW potential capacity exploited, representing one of the largest untapped hydroelectric potentials in Africa; both public and private interests exist to develop these resources, although concrete plans have not yet materialized; most of the electricity currently produced is exported to South Africa;
- "The world's last substantial untapped coal reserve", according to Maputo Standard Bank's global head of mining and metals, in Mozambique's Moatize coal basin, situated in the remote Tete Province. Production could soon reach 100 million mt/yr with some $10 billion of private investments already mobilized. Most, if not all coal extracted in Mozambique will be destined for exports;
- Huge natural gas reserves: several private gas companies reported recent discoveries of each several 10s of trillions of cubic feet of natural gas; a total confirmed reserve of 30 trillion cubic feet (0.85 trillion m3) in the Prosperidade field (Anadarko Company) has an estimated value of $150b at 2010 price levels; private companies are investing billions of dollars to exploit these resources under a concession mainly for export; more recently, the Italian oil and gas company ENI confirmed an additional 1.1 trillion m3 some 50 km off-shore in the Mamba field; most, if not all gas will be destined for exports;
- Significant solar energy resources, thanks to an annual average insolation of 5 kWh/m2/day; a very small portion of this potential is actually being tapped; deployment of PV equipment seems limited to donor and NGO funded projects for the supply of limited electricity to households and selected institutions; and
- Extensive biomass resources, with some 50% of the country under forest cover. Deforestation rates are 0.5-1.5% per year, mainly due to timber extraction and agricultural conversion. Private investments, capturing climate funds, are pouring into the country: the Government has reserved 2 million ha for biofuel production and 2 million ha for other large-scale plantation crops, mainly for export of green fuels. Biomass from forests and farmer's fields is the largest source of energy used in the country, but limited public funds are available to manage the forestry sector, and even less to manage the biomass energy sector. Worse even, there are no regular statistics to show the production and use of biomass energy, which could form the basis for such management.

With such large diversity and quantity of natural resources available, all Mozambicans can and should gain access to modern energy in the near future. The Government has a wide choice of energy sources to develop for this purpose. Although any of the above resources can be used, success can only be reached if substantial investments are realized to convert these resources into usable forms of energy, whether this is electricity, gas, solar energy, or biomass. The required investment level depends on the sector focus and strategy pursued. This strategy will present these differing costs, and will show that promoting "modern" biomass strategies is the most cost-effective way to supply a large part of the Mozambican population with modern energy services.

Huge private commercial interests have already materialized to develop and exploit electricity, coal, gas, and biomass resources, but almost exclusively for export purposes. Commercial interests for rolling out PV electricity and biomass energy systems for domestic and small-scale industries in the country are much lower, and except for an initial trial of commercial ethanol production, private companies appear not very keen to invest in modernizing Mozambique's biomass energy and PV electricity sectors. Public funds for realizing this have also not been made available on a large-scale either.

As a result, the current status quo is likely to continue: some 82% of the energy used in 2011 is in the form of traditional biomass, and there is no reason to believe that this will rapidly change in the near future. However, population growth, urbanization, agricultural expansion, and conservation all lead to further pressure on the remaining biomass resource base. The same declining base is also used to satisfy the ever increasing demand for woodfuels. It is therefore not surprising that in the medium term future biomass is expected to stop being

the reliable and cheap source of energy that it has been until now. In fact, pressure on biomass resources in some regions is critical already and irreversible damages are being done.

The proposed biomass energy strategy is designed to reverse this process by developing the multiple and complementary solutions to ensure a sustainable biomass supply well into the near future. This will allow Mozambicans to continue using biomass for as long as they like, or switch to using other forms of energy if and when they like. Not acting now is a real and realistic scenario, which necessarily means that problems with the supply of biomass will start, sooner or later – and indeed has started in some areas already.

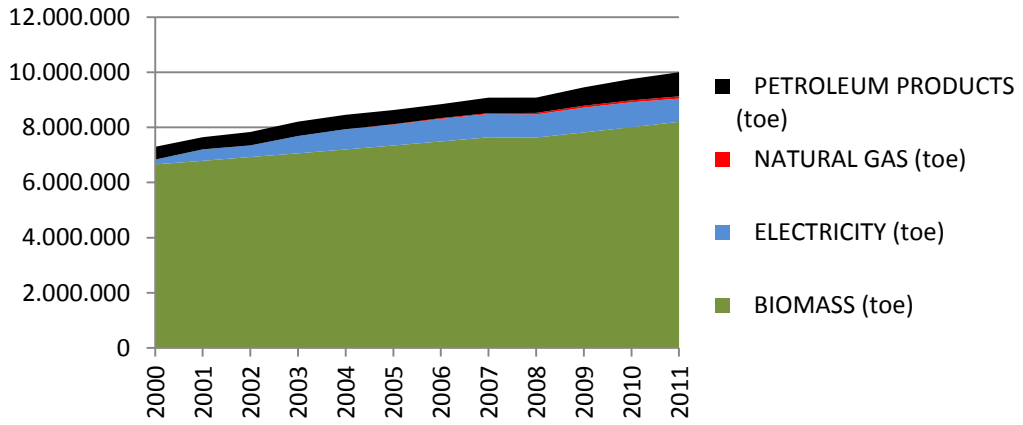
2.2 Rationale for a national biomass energy strategy (BEST)

With reportedly about half of the land under forest cover, Mozambique is a country that heavily depends on biomass fuels, defined as firewood, charcoal, crop residues and animal dung. The National Energy Policy (2003) estimated that biomass accounted for 93% of total energy consumption in 2000 and new research conducted under the Clean Energy Assessment Report suggests that the contribution of biomass was still 85% in 2011, see Figure 1 below[1]. Although more recent work suggests that the level is now around 80%, this still remains a heavy dependence on biomass for energy use.

In spite of their significance, biomass fuels have historically been associated with environmental degradation, poverty and under-development. This applies especially to charcoal, Mozambique's dominant commercial fuel in terms of volume and value, which exceeded US$ 250m in 2011. Charcoal is widely perceived as a destructive and inefficient energy source, however, this does not need to be so, and biomass could also be considered a clean and modern fuel that remains affordable to the majority of the population for the foreseeable future. The status quo,

In 2010, the GoM requested assistance from the European Union Energy Initiative Partnership Dialogue Facility (EUEI-PDF)[2] for the design of a national Biomass Energy Strategy (BEST). The BEST objective is to develop a rational and implementable approach to the management of Mozambique's biomass energy sector through a combination of measures designed to improve the sustainability of biomass energy supply, raise end-user efficiencies and promote appropriate alternatives. The resulting Strategy addresses thermal applications of energy, primarily cooking. It covers domestic, institutional and industrial applications for biomass, and includes both commercial and non-commercial users of fuel.

Figure 1: Current fuel mix in Mozambican consumption



[1] Data based on information from David Thierry, Expert at the Ministry of Energy, who coordinated an effort to produce an energy balance for Mozambique based on as much existing (research and statistical) information as possible.

[2] EUEI PDF is an instrument developed by Austria, France, Germany, the Netherlands, Sweden and the UK to support the development of policies and strategies for the promotion of access to energy at national and regional level. See www.euei-pdf.org

Given the availability of modern alternatives to biomass energy in the country, the only appropriate solution for the government is to invest in a transformation of biomass into a modern energy carrier should it decide to do so. To sustain the continued use of traditional biomass energy is not advisable, although of course it will persist for a long time particularly in rural areas. Consequently, the BEST proposes to transform the biomass energy sector into a more modern source of energy, on par with electricity, gas, and coal.

The BEST development process was managed on behalf of EUEI-PDF by the German Agency for International Cooperation (GIZ) and implemented by a consortium team from the German consulting firm *ECO-Consulting GMBH* and the French consulting firm *Marchéage et Gestion de l'Environnement SARL* (MARGE). Guidance in Mozambique was provided by the Department of Renewable Energy (DRE) and the Department of Forestry in the Ministry of Agriculture and Lands..

The ECO-MARGE team comprised five international consultants and additional experts recruited in Mozambique. The team also liaised closely with designated counterparts from DRE and FUNAE. A collaboration agreement was signed with another EU-funded capacity building project to conduct empirical surveys in order to update existing energy supply and demand data in Maputo, Matola, Beira and Nampula.

The Strategy was developed in accordance with Terms of Reference drafted jointly by EUEI-PDF and the DRE (see **Fehler! Verweisquelle konnte nicht gefunden werden.**) and the EUEI-PDF BEST Guide[3].

2.3 Interaction with Stakeholders

During the Strategy development a wide range of resource persons and documentary sources were consulted, as listed in **Fehler! Verweisquelle konnte nicht gefunden werden.** and **Fehler! Verweisquelle konnte nicht gefunden werden.** respectively. The existing Biomass Working Group (BWG), shared by the Director of DRE and comprises of several public and private institutions, acted as the Steering Committee. The BWG met several times with the consultant team every time it visited the country.

The following workshops were organized:

- In July 2011 an *inception workshop*, to discuss and verify the GoM's biomass energy vision and discuss several important issues related to the BEST that need to be addressed during the work. Timing was also discussed, particularly the time it was expected to take for realizing the surveys, which delayed the original time table for preparation of the BEST.
- In February/March 2012, *regional workshops* in Matola (Maputo Province), Beira (Sofala Province), and Nampula (Nampula Province), while officials of Gaza, Manica Tete, and Zambezia were present as well.
- In March 2012, a *working session* with the BWG, to discuss initial findings in the regions and the major thrust of the proposed BEST.
- On December 7, 2012 (expected) a *validation workshop* to present and discuss the results of the proposed strategy.

Complementary surveys were organized on the consumption patterns of energy as well as the market & value chain for charcoal and firewood in Maputo, Matola, Beira and Nampula by Green Light under contract with the Europe Aid project /127640/SER/MZ: Capacity Building in Energy Planning and Management (José Miguel Q. Nicolau, Consultor de Energia). This resulted in the report: "Mozambique Biomass Energy Baseline Study 2012", which was used in the final analysis of the baseline data.

Finally, under the AMES project implemented by GIZ, separate stakeholder discussions have been organized in most Districts; feedback was sought from a wide range of local participants on the six problems statements presented in the short version of the final report.

[3] See www.euei-pdf.org/admin/gtz/upload/publications/-1%20BEST-Guide-07-08-08.pdf

2.4 BEST process

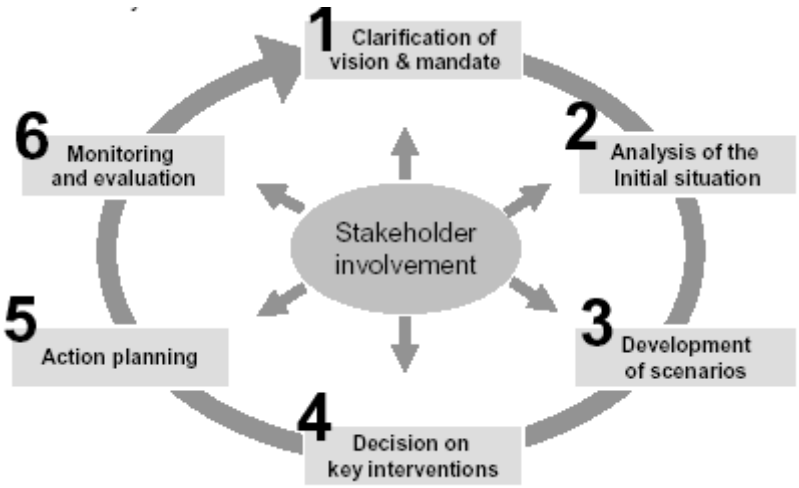
A strategy describes the key interventions of an organization or a government institution to achieve policy aims. While policies address challenges and set goals for change, strategies analyze the different options how to reach the goal, propose the appropriate intervention lines and set out concrete actions by which the goals will be achieved. A strategy is not a blueprint but rather a set of concepts to facilitate decisions and take actions for implementing a policy.

A strategy answers the following questions:

- What is the final goal and who defines it? (vision and mandate)
- What is the problem and who is involved? (analysis of initial situation)
- Which way is the best to reach the goal? (scenario development)
- What has to be done? (decision on key interventions)
- Who does what by when and with which resources? (action planning)
- How can the results be measured? (monitoring and evaluation)

The development of a BEST follows a systematic approach which can be described as a cycle:

Figure 2: BEST process



Each step is crucial for the success of the process. If, for instance, the analysis of the actual situation has not been done carefully, actions might be developed which have no impact at all or even a negative impact. Without a proper development of scenarios it is difficult to define realistic targets for the future. And without a detailed planning of actions, involving relevant stakeholders and attributing sufficient resources, the strategy will never be implemented. Finally, without systematic monitoring and evaluation nobody will ever be able to state if the strategy has been successful or not.

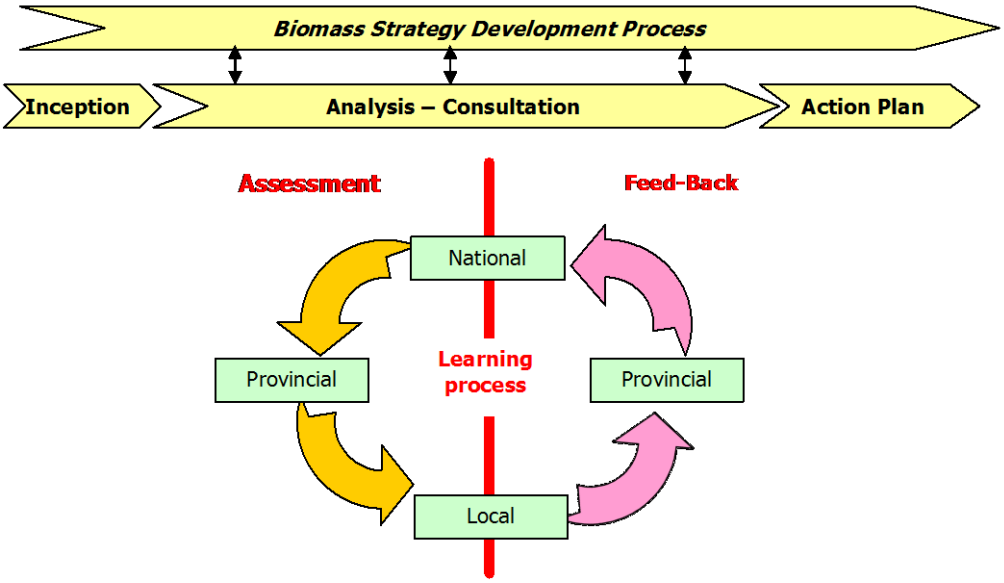
The process of developing a BEST is at least as important as the final strategy paper. The aim should be to reach a common understanding amongst the stakeholders and a consensus on necessary actions. At each step, discussions have been organized between the actors concerned in order to collect their responses and observations.

2.5 BEST approach and methodology

Considering the scope of work spread over many provinces in a large country and the tight budget available we assume that the consultants can tap all on-site data available and have the active assistance of the relevant authorities including the Biomass Working Group. This comprises in particular the WISDOM geo-database hosted by the Ministry of Agriculture to assess and map the wood-energy supply situation of the four

consumption sites. In case that during the inception phase severe deficits in the data availability are encountered and thus making more thorough surveys and/or assessments necessary the consultant will have to renegotiate changes to the budget agreement. Currently only minor surveys are planned, so as to assess economic as well as consumption data of the woodfuel value chain.

Figure 3: Elements of the Consultant's Approach to Project Implementation



The missions focus is set on the participatory development of a biomass modernization strategy. To this end, **consultations** and **participation** are the two means or levels of stakeholder involvement. The biomass strategy planning process in Mozambique will follow bottom-up and top-down linkages in order to align sectoral strategies with policies and resources (see figure 3). Therefore the participation of all stakeholders on national, provincial and local level is essential.

Stakeholder participation at the **national level** analysis is a pre-condition for a well-designed, successful mission. The ultimate goal of the exercise is to sensitize political decision makers and top-level planners for the biomass contribution to energy sector planning. This requires deliberate advocacy and agenda setting. To this end, transparency is crucial right from the beginning of the assignment. National level stakeholders need to (i) understand the mission's objectives, (ii) embrace the notion of mainstreaming biomass energy-linkages at all stages of a national energy development process, and (iii) accept the biomass energy strategy comparative advantages, usefulness, and validity.

On the **provincial level**, stakeholder participation calls for focused involvement of biomass -related decentralized branches of government, and civil society. This requires a clear understanding on the team's part of the various stakeholders' respective institutional responsibilities and mandates, as well as their involvement/interest in national strategy formulation. Openness and mutual trust are required to ensure that district-level stakeholders identify persistent policy/legal and institutional obstacles to pro-biomass energy development.

On the **local level**, stakeholder participation means that rural and urban target groups have the opportunity to freely express their views in regard to biomass supply and consumption. This calls for (i) appropriate timing and preparation on the team's part, (ii) culturally sensitive & well-adapted presentation/use of data-collection tools, and (iii) careful observation of gender-perspectives.

Consultations on various levels will be enhanced through the organization of well-prepared workshops with a strong involvement of different stakeholders. The outcome of the workshops will have subsequent implications on the planning of implementation and follow-up arrangements in regard to the biomass strategy development. This increases ownership of the approach, and creates openness and dialogue from the outset of the mission.

The preparation of the strategy will be based on the Biomass Energy Strategy Guide (EUEI PDF - GIZ). The consultant team leader will be responsible to ME for the management and coordination of the project, including:

- Formulation of the work program,
- Communication with the Biomass Working Group and the funding organization as well as with relevant stakeholders.
- Organization of meetings (project team, clients, other).

Main steps of the work are as follows:

- Inception period
- Analysis of the initial situation
- Scenarios and draft strategy formulation
- National stakeholder workshop and preparation of a two-year action plan
- Finalization of the strategy and initial implementation stage

2.6 Outline of the report

After an Introduction (**Chapter 1**), the Strategy document begins with contextual information on Mozambique, its geography, socio-economics and strategies for achieving growth and development (**Chapter 2**).

Chapter 3 summarizes the current biomass energy supply and demand situation, prior to a more detailed presentation in the chapters that follow.

Chapter 4 provides information on the policy, legal, and regulatory context of the biomass energy sector, highlighting relevant energy and forestry legislation.

Chapter 5, Provides a stakeholder analysis of the institutions and actors in the biomass energy sector.

Chapter 6 balances the information with supply and demand-side estimates, placing the consumption figures in context and highlighting the key issues related to the greatest sustainability challenges.

Chapter 7 presents the elements of a biomass energy strategy including a package of suggested interventions to improve management of the biomass energy sector that cover the supply-side, demand-side and institutional arrangements.

Chapter 8 proposes a biomass energy strategy for Mozambique, including costs and benefits for a number of different development scenarios.

3 Background

3.1 Population and Economy

Mozambique is located on the eastern coast of Southern Africa (between parallels 10º27'S and 26º52'S and longitudes 30º12'E and 40º51'E) with a total area of 799.380 km² of which 2%) 13.000 km² are internal waters (table 1). The country has a terrestrial border of 4330Km that is shared with 6 countries of the Southern African Development Community (SADC) in the North, West and South region namely: Tanzania, Zimbabwe, Zambia, Malawi, South Africa, and Swaziland. At the East, the country is limited by the Indian Ocean along a coastline with a length of approximately 2600km.

Table 1: Mozambique's Territorial Extension

Territorial extension	Territory /area (km^2)
Total	799 380
Firm Land	786 380
Internal waters	13 000

Source: INE, 2011

The country comprises a network of over 80 rivers seasonal and permanent, some with economic importance (e.g. Rovuma river is important for the existing oil deposits and Zambezi river the largest in Eastern Africa has rich valleys that are good for agriculture development). There are 9 main rivers totalling 4063km in extension (table 2). Majority of the rivers (~80%) enter the Indian Ocean through the Sofala Bank in the central region.

3.2 Biophysical Context

Most of the country's surface is flat below 200m altitude rising from the coastal area to the inland. The morphology has gentle undulations and some rocky outcrops/inselbergs/ridges inland. Mt. Binga is the tallest mountain with 2.436m altitude, in the Chimanimani complex in Manica Province.

Approximately 2/3 of Mozambique are covered by igneous and metamorphic rocks formed during the archaic and neoproterozoic period[4]. These are an extension of the Zimbabwean Craton and they make up to 90% of the Mozambican Precambric.

The soils of the country are diverse varying from sandy and less fertile in the coastal areas to clay and clay loam with moderate fertility and good physical characteristics in the northwest. Along the rivers, the soils are alluvial with good agriculture

Figure 4: Provinces of Mozambique

Table 2: Extension of the main rivers in Mozambique

Ord.	Main River	Extension (Km)
1.	Zambeze	820
2.	Rovuma	650
3.	Lúrio	605
4.	Messalo	530
5.	Licungo	336
6.	Save	330
7.	Pungue	322
8.	Buzi	320
9.	Maputo	150
Total		**4063**

Source: INE, 2011

Table 3: Highest elevations in the country

Mount	Rise (meters)
Binga Mount (Manica)	2436
Namule Mount (Zambézia)	2419
Zuira Mountain range (Manica)	2277
Messurussero (Manica)	2176
Massasse (Manica)	2134
Domue Mount (Tete)	2095
Mácua Mountain range (Zambézia)	2077
Chiperone Mountain range (Zambézia)	2054

Source: INE, 2011

[4] DNG, 2005

potential and suitable for irrigation.

Given its location, Mozambique lies in a region of Inter-tropical climate that ranges from the very dry arid zone to a very wet humid zone. There are two distinct seasons, the dry and cold winter and the hot and rainy summer. The average temperatures are 25-27C in summer and 20-23C in the winter distributed according to the oceanic influences.

The rainfalls decrease from North to South and from the coast to inland. They are influenced by the Ocean currents, specially the warm current. The rainfall varies between 350 mm in Pafuri (semi-arid region in the South) to 2,000 mm in Gurué [1] with average of about 968 mm restricted to the rainy season between November and April. The mean annual potential evapotranspiration exceeds significantly the mean annual rainfall for the majority of the country with values between around 1600 mm in Tete and 1200 mm in Lichinga [1].

3.3 Administration and Population

Administratively, Mozambique is divided into 3 regions (North, Center and South) and eleven provinces namely: Cabo Delgado, Niassa, Nampula, Tete, Zambezia, Manica, Sofala, Inhambane, Gaza, Maputo Province and Maputo City. The country population includes indigenous tribal groups (Makhuwa, Tsonga, Lomwe, Sena, and others) that make 99.66%, Europeans with 0.06%, Euro-Africans with 0.2% and Indians with 0.08%.

In 2011, the total population of the country was estimated at 23.049.621[5] inhabitants while the last census carried out in 2007, estimated it 20.530.714 inhabitants (Table 4) over the 11 provinces. The population growth rate was 2.4% between 1997 and 2007 with Maputo province presenting the highest growth rate (52%)[6]. The average population density was estimated at 24.8 inhabitants/Km^2, the median age of 18.29 years for the country population and the fertility rate (children born/woman) was 4.7 (2005 estimates)[7].

Table 4: --- Population statistics per province of Mozambique

Province	Total	Women	Men	Nr. Households	Area (Km^2)	Density (Inhab/Km^2)
Niassa	1 178 117	604 349	573 768	270 021	129 056	9,13
Cabo Delgado	1 632 809	849 574	783 235	417 837	82 625	19,76
Nampula	4 076 642	2 076 684	1 999 958	993 964	81 606	49,96
Zambezia	3 892 854	2 030 763	1 862 091	922 989	105 008	37,07
Tete	1 832 339	947 028	885 311	421 316	100 724	18,19
Manica	1 418 927	744 670	674 257	283 612	61 661	23,01
Sofala	1 654 163	852 746	801 417	348 046	68 018	24,32
Inhambane	1 267 035	707 192	559 843	279 256	68 615	18,47
Gaza	1 219 013	677 147	541 866	251 873	75 709	16,1
Maputo	1 259 713	686 118	573 595	274 193	26 058	48,34
Maputo Cidade	1 099 102	567 308	531 794	223 052	300	3.663,67

Source: INE, 2007 census

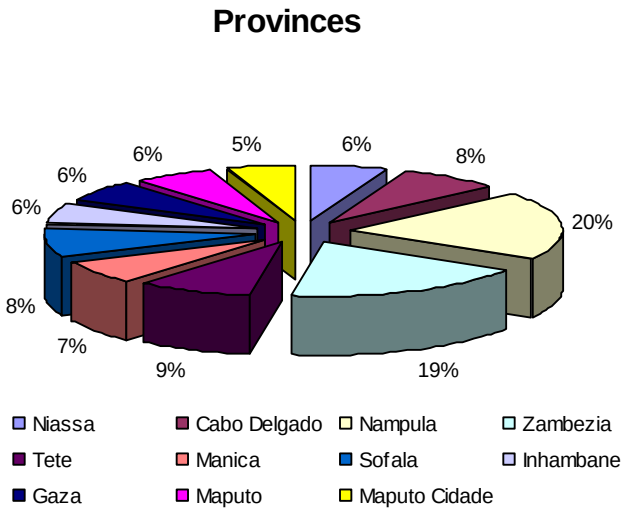
Nampula is the most populated province followed by Zambézia and Tete. Almost 40% of the country population is concentrated in Nampula and Zambézia provinces. Maputo Cidade is the least populated province but, despite its lower population size, it is also the province which has the highest population density in the country mainly due to the small area size of the province. Below is shown a division/share of population per province in 2005:

[5] INE 2011. www.ine.gov.mz

[6] INE 2007

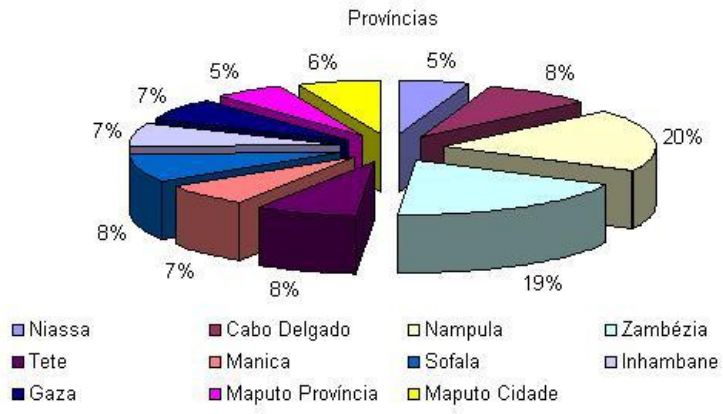
[7] Country profile

Figure 5: population distribution by province (2007)



There were no significant changes in the population distribution between 2005 and 2007 however, population size in Niassa increased while Maputo Cidade and Inhambane decreased by 1%. The majority of the population (~70%[8]) lives in the rural areas where the population has increased, despite the reclassification of some rural areas into urban/municipalities. Significant increases in the number of rural populations is mainly attributed to the migration of people from urban to rural areas under the Government initiative that promotes the districts as the development poles.

Figure 6: Population distribution per province (2005)



2.4. Resources and Potential

Mozambique is rich in natural resources such as minerals (e.g. coal, titanium, tantalum, and graphite), hydropower, hydrocarbons (e.g. natural gas), aquatic resources (seafood such as the prawns), forests, fauna and others that can be used to boost the economic growth of the country[9]. Additionally, the country has huge potential for ecotourism development (beautiful beaches in the long coastline, safaris, national parks and

[8] The percent of population living in rural areas in 2003 was 64.4% which shows an increase between 2003 and 2007.

[9] PARPA II

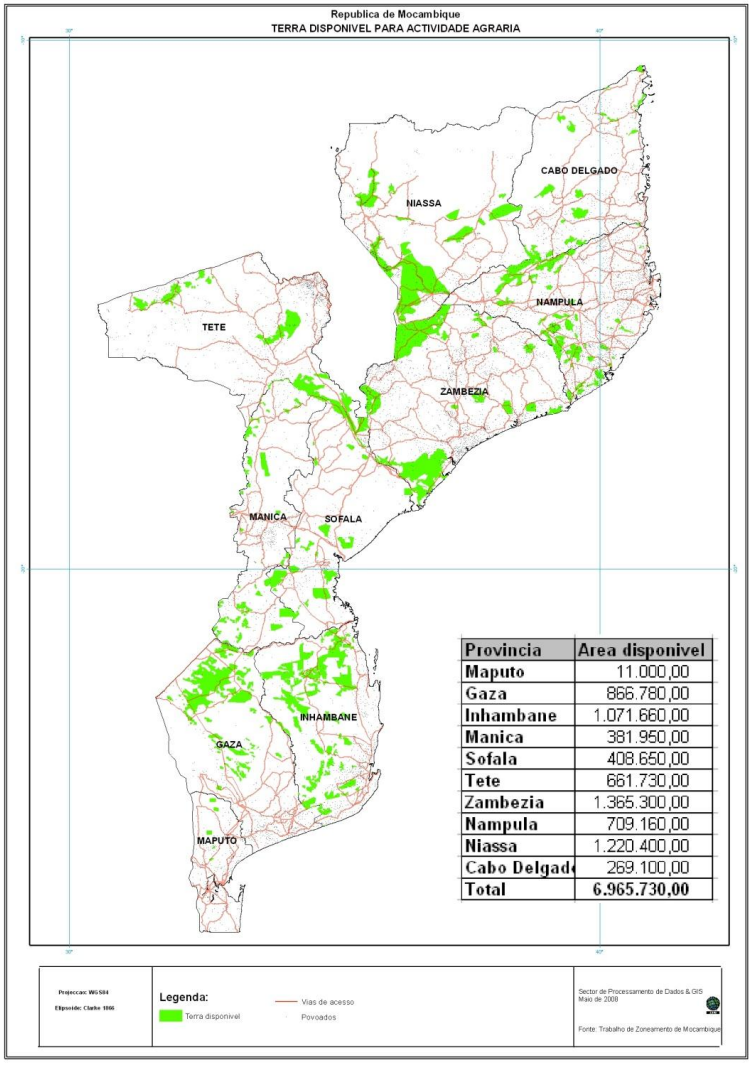
diving opportunities) [10] which is currently attracting foreign investment. The Government policies are currently promoting the sustainable development of these natural resources which include native forests and wildlife.

It is estimated that approximately 45% of the total country surface are potential for agriculture but currently only 20-30 of the lands are being used for production of which 90% belongs to the family sector that undertakes subsistence agriculture under the shifting cultivation system. Despite its low productivity, agriculture is still the main economic activity of the country with over 80% of the population.

The national zoning exercise carried out in 2008, estimated that 6.966.030 ha of the country surface are available for agriculture activities with Zambézia province presenting the highest available area (1.365.300 ha) and Maputo the least (11.000 ha)[11].

The central and Northern regions are the most fertile with abundant rainfalls which makes it more suitable for the development of agriculture however the access is somewhat limited due to the roads condition. The southern region is drier with lower agriculture productivity and production however the access is reasonably good.

Figure 7: Map showing the lands available for agriculture activities in Mozambique



Provincia	Area disponivel
Maputo	11.000,00
Gaza	866.780,00
Inhambane	1.071.660,00
Manica	381.950,00
Sofala	408.650,00
Tete	661.730,00
Zambezia	1.365.300,00
Nampula	709.160,00
Niassa	1.220.400,00
Cabo Delgad	269.100,00
Total	6.965.730,00

[10] PARP II

[11] DNTF (2008). Zoneamento agrário – relatório dos resultados do exercício de validação de resultados de terra disponível a nível local (fase 2)

The high levels of poverty combined with the population growth and other anthropogenic activities is leading to decreases in the forest cover in the recent years and consequently, the diversity of the wildlife species has also reduced. Marzolli (2007) stated that the annual deforestation rates are quite low and have been estimated at 219.000ha corresponding to a cover change of 0.58%. Niassa presents the lowest deforestation rate in the country (0.22%) and Maputo the highest (1.67%). Major drivers for the deforestation are: itinerant agriculture and associated uncontrolled burnings, over-exploitation both of wood and fire wood mainly for charcoal production, selective timber exploitation and the clearing of forested areas for the establishment of human settlements and other socio-economic activities.

Conversion of forests to agriculture areas has been considered the main cause of deforestation in the country. For instances, Marzoli has estimated that 7.5% of deforested dense forests in Manica province were converted to permanent agriculture (mainly tobacco) and 67% of dense forests were converted to areas of forest with shifting cultivation[2]. It is however important to note that shifting cultivation normally degrades the forest without deforesting the entire area.

3.4 Macro-economic Policy Framework

After the country independence, in 1975, Mozambique was one of the poorest countries in the world and this was aggravated by the civil war (1977-1992) and socialist mismanagement. In 1987, the GoM initiated a series of economic structural readjustments (PRE) to stabilize the economy. This program changed the macroeconomic scenery of the country, which was having a GDP reduction, and allowed for an annual growth of approximately 1.5% between 1987 and 1991. However, the impacts of these measures were affected by the drought period 1990-1992 and the process of resettling the local communities (Michaque, 2003).

In the subsequent years, the peace agreement in 1992, the social and political reforms, donor assistance and the political stability since 1994 (democracy) combined with structural readjustments led to increased economic growth rate that exceeded an average of 10% in the late 1990s. In 2000, due to the floods, the GDP decreased to 1.5% but in 2001 it reached 13% and in 2002 8.3%[12]. The country experienced an impressive strong economic growth averaging 8% p.a. between 1996 and 2006, and has made significant progress in reducing poverty[13]. Inflation was reduced from two digits (60%) in the beginning of the 1990s to single digits (2.9%) in the late 1990s (1999)[14] but returned to double digits in 2000-03; in 2000, inflation increase to 12% and reached 21% in 2001 (Nathan, 2002). In 2002, inflation dropped again reaching the 9.1%[15] (INE, 2004).

In September 1997, Mozambique was elected for a debt reduction under the IMF's Heavily Indebted Poor Countries (HIPC) and enhanced HIPC initiatives. As such, the country external debt was reduced through forgiveness and rescheduling, to a more manageable level, from US$ 6 billion to US$ 1.7 billion (PROAGRI, 1998). In 2002 it was estimated that the country external debt was around $966 million. Following is presented the evolution of the external debt between 2002 and 2010.

Table 5: External Debt and Financial Flows

US $ (Millions)	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total external debt	4.988	5.179	8.750	9.040	7.431	5.859	6.102	6.291	6.478
Private	0	0	4.334	4.391	4.149	2.542	2.418	2.173	1.983
Public	3.606	3.939	4.416	4.649	3.282	3.317	3.684	4.118	4.495
Total external debt service	49	57	59	65	62	48	50	47	67
Net Foreign Direct Investment Inflows	348	337	245	108	154	427	587	893	789
Net Total Official Development assistance	...	...	...	...	...	...	...	...	...

Source: African statistics yearbook 2011

Fiscal reforms such as the introduction of a value-added tax (VAT) and the customs service reform improved the government's revenue collection abilities. Mozambique is now seen as one of Africa's most successful

[12] Michaque 2003

[13] http://mz.one.un.org/eng/About-Mozambique/Development-Context-in-Mozambique

[14] Michaque, 2003

[15] Michaque 2003 citing the mentioned ones

stories of post-war reconstruction and economic recovery[16]. The country held its fourth peaceful and democratic legislative and presidential elections in 2009, showing its commitment to political stability, democratic governance and national reconciliation. There is an increasingly growing in the foreign investments in Mozambique and the country's macroeconomic indicators over the last ten years have shown significant improvements in economic growth.

In 2005, the GDP per capita was estimated at $ 1.300 p.a.[17]. The Country average real per capita GDP growth rate was estimated at 7% p.a. in 2005[18] and 7.6% between 2005 and 2009[19].

Table 6: --- Gross National Product (between 2002 – 2009 at current prices

Year	2002	2003	2004	2005	2006	2007	2008	2009
GDP (million Mts)	85.494	107.110	122.140	143.711	165.840	194.648	225.805	254.794

Mozambican economy continued performing well in 2010 with an estimated growth of 8.1% mainly due to the increased foreign direct investments in coal projects and the recovering of aluminium prices. The exports increased in 2011 due to the start of coal exports but the current account balance is still negative mainly due to the dependence on imports of food, oil and manufactured products. Despite the increases in the inflation that hit double digits in 2010, Mozambique is expected to maintain high growth rates in the medium term, driven by mega-projects.

Along with the economic development there are also advances in human and social development however, the country is still dependent upon donor aid for much of its annual budget ($632.8 million in 2001). Mozambique is still one of the world's poorest countries (ranked 172nd out of 177 in the 2007/08) and the majority of the population (~70%)[20] lives below the poverty line poverty (PARP, 2001).

The GoM has invested a lot in the public sector reform, capacity development and a decentralisation programme to improve the efficiency enhancing transparency and devolving responsibilities to the province and district levels[21]. However, the limited operational and managerial capacity of some sectors remains a concern, particularly at the sub-national levels and in relation to the recruitment and retention of qualified human resources. Hence, development planning and coordination represents a great challenge to reduce the poverty and promote inclusive economic growth[22].

In addition to the above, a substantial trade imbalance persists and the country continues to experience persistently high levels of poverty and inequality between the urban and rural areas, low Human Development Index (HDI) score, and a labour force which is highly dependent on subsistence agriculture or employment in the informal economy. In 2008 about 59.9% of the population were illiterate[23].

Table 7: prevalence of tuberculosis and HIV/AIDS in women and adults

Nr. of women (15+) living with HIV	Prevalence of tuberculosis (per 100.000 population)		Adult HIV prevalence rate (aged 15-49)	
2009	2000	2009	1990	2009
760.0	425.0	109.0	1.2	11.5

Source: African statistics yearbook 2011

People living in urban areas have more access to the basic services compared to the rural areas. The country problems are aggravated by its vulnerability to natural disasters, HIV/AIDS, malaria and Tuberculosis and the

16 http://mz.one.un.org/eng/About-Mozambique/Development-Context-in-Mozambique
17 Country profile
18 Country profile
19 PARP 2011-2014
20 The 2011 African statistics Yearbook estimated that 74.7% of the people in Mozambique were living below 1dollar a day in 2003. the Poverty gap at $1 a day in the same year was 35.4%.
21 http://mz.one.un.org/eng/About-Mozambique/Development-Context-in-Mozambique
22 http://mz.one.un.org/eng/About-Mozambique/Development-Context-in-Mozambique
23 African statistics 2011

weak national capacities to provide basic social services. When it comes to the consumption, the level of food poverty (measured by the national index of poverty prevalence) is slightly less than 55% of the population[24].

Table 8: Poverty prevalence and imbalance level measured by the Gini index

Geographical area	Poverty prevalence			Imbalance (Gini)		
	1996-97	**2002-03**	**2008-09**	**1996-97**	**2002-03**	**2008-09**
Niassa	70.6	52.1	31.9	0.36	0.36	0.43
Cabo Delgado	57.4	63.2	37.4	0.44	0.44	0.35
Nampula	68.9	52.6	54.7	0.36	0.36	0.42
Zambézia	68.1	44.6	70.5	0.35	0.35	0.37
Tete	82.3	59.8	42.0	0.40	0.40	0.32
Manica	62.6	43.6	55.1	0.40	0.40	0.35
Sofala	87.9	36.1	58.0	0.43	0.43	0.46
Inhambane	82.6	80.7	57.9	0.44	0.44	0.38
Gaza	64.6	60.1	62.5	0.41	0.41	0.43
Província Maputo	65.6	69.3	67.5	0.43	0.43	0.39
Cidade de Maputo	47.8	53.6	36.2	0.52	0.52	0.51
Urbano	62.0	51.5	49.6	0.47	0.48	0.48
Rural	71.3	55.3	56.9	0.37	0.37	0.37
Nacional	69.4	54.1	54.7	0.40	0.42	0.41

The nutrition indicators refer that 46.4% of children under 60 months suffer from moderate chronic malnourishment/ undernourishment, 18.7% have weight insufficiency and 6.6% suffer from acute malnutrition also moderate. The incidence of severe chronic malnutrition is 23%. Rural areas present higher prevalence of malnutrition (50%) in comparison with the urban areas (36%)[25].

Table 9: Prevalence of undernourishment in total population (%) is still above 30%

Year	2000-02	2005-2007
Prevalence of undernourishment (% of total population)	46.0	38.0

Source: African statistics yearbook 2011

Various factors contributed for the stagnation of the prevalence of food poverty between 2002/03 and 2008/09 being the main ones the low agriculture productivity growth rate in the food crops and the country vulnerability to natural disasters. Mozambique suffers from recurrent droughts, particularly in semi-arid areas, leads to pockets of food and nutrition insecurity and reduced access to safe water and sanitation in affected areas. The country is also prone to occurrence of cyclones and floods that result in loss of crops and livelihoods, cholera outbreaks and high levels of diarrhoea among children, particularly in the rural areas[26].

In 2005, the national Millennium Development Goal (MDG) progress report indicated that only 5 of the 11 MDG targets for which data was available, had the potential of being met without a considerable acceleration of efforts namely: the ones relating to poverty, under-five mortality, maternal mortality, malaria and the establishment of an open trading and financial system[27] (tables - -to ---). The infant-juvenile mortality rate reduced from 245.3 to 138 in each thousand born from 1997 to 2008 and, over the same period the child mortality rate reduced from 143.7 to 93 in every 1000 born.

Table 10: Mortality rates

Year	1997	2008	2015 (target)
Infant mortality (per 1000)	143.7	93	46.8
Under five mortality (per 1000)	245.3	138	80.7

[24] PARP, 2011-2014

[25] PARP, 2011-2014

[26] http://mz.one.un.org/eng/About-Mozambique/Development-Context-in-Mozambique

[27] http://mz.one.un.org/eng/About-Mozambique/Development-Context-in-Mozambique

To attain the MDGs, it was recommended that Mozambique should: stop and reverse the incidence of HIV, improve the efficiency of services delivery to the poor, increase the employment opportunities and the state revenue, reduce the dependence on foreign aid, and increase the preparedness for recurrent natural disasters. Particular emphasis should be put in reaching the most disadvantaged communities to reduce the prevailing disparities, increase their participation in development processes and ensure that they all benefit from the development gains[28].

Subsistence agriculture continues to employ the vast majority of the country's workforce (81%), the industry employs 6% of the labour force and the services 13% (1997 estimates)[29]. The current unemployment rates are very high particularly in the urban areas and mainly in the southern region.

Table 11: Unemployment situation

Selected features	Unemployment rate			Occupation/employment rates		
	Men	**Women**	**Total**	**Men**	**Women**	**Total**
Total	14.7	21.7	18.7	72.3	77.6	74.6
Residence area						
Urban	25.6	35.7	31.0	54.1	62.8	58.2
Rural	9.1	15.7	12.9	81.3	86.2	83.4
Region						
North	10.4	22.0	16.6	73.9	82.7	78.0
Centre	12.0	19.6	16.2	75.0	80.9	77.6
South	25.6	24.5	25.0	67.1	65.2	66.3
Provinces						
Niassa	23.2	38.4	31.7	58.8	71.2	64.3
Cabo Delgado	5.4	15.5	10.9	78.9	85.6	81.9
Nampula	9.9	21.0	15.7	75.3	83.9	79.4
Zambézia	8.3	13.5	11.2	82.3	85.1	83.6
Tete	10.3	21.7	16.5	74.4	85.0	79.3
Manica	20.8	26.3	23.9	66.4	71.0	68.4
Sofala	14.8	26.4	21.2	66.6	76.0	70.8
Inhambane	11.7	11.3	11.5	83.3	79.1	81.7
Gaza	18.0	15.4	16.3	77.4	71.7	75.4
Maputo Província	35.5	37.1	36.3	56.4	58.8	57.5
Maputo Cidade	35.2	44.2	40.0	43.8	53.8	48.4
Education level						
None	8.0	15.7	13.9	79.5	85.8	81.0
Primary (1st Degree)	11.6	21.1	16.5	74.9	84.0	79.3
Primary (2nd degree)	20.2	38.1	27.0	52.3	69.3	62.7
Secondary and more	27.7	45.8	34.2	41.6	58.2	52.1
ND	0.0	9.6	5.5			
Civil status						
Single	37.0	39.9	38.1	45.7	48.4	47.4
Married	5.0	20.3	13.1	76.7	91.1	83.5
De facto union	7.3	22.3	15.5	75.5	90.8	82.4
Divorced/Separated	19.7	12.9	14.0	83.2	75.1	81.8
Widow	7.5	8.6	8.5	79.3	72.4	78.6

Source: INE citing IFTRAB 2004/5

[28] http://mz.one.un.org/eng/About-Mozambique/Development-Context-in-Mozambique & http://www.undp.org.mz/pt/What-we-do/Economic-and-Policy-Analysis/Economic-Policy-Analysis-the-Mozambican-context

[29] Country profile

Poverty Reduction Strategy In order to tackle existing economic problems the GoM prepared the Absolute Poverty Reduction Action Plans (PARPA I & PARPA II) which comprised policies that created an enabling environment and incentives for investment and productivity. With the implementation of these plans, the country managed to reach an average increase in the GDP of 8% (PARPA, 2001)[30].

Currently, the country's main policies and strategies are based on the long term vision of the Agenda 2025 and the midterm Government Five-Year Programme (Plano Económico e Social – PES) along with its operational plan the ***Plano de Acção para a Redução da Pobreza (*PARP 2011-2014)**.[31]. The PARP is targeting the: i) increased production in the agriculture and fisheries, ii) employment promotion, and, iii) human and social development. Therefore, priority will be given to improve the access to production factors, facilitate the market access, improve the sustainable management of natural resources (land, waters, fisheries and forests), incentivize the employment creation, improve the availability and quality of the access to social services and, social infrastructures. As such the country will ensure investments in agriculture to attain increased agriculture productivity for the family sector[32].

Under these priorities, the GoM will implement projects/ programs targeting:

- Expansion of infrastructures including the electrical energy and promote the use of alternatives mainly for the areas with potential for agriculture and fisheries,
- Installation of solar systems in rural areas with no access to the electric grid prioritizing schools, health centres in all provinces.
- Electrification of all the district and administrative headquarters that are not yet connected to the national electric grid

Currently the following projects are being implemented by the GoM

1. Project Renewable energy and new sources that aims at creating capacity for the use of new and renewable energies in the country to stimulate the development of technologies for production and installation of systems of solar, wind and hydro prioritizing their installation in schools and health centres.
2. Access to electric energy which aims to continue expanding the access to energy with low costs through expansion of the geographic coverage of the energy supplying infrastructures and services.

It is important to refer that Mozambique is benefiting from a strong commitment from the international donor community but the down side of this is the creation of a high level of aid dependency. Just under 50% of annual government spending is being met through external assistance and the high number of donors also represents coordination and administration challenges for a Government with capacity constraints[33].

3.5 Linkages between Energy Supply and Poverty Reduction

The prevalence in the use of biomass energy in the country may lead to serious environmental problems. As the bulk of charcoal wood is clear-cut from secondary, and in some cases, from primary forests, charcoal production and use lead to considerable deforestation, which is now one of the most pressing environmental problems such as the forest cover depletion/deforestation. Deforestation has negative implications such as increased erosion, reduces the existing capacity to sequester carbon, carbon releases that increase the GHG and contribute negatively for the climate change which threatens the biodiversity. Reduction of natural resources on which the poor depend, and land degradation, contributing negatively to the poverty.

The impact of energy use on the environment in Mozambique makes the promotion of energy efficiency an important issue[34]. Therefore it is crucial to promote the efficient use of energy resources, but also to carry out

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[30] Michaque, 2003

[31] http://www.undp.org.mz/pt/What-we-do/Economic-and-Policy-Analysis/Economic-Policy-Analysis-the-Mozambican-context

[32] PARP 2011-2014

[33] http://www.undp.org.mz/pt/What-we-do/Economic-and-Policy-Analysis/Economic-Policy-Analysis-the-Mozambican-context

[34] Trade and energy Security

awareness campaigns, mainly with local communities or people living in rural areas, where inefficient energy use is apparent, causing damage to the environment[35]. Additional measures that can be more easily implemented in the country such as the technical regulations and standards are important tools to increase the efficient use of energy and reduce greenhouse gas emissions[36].

Measures such as support programs for renewable energy, energy taxation and technical regulations related to energy efficiency need to be implemented in ways that will promote social and economic growth and sustainable development[37]. These activities must be accompanied by a process of harmonization and coordination among the different government entities to merge the various policies and strategies, especially regarding natural resources use[38].

Access to energy is a precondition for economic development and social progress in Mozambique, especially in the peri-urban and rural areas.[39] Additionally, the sustainable use of natural resources is fundamental to the production and productivity increase. Therefore the challenge is to improve the sustainable management of natural resources, reducing the illegal harvesting and excessive consumption of fuelwood that constitute the great threat to the agriculture sector (PARP 2011-2014).

3.6 Climate Change

Mozambique's relatively weak socio-economic infrastructure and geographic location make it particularly vulnerable to the impacts of climate change. The climate is predominantly semi-arid, with 80% of the area being classified as tropical semi-arid and 15% as a sub-humid zone. The extreme zones (arid and humid) constitute respectively 2% and 3% of the total area of the country. In the southern region (provinces of Maputo, Gaza and Inhambane) the annual precipitation averages 600mm – 800mm and the annual temperature averages 23°C in coastal regions and 25°C in the interior. In the central region (provinces of Sofala, Manica and Zambezi) the annual precipitation averages 800 mm – 1,200 mm and the annual temperature averages 20°C - 25°C. The northern region has an annual precipitation averaging 800 mm – 1,400 mm, and annual temperature averages 20°C - 26°C [3].

Mozambique is subject to frequent periods of drought, particularly in the south and center. Cyclones regularly strike coastal districts in the summer months (October to March), bringing heavy rains, strong winds and storm surges. The main concern for arid and semi-arid regions will be rising temperatures plus reduced rainfall, while sea-level rise, storm surge and coastal erosion will be more problematic in low-lying coastal areas.

Table 12: Summarized findings of climate related adverse effects

Climate related adverse effect	Sector / Area Impacted	Impacts
Floods	Agriculture, forest, water resources, health, livestock, coastal resources, tourism, ecosystems, infrastructure, flood plains of main river basins such as Limpopo, Incomati, Pungue, Save, Zambezi, Umbeluzi, Maputo, and Buzi	Loss of life, crops, ecosystems, property, human and animal habitate, outbreaks of pests and diseases, displacement of people, movement of land mines, destruction of infrastructure (communication network, schools, hospitals, houses, etc.), erosion, land degradation, etc.
Droughts	Agriculture, water resources, ecosystems, health, food security, livestock, and low lying areas	Crop failures, water scarcity, drying of water reservoirs (dams, fish pond, lake, rivers), famine, loss of human and animal lives, stresses in the marine living organisms, loss of biodiversity, environmental degradation, salt intrusion, erosion.
Tropical cyclones	Country wide, particularly along the coastal area, during rainy season	Loss of life from collapsing structures. Damage to structures (rural community houses, school blocks, hospitals, etc.) due to substandard constructions. Destruction of crops, forest plantations & natural trees. Bush fire enhancement in the dry season.
Sea level rise	Coastal area, river water resources	Loss of land and infrastructures, increased erosion, salt intrusion.

Source: [4]

[35] Trade and energy Security
[36] Trade and energy Security
[37] Trade and energy Security
[38] Trade and energy Security
[39] Chambal, 2010

The emission of greenhouse gases (GHGs) varies depending on the level of development and sources of emissions of a particular country. In Mozambique, however, the major sources of emissions are land-use change and the deforestation and degradation of forests due to unsustainable land-use practices. According to Mozambique's Initial National Communication to the UNFCCC, land use change and agriculture account for more than 80% of Mozambique's GHG emissions. To this end, the management of land and forestry resources is critical to sustainable development in Mozambique.

According to the National Forest Inventory of 2007, the main cause of deforestation in the country is the pressure from human activities, particularly the use of fire for clearing land for agriculture. As a result, 219,000 ha of forests are lost annually [2]. The total annual CO2 emission from deforestation and degradation is estimated to be around 25 million tons [5]. In addition, the miombo woodlands contribute about 400 million tons of carbon emitted annually due to uncontrolled human-induced fires[6].

There is an indication that the sectors most affected by climate change besides forestry include agriculture, animal husbandry, water resources, health, infrastructure and food security. All of these are key sectors for the development of the economy.

In regard to forest change, Mozambique prepared and submitted to the Forest Carbon Partnership Facility (FCPF) a Readiness Plan Idea Note (R-PIN) in 2008[40]. A National REDD+ Working Group was established in 2009. The working group's initial work plan was revised in March 2010 to accommodate

1) the emerging priority of developing a national REDD+ strategy to inform the implementation of pilot projects whilst

2) allowing the preparation of the Readiness Preparation Proposal (R-PP). The two processes were subsequently merged.

Since August 2010, the first draft REDD+ strategy document, authored by Mozambican experts, has been available for government consultation, to be followed by public consultations in 2011.

According to an IIED document [7], private investors are already rushing to capitalize on the opportunity; looking to invest in land, particularly in the north and center of the country, to establish REDD+ projects to earn carbon rights and subsequent credits. Some private companies, such as the UK-based Envirotrade, already work with Mozambican communities to sell carbon credits in voluntary markets. It is further stated that all in all, private sector interest in land for REDD+ so far covers an area equal to 22 per cent of the country — this is more than the 16 per cent of protected areas and includes nearly 42 per cent of the country's forests.

There is thus a risk that a rush to present a position for the development of REDD in Mozambique, without an understanding of all the related issues and potential impacts, could lead to an increase in land conflicts, the abuse of community rights, and other significant environmental and social impacts.

Measures to remedy the situation as formulated in the Mozambique REDD+ (R-PP) [8] are as follows.

- Develop legislation on carbon rights
- Undertake land use mapping,
- Define biomass energy concessions and management requisites
- Support improvement of efficiency of processing and consumption of biomass energy including use of alternatives
- Invest in increased land productivity (agroforestry, conservation agriculture,...)
- Scale up CBNRM and sustainable enterprise development
- SFM (sustainable forest management), conservation and tree planting for rehabilitation of degraded areas
- Capacity building – fire management
- Support small scale timber operators to adhere to associations and forest concessions

[40] The National Directorate of Environmental Management (DNGA), MICOA and the National Directorate of Lands and Forests (DNTF), MINAG coordinated the formulation process and ensured national ownership and responsibility of the national institutions.

- Support participatory law enforcement for SFM practices in forest concessions and Environmental Management Plan (infrastructure, mining, ...)

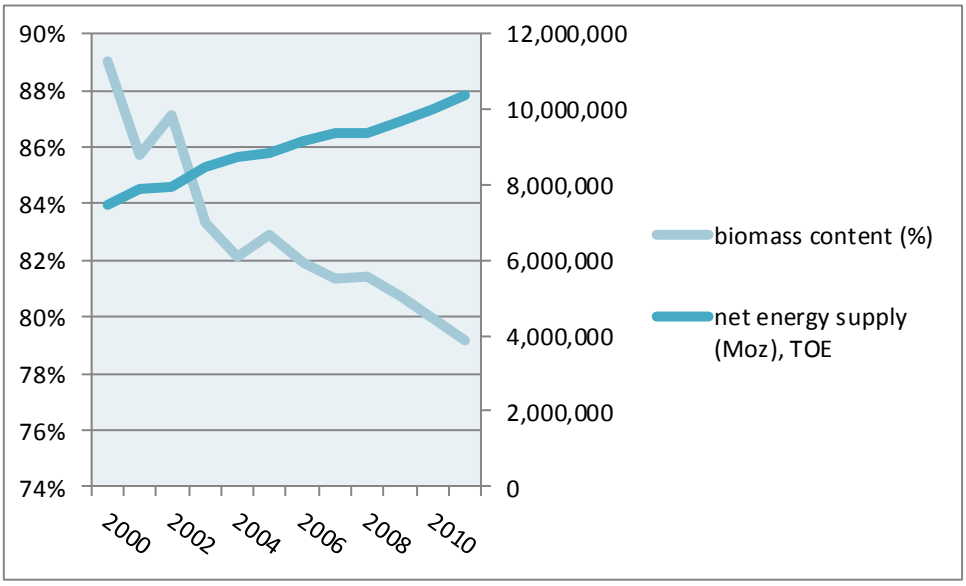
The development of new incentive mechanisms such as REDD have the potential to mobilize particularly the poor rural communities to engage in sustainable management practices for wood energy production and are therefore considered as one of the possible financing mechanisms in the BEST.

3.7 Non-biomass energy supply

As mentioned earlier, Mozambique is endowed with a large energy resources base. Large coal, gas, solar and hydro-electricity resources are available and many are being exploited commercially. Much of the exploited coal, gas, and hydro-electricity is exported. Non-biomass energy sources actually used in Mozambique are mainly hydro carbons (diesel, petroleum fuels, LPG, natural gas), electricity, and solar energy. Hydro carbons are mainly used for transport, process heat for industries, and to a lesser extent for domestic cooking and lighting. Electricity is mainly used in towns, for a variety of reasons including cooking. Solar energy is mainly used for crop drying and its total contribution to the energy balance has not been estimated.

The non-biomass contribution to the energy balance is growing, as can be seen in Figure x below. At just below 80%, the biomass contribution is still relatively high, higher than in most neighboring countries[41].

Figure 8: Declining Biomass Energy Contribution to the Energy Balance



Source: Ministry of Energy, 2012

3.7.1 Petroleum products

All liquid petroleum products are imported by Petromoc largely from South Africa and distributed by several other distribution companies. A small refinery at Maputo was mothballed in 1984. A joint plan exists to build a petroleum refinery in Mozambique, with a capacity of 10,000 bpd and will be jointly managed by Malawi, Zimbabwe and Mozambique. The Iranian government is expected to fund the project. Distribution and marketing of liquid petroleum fuels is also carried out by the state-owned oil company, Petromoc which controls much of the market, and other private companies include BP, ExxonMobil and Caltex. BP has increased its market share to bring itself to a similar level as Petromoc. Both BP and Petromoc service the aviation sector while BP holds the dominant share in the jet fuel market and Petromoc dominates the kerosene market.

[41] World Bank Statistical database (2009): Zimbabwe: 74.3%; South Africa: 12.3%; Tanzania 88.9%; Botswana: 35.7% no information about Malawi, Swaziland, Lesotho, Zambia.

The three ports of Mozambique - Maputo in the south, Beira in the centre, and Nacala in the north - offer an economic supply corridor to neighbouring landlocked countries. Presently, only Zimbabwe is transporting most of its petroleum products through Mozambique. Swaziland, receives approximately 5% of its product through the Maputo port and Malawi receives 18% through Nacala. Engen imports small volumes through Maputo to Swaziland using Petromoc's depots at Matola (Maputo). Maputo and Beira are important for domestic imports. The pipeline between Beira and Harare has been extended and is operating close to full capacity even with an expansion through the addition of pumping stations. A new oil product jetty accommodating vessels of 50,000 tons has been completed at the port of Beira. The other port that can accommodate large vessels is Nacala; however, due to low consumption in the area and poor transport connections to the rest of the country, the importance of Nacala in the distribution of petroleum products is diminishing.

In terms of gaseous petroleum fuels, mainly LPG and natural gas, most if not all is exported while LPG for domestic use is imported. Several very large gas fields have been discovered and are being or intended to be exploited by private companies under concession with the Government of Mozambique. In fact, the gas reserves are huge: several private gas companies reported recent discoveries of each several 10s of trillions of cubic feet of natural gas; a total confirmed reserve of 30 trillion cubic feet (0.85 trillion m3) in the Prosperidade field (Anadarko Company) has an estimated value of $150b at 2010 price levels; private companies are investing billions of dollars to exploit these resources under a concession mainly for export; more recently, the Italian oil and gas company ENI confirmed an additional 1.1 trillion m3 some 50 km off-shore in the Mamba field; most, if not all gas will be destined for exports.

The Mozambican government has recently (May 2012) appointed Petromoc as the official importer of cooking gas (LPG - liquefied petroleum gas), and has abandoned any further attempt to choose suppliers of gas by international public tender as was practiced before. Engen of South Africa ran into severe supply problems because of a fire at its refinery in Durban, leading to several weeks of severe shortages of LPG. Petromoc has the power to sign contracts with suppliers, to ensure "an effective, efficient and economic supply, taking market conditions into account". The National Fuel Directorate in the Energy Ministry is to work with Petromoc to ensure that the new import system is correctly implemented. Distribution of LPG was carried out by several private companies, GALP, AFROX, and VITAGAZ. In the past, GALP focused on the South, while the other two focused on the rest of the country, but now they try to capture markets where they can. Although LPG use has increased considerably from 8000 t in 2001 to 17,000 t in 2010, the per capita consumption remains low compared to other countries.

The main projections for the evolution of these fuels are presented in Table X below. A more detailed description of domestic usage is provided in the next chapters.

Table 13: Projected National hydrocarbon consumption by fuel type 2010 to 2030

Year	Hydrocarbon consumption						
	Diesel (m3)	Gasoline (m3)	Jet A-1 (m3)	Kerosene, lighting (m3)	LPG, cooking (m3)	N. Gas (m3)	Totals
2010	**643,639**	**251,331**	**80,013**	**35,243**	**30,430**	**349,435**	**1,390,090**
2011	687,439	268,434	85,458	37,641	32,501	373,231	1,484,704
2012	734,219	286,701	91,273	40,203	34,713	398,648	1,585,757
2013	784,183	306,211	97,484	42,939	37,075	473,415	1,741,307
2014	837,547	327,049	104,118	45,861	39,598	623,211	1,977,383
2015	**894,542**	**349,305**	**111,203**	**48,981**	**42,293**	**815,276**	**2,261,599**
2016	955,416	373,075	118,771	52,315	45,171	848,356	2,393,103
2017	1,020,432	398,463	126,853	55,875	48,244	883,690	2,533,557
2018	1,089,873	425,578	135,485	59,677	51,527	921,429	2,683,570
2019	1,164,039	454,539	144,705	63,738	55,034	961,739	2,843,794
2020	**1,243,252**	**485,470**	**154,552**	**68,075**	**58,779**	**1,004,793**	**3,014,923**
2021	1,327,856	518,507	165,070	72,708	62,779	1,050,780	3,197,700
2022	1,418,217	553,791	176,303	77,656	67,051	1,099,899	3,392,917
2023	1,514,727	591,477	188,300	82,940	71,614	1,152,362	3,601,421

Year	Hydrocarbon consumption						
	Diesel (m3)	Gasoline (m3)	Jet A-1 (m3)	Kerosene, lighting (m3)	LPG, cooking (m3)	N. Gas (m3)	Totals
2024	1,617,805	631,727	201,114	88,584	76,487	1,208,398	3,824,116
2025	**1,727,897**	**674,716**	**214,800**	**94,612**	**81,692**	**1,268,250**	**4,061,969**
2026	1,845,481	720,631	229,417	101,051	87,251	1,332,178	4,316,010
2027	1,971,066	769,670	245,029	107,927	93,189	1,400,460	4,587,342
2028	2,105,198	822,047	261,704	115,272	99,530	1,473,392	4,877,142
2029	2,248,457	877,987	279,513	123,116	106,303	1,551,290	5,186,667
2030	**2,401,466**	**937,734**	**298,533**	**131,494**	**113,537**	**1,634,493**	**5,517,258**

Source: WWF, Clean Energy Assessment, 2011 [9]

Since the bulk of petroleum products are used for non-domestic purposes[42], i.e., not for household use, they are not further discussed here.

3.7.2 Electricity

The country's realized hydro electricity production capacity is about 2 GW while the potential capacity is about 16 GW. Indeed, Mozambique has large hydroelectricity resources, one of the largest untapped in Africa. Both public and private interests exist to develop these resources, although there are no concrete plans at the moment. Much of the electricity is exported to South Africa under long-term supply contracts.

The main electricity authority is Electricidade de Mozambique (EDM), established by the state in 1977, two years after independence. EDM is responsible for generation, transmission and distribution, but there are other companies that produce and distribute electricity. The main one is Hidroelectrica de Cahora Bassa, a company jointly owned by Portugal (82%) and Mozambique (18%) and the biggest hydroelectric scheme in Southern Africa. Operations at Cahora Bassa, on the south side of the Zambezi River, are operating at higher capacities following restoration of the DC transmission line from Cahora Bassa to South Africa by EDM and Eskom, the South African power utility. Other large hydro power plants in Mozambique have continued to operate, including Mavuzi (44.5 MW effective capacity out of 52 MW nominal capacity); Chicamba (34 MW of 38.4 MW); and Corumana (14 of 16.6 MW).

Mozambique is seeking to boost power output as demand grows in South Africa. The country also needs to meet a national growing demand from a planned titanium plant and a possible future expansion to an aluminium plant. Mozambique is one of the largest power producers in the SADC region. It is also a member of the Southern African Power Pool (SAPP).

Electricity is used in some urban areas, particularly in Maputo and Matola. With only 12% of the population with access to electricity in 2009 (World Bank), the use of electricity is rural areas is only limited. Table X below shows the projected use of electricity by type of user.

Table 14: Projected Electricity Demand by type of user, 2010 - 2030

Year	Grid Electricity Demand Projections (GWh/year)									
	Mains-grid Demand by Consumer Type								Off- Grid Needs	Total Grid & Off- Grid
	Domestic	General Commercial	Agriculture	LV Big Consumers	Med. & High Voltage	Public Lighting	EDM Internal	Total		
2010	**1,192**	**388**	**0.24**	**228**	**1,201**	**78**	**16**	**3,103**	**1,952**	**5,055**
2011	1,286	419	0.26	246	1,296	84	17	3,348	1,988	5,336
2012	1,361	444	0.28	260	1,372	89	18	3,544	2,025	5,569

[42] LPG and kerosene for lighting contribute for less than 5% in energy terms

2013	1,465	478	0.30	280	1,476	96	20	3,814	2,063	5,877
2014	1,571	512	0.32	300	1,583	103	21	4,090	2,103	6,193
2015	**1,658**	**540**	**0.34**	**317**	**1,671**	**108**	**22**	**4,317**	**2,146**	**6,462**
2016	1,771	577	0.36	338	1,785	116	24	4,611	2,190	6,801
2017	1,863	607	0.38	356	1,877	122	25	4,850	2,236	7,086
2018	1,988	648	0.41	380	2,003	130	27	5,175	2,284	7,459
2019	2,082	679	0.43	398	2,098	136	28	5,421	2,334	7,755
202The	**2,212**	**721**	**0.45**	**422**	**2,229**	**144**	**30**	**5,758**	**2,387**	**8,145**
2021	2,339	762	0.48	447	2,357	153	31	6,089	2,441	8,530
2022	2,478	808	0.51	473	2,497	162	33	6,451	2,498	8,949
2023	2,615	852	0.54	499	2,635	171	35	6,807	2,558	9,364
2024	2,754	897	0.56	526	2,775	180	37	7,168	2,620	9,788
2025	**2,890**	**942**	**0.59**	**552**	**2,912**	**189**	**39**	**7,524**	**2,684**	**10,208**
2026	3,029	987	0.62	578	3,052	198	40	7,886	2,751	10,637
2027	3,166	1,032	0.65	604	3,190	207	42	8,241	2,821	11,062
2028	3,293	1,073	0.67	629	3,318	215	44	8,573	2,893	11,466
2029	3,420	1,115	0.70	653	3,446	223	46	8,904	2,968	11,872
2030	**3,540**	**1,154**	**0.72**	**676**	**3,567**	**231**	**47**	**9,216**	**3,047**	**12,263**

Source: WWF, Clean Energy Assessment, 2011 [9]

3.7.3 Coal

Mozambique has substantial coal deposits situated in the Moatize and Mucanha - Vuzi coal basins, all in the Tete province. The basin contains seven coal seams and has reserves estimated at 750 Mt. The Mucanha – Vuzi basin is said to contain as much as 3600 Mt coal reserves, although the basin is severely block faulted.

- The Brazilian company Vale has so far spent hundreds of million US$ on development of the $1.3bn Moatize coal mine and has started production in late 2011. Full production from the Moatize mine in terms of Phase One is planned at 12.7 million tonnes annually of hard coking coal for export; 2.4 mt/year of export thermal coal and 2.5 mt/year of thermal coal to supply a local power station.
- Riversdale Mining Limited started exploring the Benga coal project in Mozambique and was subsequently taken over by Rio Tinte. The project was a joint venture between Riversdale (65%) and Tata Steel Limited (35%) and is located in the Tete Province of Mozambique. Coal resources of 4.0 billion tonnes and a coal reserve of 502 million tones have been identified.
- The Zambeze Project, adjacent to the Benga Coal Project, has an identified coal resource of 9 billion tonnes. The Zambeze Project is similar in structure to Benga with 22 coal seams outcropping over strike length of 14 kilometers across the northern portion of the tenement. In June 2010 Riversdale signed a non-bonding MoU with Wuhan Iron and Steel Corporation and a logistics partnership agreement with the China Communications Construction Company for the development of the Zambeze Project.
- Mozambi Coal has a 70% interest in two mineral exploration licenses situated in the Zambeze coal basin. In July 2011 the company announced an agreement to acquire an 80% interest in a third exploration license, 2738L (“Songo” project), also within the Zambeze coal basin, an emerging and highly prospective coal region that is within economic reach of the East African coast.

Coal is not used for domestic purposes, and therefore not further described here. Most is exported, and a small amount is used in industries and electricity production.

4 Current Status and Trends in the Biomass Energy Sector

4.1 National energy balance, trends and regional variations

The national energy balance made up of all different energy sources in the country is characterized by two main trends:

- The predominance of nationally produced and consumed biomass
- A recent surge in national natural gas consumption, almost exclusively for export

Both of these trends can be seen clearly in the below two charts of national energy sources and national energy consumption respectively.

Figure 9 : Energy sources in Mozambique in tons oil equivalent (toe)

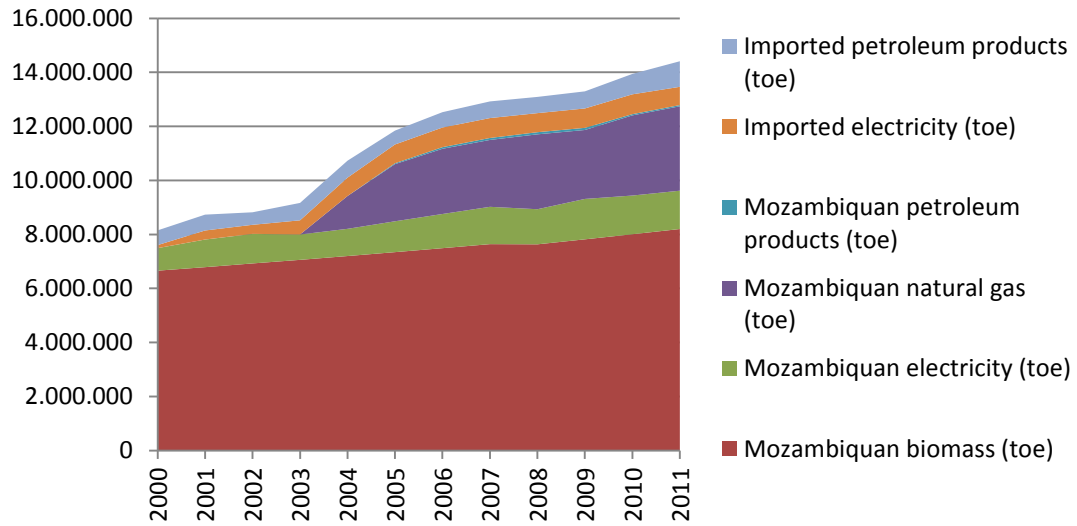
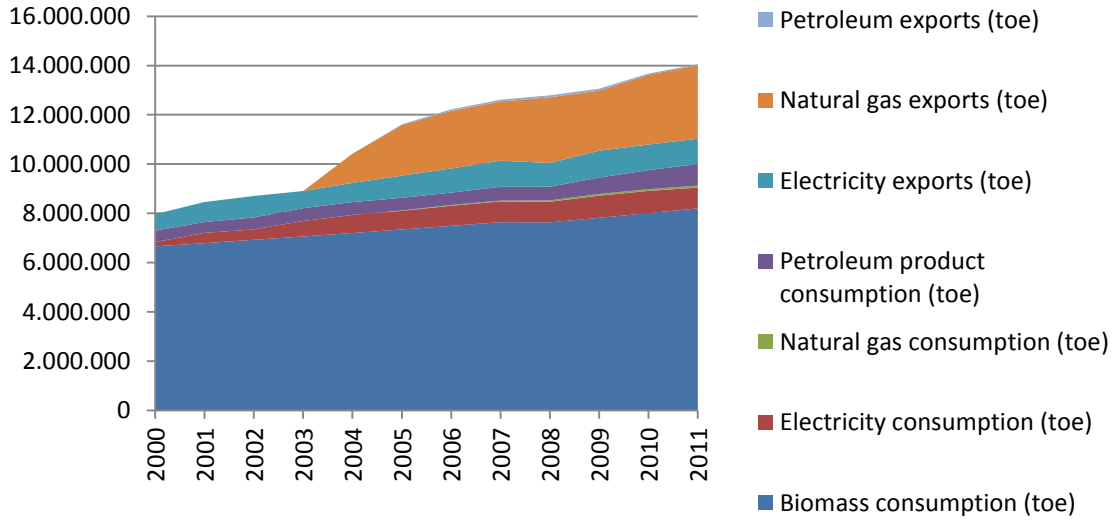


Figure 10: Energy uses including export and national consumption, in toe



Source: Ministry of Energy, 2012

These graphs reveal clearly the major opportunities open to Mozambique in improving its energy use and the contribution of energy to economic growth:

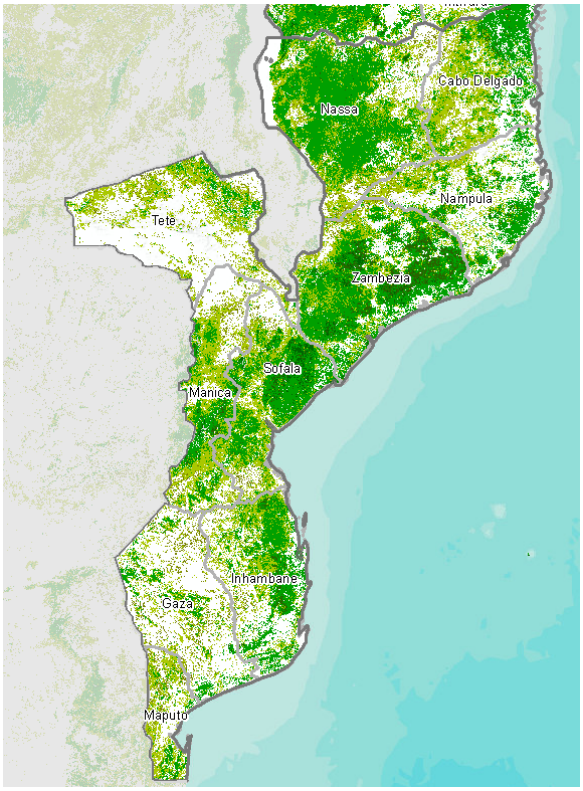
- The relentless growth of energy use needs to be directed towards specific fuels according to national priorities and government strategy.
- The continuing linear growth of biomass use represents a major threat to national biomass resources. It is clear that with a slowly declining forest cover, it is only a matter of time before this growth in biomass use can no longer be supported.
- By using natural gas locally, the government could:
    - significantly reduce the export of valuable energy resources in the form of natural gas exports
    - Displace some of the national biomass use

In 2011 energy produced *before imports* amounts to around 13m toe. Energy use in the same year amounts to less than 10m toe. From this we can conclude that Mozambique is able to cover its own energy needs with its current gas and electricity infrastructure, whilst reducing biomass consumption by 2m toe. This is a strong argument in favor of in-country use of natural gas in order to reduce deforestation.

4.2 Energy Resources and Supply

Nearly all of Mozambique's current demand for energy is met from indigenous, renewable resources[43] mainly forests and trees outside forests. There has been considerable debate as to whether the supply of biomass is sustainable and this will be discussed in detail in the following sections. When analyzing the supply and demand balance situation for biomass fuels, the availability within a physically or economically accessible radius has to be considered. The potential supply has to be judged on whether it is sustainable and whether there are more attractive alternative uses for the biomass resource or the land on which it is growing, both economic and environmental. Not only is most of the surplus biomass inaccessible to the main zones of consumption, but the wood resource base is also diminishing, principally because woodlands and trees in agricultural areas are being cleared to open up new land for farming. Therefore also projections in land use change have to be taken into account.

Figure 11: Forested area Mozambique



Source:ArcGIS Online [10]

4.2.1 Biomass energy supply

In order to determine the degree to which current levels of biomass energy consumption are sustainable, providing the information required designing appropriate sector interventions, it is necessary to establish the available annual supply.

Most of the data used are provided by the national forest inventory (AIFM) [2] in 2005 being published in 2007 and the WISDOM exercise [11]. Some of the data have been updated by the BEST team to reflect the current and future situation. It has to be noted that on the whole the forest data situation in Mozambique is extremely poor mostly based on "best approximations" and sometimes even referring to poor references (cf. Box 1).

[43] Biomass is considered a "conditionally renewable source of energy", meaning that it can be renewable if managed correctly, but that it also can be a non-renewable source.

The amount of biomass energy available is essentially a function of the woody growing stock and the annual yield. This chapter therefore develops estimates of the woody growing stock nationally, by region and for the four main urban catchment areas, and from this determines annual yield based on the relative coverage and known productivity of the different land cover classes. These yields are compared with estimated demand from the previous chapter, by region and for the main urban CAs, to establish the relationship between demand and sustainable supply both nationally and around the principal demand centers.

Box 1: Data limitations as described for the WISDOM exercise [11]

Reference data, such as the total woodfuel consumption in Cidades, Vilas and rural areas, are estimates rather than objective measurements since systematic consumption data was never collected and the availability of survey data was strongly unbalanced between Maputo, the other major and minor cities, and rural areas.

The estimation of woody biomass stocking and productivity was based on AIFM's National Forest Inventory data and Land Cover maps that provided solid information on forest classes but only indicative values for most non-forest classes. This means that for these classes the estimates cannot be more than "best approximations" based largely on poor references and inference.

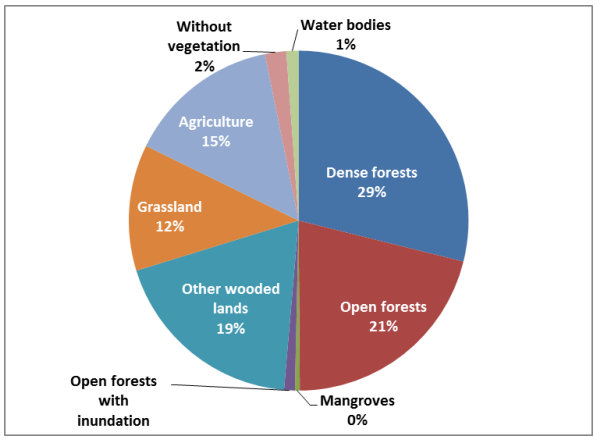
"..The values for stocking ranged around the mean, with a factor of between 0.76 and 1.24, and a similar factor range was assumed for the mean annual increment."

Mozambique can be broadly be divided into three geographical regions: North (Niassa, Cabo Delgado, and Nampula), Central (Zambézia, Tete, Manica, and Sofala) and South (Inhambane, Gaza, and Maputo). Its climatic zones range from arid and semi-arid (mostly in the south and southwest) to the sub-humid zones (mostly in the center and the north) to the humid highlands (mostly the central provinces).

4.2.1.1 Land cover

In order to assess the current and future land availability for biomass, current land use needs to be assessed. A large part of the country is covered by forest vegetation (51%) consisting of dense forests, open forests, mangroves etc.. 19% of the country is mosaic cropland meaning thicket, woodlands and forests in areas of shifting agriculture , but only a small part is actually cultivated (15%) as the majority is under shifting cultivation (see Figure 12). Although just a couple of land use classes are identified here, the diversification within these classes is rather large.

Figure 12: Share of land cover types



Source:[2]

Statistics on land use vary to a great extent; this is due to differences in measurement methods, differences in time of measurement (both inter annual as inter seasonal), and to inconsistencies in interpretation and classification.

Table 15 summarizes Mozambique's land cover types by region and gives their estimated areas.

Miombo[44] woodlands are the most widespread vegetation formation in Mozambique covering between 60 and 70% of the country. They occur in areas where the rainfall is between 500 and 1500 mm per year and where there is strong seasonality of the rainfall with an extended dry season. Mopane forests are dominant in the southern part of Mozambique.

[44] Miombo woodlands are mainly dominated by three species: Brachystegia, Julbernardia and Isoberlinia. However, they include a wide range of ancillary tree species providing high value timber such as Dalbergia melanoxylon, Burkea africana, Milletia stuhlmani, Afzelia quanzensis and Pterocarpus angolensis.

Table 15: Distribution of land cover types per province

Type of vegetation	Total		Cabo Delgado	Gaza	Inham-bane	Manica	Maputo	Nampula	Niassa	Sofala	Tete	Zam-bezia
	(1000 ha)	%					(1000 ha)					
Dense forests	22,519	29%	3,295	1,696	1,100	1,424	268	1,828	5,787	854	1,966	4,301
Open forests	16,390	21%	1,458	2,075	1,206	1,854	516	863	3,635	1,996	2,241	547
Mangroves	357	0%	32		29		5	75		93		122
Open forests with inundation	802	1%	18	8	84	178	31	5	8	362	15	94
Sub-Total Forests	40,068	51%	4,803	3,779	2,419	3,456	820	2,771	9,429	3,305	4,221	5,064
Other wooded lands	14,712	19%	1,045	2,008	2,390	1,253	439	802	975	1,261	2,408	2,130
Grassland	9,359	12%	475	994	634	821	700	389	808	1,676	2,134	729
Agriculture	11,369	15%	1,149	564	1,188	628	309	3,391	864	445	862	1,969
Without vegetation	1,580	2%	239	33	95	53	50	434	135	44	160	340
Water bodies	903	1%	77	154	152	22	44	30	29	39	280	76
Total	77,991	100%	7,787	7,532	6,877	6,232	2,362	7,817	12,240	6,770	10,065	10,308

Source: [2]

The total amount of productive forests has been estimated to 26.9 million ha. The provinces with the largest share Niassa (6 million ha), Zambezia (4.1 million ha), Tete (3.3 million ha) and Cabo Delgado (3.1 million ha) are found in the central and northern region. Furthermore, 13 million ha of forests about 16% of the countries land cover are protected or conservation areas.

Table 16: Distribution of protective and productive forest per province ('000ha)

Province	Forest cover 2005	Conservation/ Protection forests	Productive forests
Cabo Delgado	4,803.1	1,627.6	3,175.5
Gaza	3,778.8	1,356.9	2,421.9
Inhambane	2,419.3	982.1	1,437.2
Manica	3,456.0	1,504.7	1,951.3
Maputo	820.4	137.6	682.8
Nampula	2,771.4	454.6	2,316.8
Niassa	9,429.1	3,379.3	6,049.8
Sofala	3,304.9	1,885.6	1,419.3
Tete	4,221.4	881.5	3,339.9
Zambezia	5,063.6	951.1	4,112.5
Total	**40,068.0**	**13,161.0**	**26,907.0**

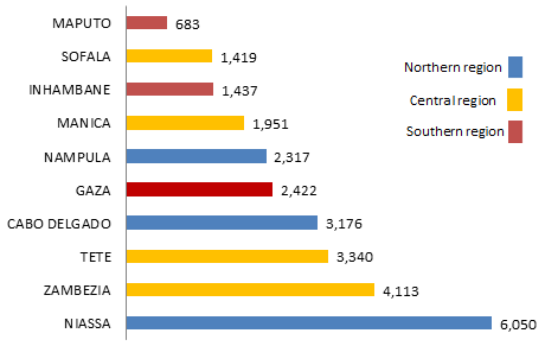
Source:[2]

4.2.1.2 Drivers of land use change

Population

Population growth is certainly the main driver to land use change. The Mozambican resident population, as counted in the national census conducted in 2007, was 20.6 million. The 1997 census forwarded a total population of 16.1 million. So between the two censuses the population has grown by 4.5 million, or by 2.8% per year. The projection data (2011-2020) of the National Institute for Statistics [12] have been prolonged until 2025 to serve the BEST purpose of estimating the future supply and demand situation. In 2007 around 29.8 % of the population is urban and 70.2 % live in rural areas. In 2025 the population is expected to reach 34 million people of which 35% are considered urban and 65% rural. This amounts to an average annual population growth of 3.2%. Urban growth is expected to rise at a rate of 4.4% and rural growth at a rate of 2.6%.

Figure 13: Amount of productive forests per province (`000 ha)



Source: [2] adapted

Nampula remains the most populous province with almost 6.4 million inhabitants in 2025, followed by Zambezia, with 6.2 million. This also holds true for the population density (Nampula 82 pers./km^2; Zambezia 62 pers./km^2) except for Maputo province (168 pers./km^2). However, the population density of Tete, Niassa and Manica province will increase disproportionately compared to provinces like Inhambane, Gaza or Cabo Delgado (cf Figure 14).

Table 17: Population projections 2011-2025

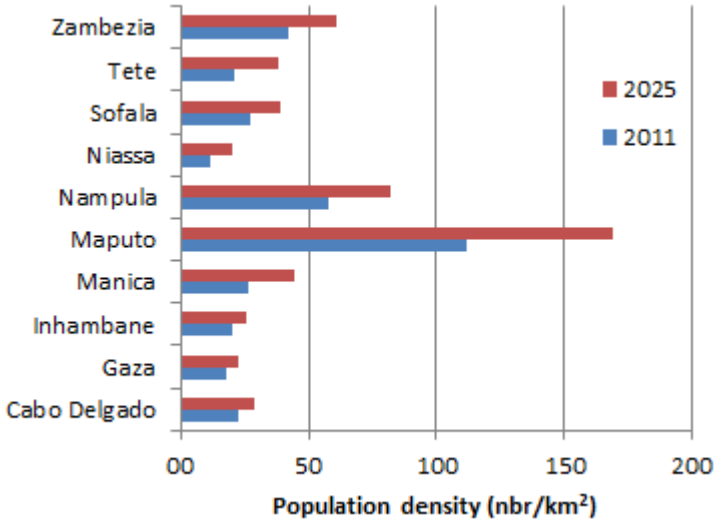
	Population (2011)			Population (2025)			Growth 2011-2025		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Cabo Delgado	395	1,369	1,764	717	1,517	2,234	5.4%	0.7%	1.8%
Gaza	339	982	1,321	438	1,241	1,679	1.9%	1.8%	1.8%
Inhambane	322	1,080	1,402	476	1,277	1,752	3.2%	1.2%	1.7%
Manica	410	1,262	1,672	615	2,161	2,776	3.3%	4.7%	4.4%
Maputo	2,190	449	2,639	3,297	688	3,985	3.4%	3.6%	3.4%
Nampula	1,369	3,161	4,530	2,544	3,885	6,429	5.7%	1.5%	2.8%
Niassa	328	1,087	1,415	612	1,880	2,492	5.8%	4.9%	5.1%
Sofala	690	1,167	1,858	862	1,758	2,620	1.7%	3.4%	2.7%
Tete	290	1,848	2,138	530	3,307	3,837	5.5%	5.3%	5.3%
Zambezia	824	3,503	4,327	1,803	4,453	6,256	7.9%	1.8%	3.0%
Total	7,158	15,908	23,066	11,892	22,168	34,060	4.4%	2.6%	3.2%
Source	INE [12]			own calculations					

Farming

In Mozambique, around 81% of the economically active population is engaged in agriculture [13]. The central and northern regions are particularly apt for crop production whereas the south for livestock production. Still only about 11% of its 36 million potentially arable hectares are cultivated and agricultural productivity does not really get off the ground.

Production of food staples is dominated by smallholders, with an average area of cultivation below 2 hectares. Maize and cassava are the major staples; other food crops of significance include sorghum, beans, groundnuts, millet and rice. Tree crops, especially coconut and cashew, are grown by small farmers and are a significant source of income in coastal areas of Inhambane and Gaza provinces north of Maputo. Much of the country's soil is nutrient-poor. Use of purchased inputs is very limited; according to a national survey conducted in 2007, only 4% use fertilizers. However, it has to be noted that according to the World Food Programme (WFP) [14] the central and southern provinces of Maputo, Gaza, Inhambane, Sofala, Tete and parts of Manica do not produce enough cereals and are more vulnerable to natural disasters and, except for Inhambane HIV/AIDS.

Figure 14: Population density per province



Source: INE until 2020 adapted

The FAO/WFP study shows an increase in farming area for maize and sorghum between 2005 and 2010 of around 2.8% annually. This corresponds more or less to the population increase during this time. The traditional shifting cultivation applied is able to support 2-4 persons/km^2. Due to the increasing population density, the fallow period falls short and shorter not allowing the miombo vegetation to regenerate. In the areas of most intense farming this has resulted in an open scrubland. In addition, the frequency and intensity of fires to clear for agricultural land has a detrimental effect on miombo forests although it plays an important role in the maintenance of the ecological functions of miombo forests as it facilitates regeneration and also soil nitrification.

The AIFM team of 2007 was able to draw a regression curve between the population density and the percentage of forest cover. The following equation shows the interrelationship between the share of forested area (Y) and the population density per km^2 (X).

$$Y = 85.99 * e^{(-0.0148x)}$$

Table 17 shows that the average population density of Mozambique will increase from 30 pers. /km^2 in 2011 to 43 pers. /km^2 in 2025. This would lead to a loss of productive forest area of an estimated amount of 4.7 million ha or more than 17% of the 2011 productive forest area. Most of the forest loss will have to be attributed to an increase in agricultural production area.

It should be noted that deforestation strictly speaking only occurs when there is a change of land use. This is the case when farmers move into a cleared area and start permanent farming. If charcoal producers go into a woodland area and clear a patch to produce charcoal, for example, this is not deforestation if the area is left to recover. It is more correctly called harvesting, although the area may not recover to its original state of biodiversity. The forest has then been degraded, although the annual yield may not necessarily be affected. Similarly during the practice of shifting cultivation an area of forest may be cleared and farmed for two to three years and then left to recover, meaning that it has not been deforested but degraded.

Certainly deforestation is taking place at a rapid pace when population density is increasing and when wooded land is converted to permanent agriculture or into urban settlement, but it is important to apply the term correctly if the causes and solutions are to be properly addressed.

Conservation areas

According to political guidelines Mozambique is increasing its conservation area from 11% to 16% [16]. Although conservation areas (national parks and reserves) are not meant to produce biomass energy, they are actually being used as such, particularly for the consumption of local residents. Almost all the forest reserves and national parks have human settlements, practicing agriculture and using firewood as those people living the open access areas. There are reports of charcoal production within the conservation areas, particularly those close to the main population centers such as Licuati and Elephant reserves in Maputo, Gorongosa national park in Sofala, and Mecuburi in Nampula [17].

Table 18: Demand for land for agribusiness projects per region

Region	Nbr. of projects	Demand for land (ha)
Southern Region	9	94 598
Central Region	26	1 232 740
Northern Region	19	1 335 350
Total	**54**	**2 662 688**

Source: [15]

Land acquisition through foreign investments

Mozambique seeks to modernize and expand agricultural production, and a key strategy is to attract foreign capital to the sector. So far, several large investment projects have been established and approved. This is being reinforced by the new "Policy and Strategy for Bio-fuels" approved in 2009 by the GoM [18]. The policy declares that the bio-fuel sector will be developed in three stages: pilot phase from now until 2015, operational period from 2015 until 2020 and expansion.

Throughout the country there is a demand for more than 2.6 million ha for agribusiness (cf. Table 18) predominantly for biofuels and in the northern region also for large scale forest plantations. It has to be noted that many of these foreign companies produce energy for export and not necessarily for the national market.

Land acquisition through foreign investors is currently controversially discussed [15] under the term land grabbing. It is claimed that the investments create more conflicts and aggravate the poverty, deficits and vulnerability of the rural communities. It is clear that such a huge amount of land and investment is not established on barren land but on forested areas. This is made even more difficult as no proper zoning or land use planning exists and Mozambique lacks an adequate definition of forest that can be used to determine if the area concerned is actually a forest.

Land use planning and zoning is needed to address a growing human population and to identify areas for protection, sustainable production of biomass and for agricultural practices (food security and biofuels

production) and other land uses. Such a process would also provide valuable information to landholders when deciding whether they want to transfer land to investors.

Deforestation

The underlying causes for deforestation as partly already mentioned can be summarized as follows: (i) institutional factors: weak capacity, lenient law enforcement, (ii) demographic factors: increasing urban population and associated demand for charcoal (iii) economic factors: high profitability of export markets (sesame, cotton, tobacco, timber); (iv) technological factors: low productivity agriculture; inefficient charcoal production and consumption; lacking alternative/ affordable energy sources. The direct and indirect causes of deforestation and degradation as identified by the REDD exercise are shown in Table 19.

Table 19: Direct and indirect causes of deforestation and degradation

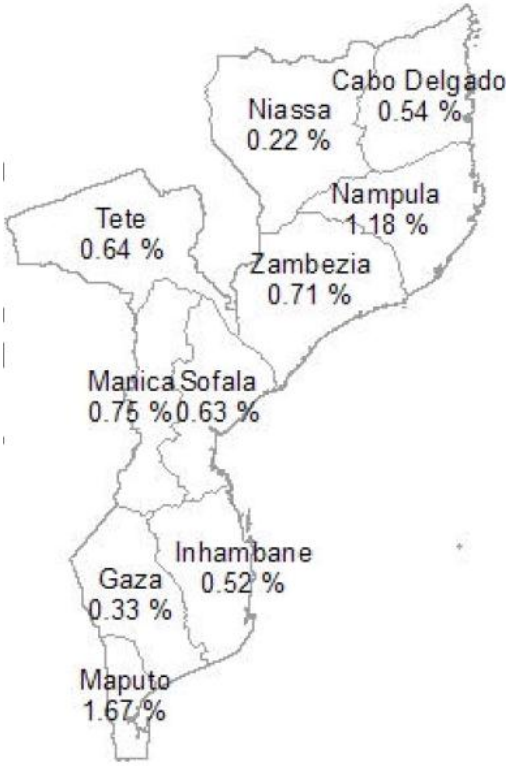
	Direct	*Indirect*
Deforestation	a) Unsustainable agriculture practices throughout the country b) Unsustainable production of biomass energy and inefficient consumption (Maputo, Nampula, Beira in particular) c) Construction materials (poles in particular) d) Unsustainable logging e) Illegal logging f) Uncontrolled fires g) Infrastructure (settlements, roads, electricity transmission from Cahora Bassa Dam-Maputo) Mining (and settlements (horizontal expansion of urban areas)	a) Population increase at 2.3 percent per annum b) Economy of the country c) Limited extension network and limited access to technologies and markets d) Demand for commodities in international markets, e.g. – Renewable energy – EU targets => land for biofuels (Cabo Delgado, Nampula, Zambézia, Manica, Sofala) e) Investment policies and taxation (including royalties) – 6mil. Ha – being negotiated with Brazilian farmers to produce soya, maize (Cabo Delgado, Nampula, Zambezia, f) The role of large scale plantations
Degradation	a) Uncontrolled fires (nearly 131,000 fire points in 2009) (Zambézia, Niassa, Tete, Nampula, Cabo Delgado, Sofala and Manica) b) Unsustainable and illegal logging practices (Zambézia, Cabo Delgado, Nampula, Sofala)	a) Limited law enforcement capacity – weak monitoring of SFM and environmental management plans b) Investment policies and taxation (including royalties)

Source:[8]

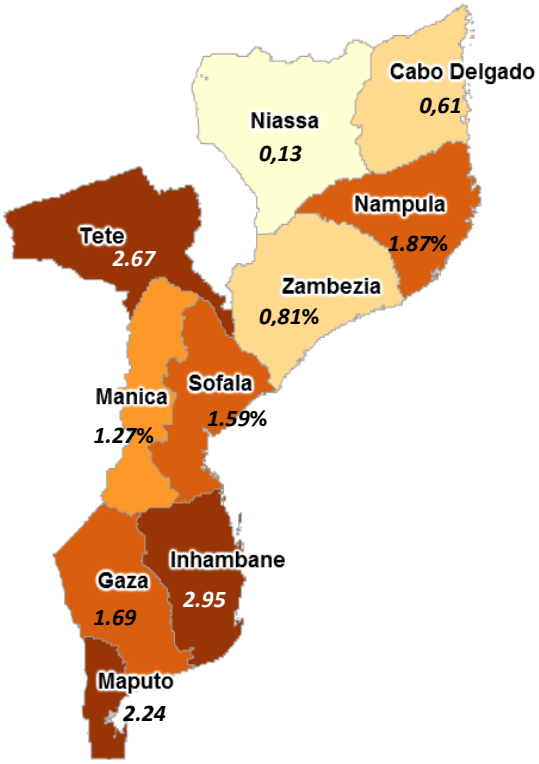
According to official documents the annual deforestation rate in Mozambique is 0.58%. This figure refers to AIFM findings by comparing the forest area of 1990 with that of 2002. However, this figure is questionable as different forest definitions were used in subsequent forest inventories. Furthermore, the figure of 0.58% is not in line with AIFM's statements on the relationship between the population density and the percentage of forest cover (cf. regression equation in chapter 4.2.1.2) and by assuming a population growth of 2.8%. Moreover, it is not comprehensible why the AIFM team did not compare the outcome of the 2005 image interpretation with those from 1990 but restricted themselves to a comparison of 1992 and 2002 data.

Figure 15: Deforestation rates per province from two different data comparisons

1990-2002 data comparison [19] [45]



1990-2005 data comparison (own presentation)



When comparing the 1990 data of the AIFM report [2] (Table 32) with the 2005 data listed in Table 5 of the same report a mean annual deforestation rate of 1.4% instead of 0.58% can be calculated.

Comparing the two derivations (Figure 15) it is striking, that the figures for the southern and central provinces deviate much more upwards than compared to the northern provinces.

4.2.1.3 Natural forests

The previous discussion is intended to highlight the main driving forces behind Mozambique's changing land use patterns, to ensure that the package of intervention measures developed by the government places due emphasis upon raising agricultural productivity and addressing population growth, and does not seek to tackle the biomass energy sector in isolation. It is, however, time to return to the estimation of sustainable biomass supply that forms the main focus of this chapter.

Having presented the land cover situation, it is necessary to estimate standing stocks and annual yields for each of the land cover types in order to determine total yields. This can indicate the level of wood harvesting likely to be sustainable in each part of the country. The limitation here is the availability of accurate and up to date empirical data. The BEST team based their estimates on extrapolation from the AIFM of 2005 [2], the last reliable study conducted at national level.

[45] Map depicted from MICOA 2008

Average standing stock

The average standing stock per ha for all different forest types per province is presented in Table 20. With an average standing stock of 57.8 m^3/ha the Zambezia province is endowed with the highest volumes, followed by Cabo Delgado (48.9 m^3/ha) and Sofala province (48.3 m^3/ha).

Table 20: Average standing stock per province

Provinces	Average standing stock (m^3/ha)
Maputo	14.7
Gaza	20.0
Inhambane	25.1
Sofala	48.3
Manica	41.8
Tete	36.3
Zambezia	57.8
Nampula	41.4
Cabo Delgado	48.9
Niassa	30.1

The share of commercially usable timber volume is estimated at around 12 to 15% of the average standing stock except for the provinces Niassa, Inhambane, Tete and Maputo where the share lies between 7 and 9%.

Forest growth rates

Evaluating the annual productivity of forest stands is necessary to establish the allowable cut and the potential stand renewal. It may be said that while the inventory and the associated information are indispensable for the spatial management of a forest, evaluating its productivity is necessary for its sustainable management. In Mozambique, hard data on forest growth rates are merely not available, except for some site specific surveys[20] which also use general approximation procedures such as the "Mantel equation" to deduct the average increment from the stock values and the average rotation period. The application of this equation entails the problem that it is extremely difficult to determine rotation ages for heterogeneous, uneven aged and mixed vegetation for which no tree ages are known. One option mentioned in the AIFM is to uniformly apply a rotation age of 40 years which seems also not very satisfactory seen the different climatic zone ranges. As an alternative mode of approximation the national inventory also discussed the application of a regression formula developed by Clement in 1982 [21] for West Africa describing the dependency of forest growth (in m^3/ha/year) and the annual rainfall (P in meters).

$$\text{Mean annual increment} = 0.05129 + 1.08171 \times P^2$$

Applying this equation would result in following growth figures as illustrated by Figure 16.

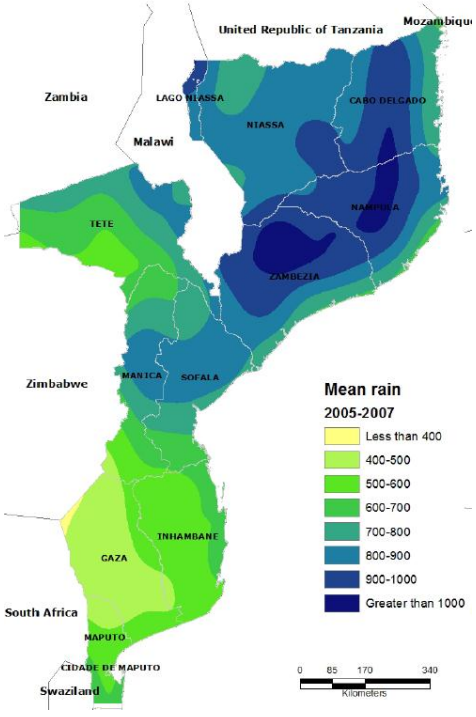
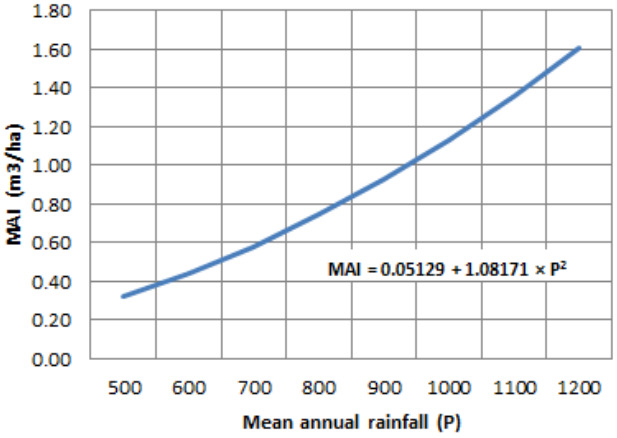


Figure 16: Mean annual increment in relation to mean annual rainfall



This also clearly shows that climate change will affect the MAI and thus the supply situation in the different provinces. As the provinces are not in line with the course of the isohyets the AIFM determined the MAI for the different provinces as shown in Table 21. It remains noteworthy, that the AIFM figures seem to be slightly superior then those resulting from the Clement equation.

Table 21: Mean annual increment as proposed by the AIFM in comparison with the Clement equation

Provinces	AIFM (m^3/ha/y)	Isohyets (mm)	Clement equation (m^3/ha/y)
Cabo Delgado	**1.28**	700-1000	0.58-1.13
Gaza	**0.41**	400-700	0.22-0.58
Inhambane	**0.65**	500-700	0.32-0.58
Manica	**1.20**	500-900	0.32-0.93
Maputo	**0.58**	400-700	0.22-0.58
Nampula	**1.16**	700-1200	0.58-1.61
Niassa	**1.57**	700-1000	0.58-1.13
Sofala	**1.19**	600-900	0.44-0.93
Tete	**0.90**	500-900	0.32-0.93
Zambezia	**2.08**	700-1200	0.58-1.61

The average figure assumed in the Chaposa study [22] concerning growth rates for the forests of Maputo, Gaza and Inhambane Province was of 0.4 ton/ha/year being in line with the AIFM figures.

The Best team decided to apply the AIFM figures as the WISDOM exercise also used these figures. Translated into rotation ages, this would give rotations between 20 and 48 years matching with common rotation periods for woodlands.

Annual available cut

For the objective of this BEST study it is necessary to determine the total annual available cut (AAC)[46]. This is the amount of woodfuel being physically accessible and usable as woodfuel on the basis of the MAI figures presented in Table 21.

There are three variables to be taken into account a) share of forest area which is accessible for harvesting b) amount of wood destined for timber/pole production and b) share of species which are usable for woodfuel.

The AAC share can be deduced from Table 5 of the WISDOM report [11] by comparing the figures for the increment physically accessible with the total increment per province. Together with the derivations made in the previous chapters the total available cut for woodfuel purposes per province (cf. Table 22) can be calculated.

Table 22: Annual available cut per province

Province	Productive forests 000 ha	Mean Annual Increment m^3/ha/y	Total annual production '000 m^3/ha/y	Reduction factor %	AAC '000 m^3/ha/y
Maputo	6,83	0.58	395	11%	351
Gaza	2,422	0.41	1,003	22%	780
Inhambane	1,437	0.65	928	16%	778
Sofala	1,419	1.19	1,686	23%	1,300
Manica	1,951	1.20	2,334	21%	1,835
Tete	3,340	0.90	3,016	39%	1,837
Zambezia	4,112	2.08	8,533	19%	6,884
Nampula	2,317	1.16	2,678	14%	2,295
Cabo Delgado	3,175	1.28	4,061	25%	3,030
Niassa	6,050	1.57	9,516	34%	6,260
Total	**26,907**	**1.25**	**34,152**	**24%**	**25,350**

46 In contrast, the term annual allowable cut describes the amount of wood that may be sustainable harvested annually or periodically per hectare in accordance with the objectives of a given management plan.

The total productive forest area of 26.9 million ha produces annually around 25.35 million m^3 of wood usable as energy source. Sitoe et al (2008) [23] estimated a national production of around 22 million tons per year[47] from the natural forests. When converting Sitoe's estimate into m^3 (conversion rate 0.7) we achieve a similar result (34.15 million m^3/ha/y) before applying the reduction factor (cf. Table 22).

Since market demand and forest access are key determinants of the intensity of wood removal, areas that are easily accessible are more intensively logged than remote ones leading to degradation. Theoretically we can say there that there is probably a balance between wood fuel demand and supply potential but in reality many regions are experiencing acute scarcity of wood fuel due to uneven distribution of forest resources.

4.2.1.4 Plantations

Plantation area

Since the late 1960s substantial efforts to establish woodfuel plantations primarily through public sector investments and supported by bilateral and multilateral agencies have been deployed. The investments in woodfuel plantations around the main consumption centers Maputo, Beira and Nampula amounted up to 31.5 million USD [24].

The overall poor performance has resulted from a combination of several factors among other things: state ownership coupled with poor management control, lack of knowledge about key technical parameters such as soils, climate and tree species behavior and substantial losses from fires. The average survival rates varied between 30 to 50% only.

After several years of little interventions in plantations, a National Afforestation/Reforestation strategy was adopted in 2005. The national forest strategy creates room for different categories of forest plantations including energy biomass plantations.

About 60,262 ha of forest plantations (mainly eucalyptus and pinus) have been established since 2007. Of these, 66% are in Niassa, 13% in Zambézia, 10% in Manica, and the rest scattered in the other provinces (Table 23). The southern provinces have very little areas under plantation, while most of the plantations are in the northern province of Niassa. These plantations include the state, private, community, and NGO for energy biomass, industrial/commercial, and conservation purposes.

The provinces with high aptitude for large scale plantation are: Niassa, Cabo Delgado, Nampula, Zambezia and Manica.

Table 23: Forest plantations (in ha) by province in Mozambique in the period 2007-2011

	2007	2008	2009	2010	2011	Total	In %
Maputo	110	4	198	30	310	652	1.1%
Gaza	19	12	18	70	24	143	0.2%
Inhambane	7	93	65	52	75	292	0.5%
Sofala	-	516	819	451	285	2,071	3.4%
Manica	710	1,306	2,086	1,208	1,029	6,339	10.5%
Tete	40	19	680	707		1,446	2.4%
Zambezia	58	1,186	2,666	2,300	1,740	7,950	13.2%
Nampula		62	86	233	92	473	0.8%
Cabo Delgado	290	203	143	276		912	1.5%
Niassa	5,040	6,404	7,307	10,460	10,774	39,985	66.4%
Total	**6,274**	**9,805**	**14,068**	**15,787**	**14,329**	**60,263**	**100.0%**

Source: reports of the DNTF 2009-2011 [25];[26]

There are few scattered initiatives to produce energy biomass from local plantations, these are limited and there are no reports about them. Initiatives such as the community agro-forestry project of Xai-Xai, or the ADPP community reforestation project in Manica are some of these examples. In general, these community

47 This estimation is done after removing out the conservation areas, the forest concessions and the fragile ecosystems, multiplying the resulting area with average stock figures of the national inventory and applying an annual growth rate of 2%.

projects cover only less than 10 hectares and are often established with multiple purpose trees to produce other goods and services (such as poles, windbreaks, home-gardens, medicinal products, etc.), they do not appear on the statistics clearly.

In addition, following the presidential directive "each community leader shall have a community forest, and that each pupil shall plant a tree", several plants have been planted all over the country. The Forest Services (DNTF) and the Agricultural Development Fund (FDA) and the Ministry of the Environment (MICOA) have been working to support this initiative. Table 24 indicates the areas planted as State and Private forests based on the statistics of DNTF. Of the forests established since 2009 up to 2011, there are 3,151 ha (7%) indicated as state forests. The Forest Service statistics do not separate the state plantations from the community. There is only an indication from the 2011 report saying that of the 913 ha of state plantations established that year, 456 ha were established in community areas under the presidential initiative "one leader, one forest".

There are disputes on the statistics of the community plantations since these are based on the areas that are established by the communities from seedlings provided by the Forest Service, without further technical assistance to maintain the trees alive. Reports from the media (Jornal Domingo, May 29, 2011) indicated that in Zambézia province, for instance, where 3060 forests were expected to be established only 256 forest plots were planted. Of those, many were in bad condition or just planted in the week before the presidential visit and after that there are no efforts to protect the planted trees from fire, grazing, and other damaging factors. The purpose of the community and school forests established under the presidential initiative although in line with forestry and environmental policies, its implementation structure is not clear. The existing plantations cannot be said to be for energy biomass as they may serve other purposes such as the timber, poles, fruits, etc.

Table 24: Forest plantations (in ha) by the state and private sector in the period 2009-2011

	2009		2010		2011		Total	
	State	Private	State	Private	State	Private	State	Private
Maputo	198		30		310		538	-
Gaza	18		70		24		112	-
Inhambane	65		52		75		192	-
Sofala	160	659	117	334	285		562	993
Manica	86	2,000	158	1,050	127	902	371	3,952
Tete	50	630	707				757	630
Zambezia	5	2,661		2,300		1,740	5	6,701
Nampula	20	66	73	160	92		185	226
Cabo Delgado	143		276				419	-
Niassa	10	7,297		10,460		10,774	10	28,531
Total	**755**	**13,313**	**1,483**	**14,304**	**913**	**13,416**	**3,151**	**41,033**

Source: DNTF 2012

No statistics were found indicating other community forest plantation initiatives by other institutions such as MICOA and the NGO´s.

Plantation forestry is seen as the brightest prospect for the long-term growth of the forestry sector. The forest department identified about 7 million ha apt for reforestation [27]. Most of these potential areas are in Zambezia, Nampula and Niassa (2.1 million ha, 1.5 ha million ha and 2.4 million ha, respectively). The Reforestation Action Plan of 2009 forwards a land allocation target of about 3 million ha.

Mozambique has already attracted several large overseas investors to Niassa and Nampula Province, for example the Norwegian industrial forest plantation company "Green Resources" being allocated an area of 126,000 ha for reforestation. Green Resources is a plantation, carbon offset, forest products and renewable energy company. It intends to certify their products and build a stream of revenue through compliance and voluntary carbon markets.

While country wide REDD consultations, suggested that plantations for rehabilitation of degraded areas, or for supplying energy as well as agroforestry systems to enhance land productivity should be eligible, the debate was not conclusive as regards large scale commercial plantations that not only will replace natural forests and reduce biodiversity but are also claiming potential financing under REDD+.

Plantation growth

Growth potential and rotation of plantations varies according to species, objective of the plantation (woodfuel/pulp&pellets/saw-logs) and site quality (rainfall and soil). Whereas concession holders timidly replant areas on their concessions with mainly native species [28], the companies investing in plantation forestry count on the higher productivity of exotic species mainly Eucalyptus camaldulensis and/or saligna. According to statements from forest officers no documentation has been kept for older plantations in Mozambique, in order to evaluate their productivity. Due to the lack of reliable data estimates ranging between 15 to 25m^3/ha/year are assumed by the plantation companies for the northern provinces[48]. It was also stated that with the deployment of superior clones these MAIs can be raised up to an average of 28 to 35 m^3/ha for the second rotation [29]. Other reports[27] come up with similar production figures e.g. for the site conditions in Zambezia province:

Table 25: Yield potential and rotation estimated for Zambezian plantation sites

Species	Initial MAI (m3/ha/yr)	Potential MAI (m3/ha/yr)	Rotation for pulp	Rotation for saw-logs
Eucalyptus ssp	18-25	25-32	8 years	12-15 years
Pinus ssp.	11-15	15-20	10-12 years	20 years
G. arborea	18-22	28-32	8 years	12 years
T. grandis	9-11	12-14	N/A	25-30 years

Source:[27]

This would be in line with analyses from Brazil indicating that precipitation is by far the most important determinant of yield in semi-arid regions[30]. The water use efficiency is estimated to be between 2 and 2.8 grams of biomass produced per kilogram of water. This is equivalent to 0.02 tons/ha per millimeter of precipitation resuming to the regression equation:

$$MAI\ (t/ha/yr) = (0.016 * Precipitation) - 1.05$$

However, the BEST team experts advise caution in applying these fairly high production figures for woodfuel projections as:

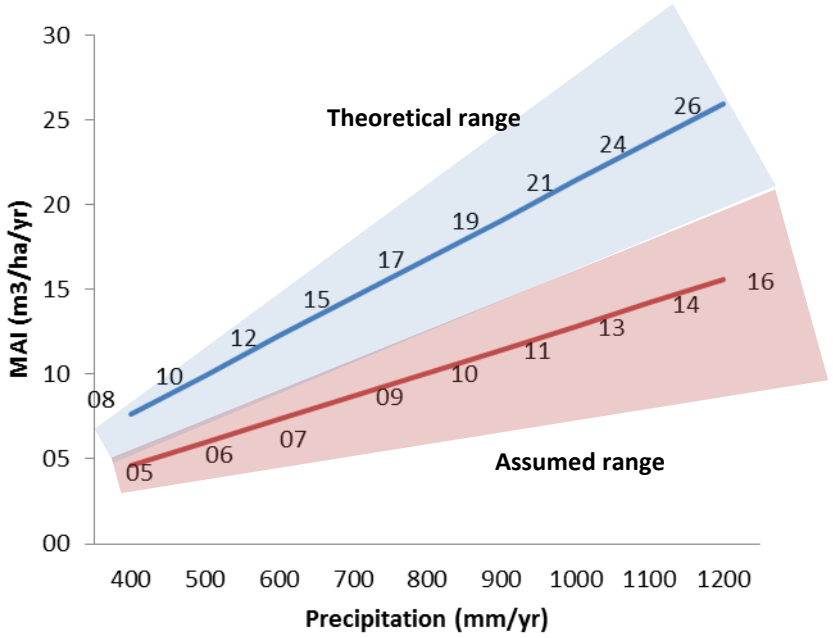
- Reforestation should not go at the expense of natural forests, meaning that only degraded soils should be reforested (see also FSC principles)[49].
- Rotation cycles for woodfuel production are very short (6 to 8 years)
- Risk of fires are detrimental to growth
- Eucalyptus are water greedy and should be spaced well apart (625-1111 plants/ha) thus leading to decreasing productivity
- Community plantations do not apply fertilizers or superior clones

Based on field data of comparable plantations in Madagascar the BEST team proposes to lower expectations by at least 30 to 40%. To this end the following mean productivities for plantation forests compared to the theoretical are proposed:

48 Personal communication by Arno Brune, Green Resources - Nampula

49 The APRONAF/Sunafop project is preparing a study on land clearing in relation to large scale plantations and forest certification.

Figure 17: Theoretical and assumed mean annual increment for Eucalyptus plantations



Contribution to woodfuel supply

One has to bear in mind that most of the existing plantations are not destined for woodfuel production but to produce poles and timber. It is estimated that less than 30% of the plantation grown wood goes into woodfuel production. Thus the current annual supply potential of the 60,000 ha's of plantations is around 190,975 m^3 (cf. Table 26).

Table 26: Woodfuel supply potential of the existing forest plantations

	Reforestation area (ha)	Average Precipitation (mm)	Assumed yield (m3/ha)	Annual woodfuel supply (m3)
Maputo	652	550	6.6	1,299
Gaza	143	500	6.0	256
Inhambane	292	600	7.3	642
Sofala	2,071	750	9.4	5,831
Manica	6,339	700	8.7	16,545
Tete	1,446	700	8.7	3,774
Zambezia	7,950	950	12.1	28,927
Nampula	473	950	12.1	1,721
Cabo Delgado	912	850	10.8	2,943
Niassa	39,985	850	10.8	129,037
Total	60,263			190,975

In regard to the intended large scale energy plantations by the various foreign companies it is noteworthy, that they are targeted to produce energy for the export market only.

4.2.1.5 Trees outside forests

Trees outside forests (TOFs) include all trees found on non-forest lands, such as agricultural including fallow lands, in urban and settlement areas, along roads, in home gardens, in hedgerows, scattered in the landscape and on pasture and rangelands. Much of the landscape today especially in the Northern provinces comprises a

mosaic of agricultural fields, with fallow and the orchards of coconut (Coco nucifera), cashew nut (Anacardium occidentale) and mango (Mangifera indica). Although TOFs fulfil a multipurpose function, wood fuel can be a main product. However, there is hardly any data on how much woodfuel is collected from TOFs in Mozambique.

We assume, that most of the land cover of 14 million hectares categorized as "other wooded land" (cf. Table 15) can be attributed to TOFs. To a great extent it concerns trees growing on fallow land. Farmers grow crops on a piece of land for a few years and then leave it fallow for 10 – 20 further years. Crops are rotated every 2-3 years. Due to the pressure on land the fallow period e.g. in the coastal region has been reduced from 20 years to 5 years, with 3 years of cropping[31]. It is noticeable, that farmers maintain fruit trees which are protected during the clearance of the area for agriculture. Some of these fruit trees such as Ziziphus mucronata are native and others such as cashew and mangos are exotics.

Any attempt to quantify the woodfuel supply potential of fallow is faced with a critical lack of data. The only available indication, validated against comparative values from other South-African countries, derives from a master-thesis, covering a communal area in Sofala province [32]. There an average accumulation rate of 1.1 t of biomass per ha and year is stated. Assuming that the rotation period will gradually fall shorter due to increasing land pressure and that not all woody biomass can be used for woodfuel purposes we assume that only 40% (about 0.63 m^3/ha) serve for woodfuel supply. However, this figure may not be generalized for Mozambique as a whole, the reason being that precipitation patterns - and, by extension, forest growth rates – vary considerably throughout Mozambique's national territory. To circumvent this difficulty, and with a view to providing at least an approximation grounded in factual measurements, correction factors for each province were calculated based on the different MAI figures presented in Table 21 accounting for growth-variations determined by precipitation patterns. As the production figure of Sofala province serves as a reference the correction factor is 1.0. The calculations, leading to the estimates on woodfuel production from fallow land are shown in the following Table 27.

Table 27: Estimated woodfuel supply from trees outside forests („other wooded lands")

	Land cover "Other wooded lands" ('000 ha)	MAI forest land (m3/ha)	Correction factor	MAI fallow land (m3/ha)	Estimated Woodfuel supply ('000 m3)
Maputo	439	0.58	0.49	0.31	135
Gaza	2,008	0.41	0.34	0.22	435
Inhambane	2,390	0.65	0.55	0.34	820
Sofala	1,261	1.19	1.00	0.63	793
Manica	1,253	1.2	1.01	0.63	794
Tete	2,408	0.9	0.76	0.48	1,145
Zambezia	2,130	2.08	1.75	1.10	2,340
Nampula	802	1.16	0.97	0.61	492
Cabo Delgado	1,045	1.28	1.08	0.68	707
Niassa	975	1.57	1.32	0.83	809
Total	**14,712**				**8,469**

4.2.1.6 Residues

Additional biomass potential also exists from other sources such as forestry residues and timber-processing activities. The allowable cut of timber estimated in the 2007 forest inventory is 500 thousand m^3 per annum of which about 40% (197.000 m^3) were formally recorded in 2008 [33]. Mozambique has around 120 registered sawmills that produced approximately 96,000 m^3 of sawn timber in 2008 [26]. However, due to frequent illegal logging activities the real amount of wood cut is estimated much higher [19, 34]. Based on a conservative average conversion rate of 40% from log to sawn timber, residues of approximately 144.000 m^3 become potentially available. Most of this potential is available in the provinces of Manica, Nampula, and Cabo Delgado (cf. Table 28). A sawmill in Meconta (Province of Nampula) visited by the BEST team processes about 8-10 m^3 of logs a day. Besides using some of the residues to make furniture more than one ton of sawdust is being produced daily, which could be used for briquetting, pellets or producing electricity.

There is also a substantial potential from logging residues (branches, tree tops etc.). However, due to selective cutting practices it is difficult to recapture the residues for woodfuel purposes. Furthermore, there is evidence that forest law and adherent regulations leave room for interpretation in regard to the amount of timber allocated to the concessionaires. Concessionaires prefer to relate the amount of timber allocated to the volume of the log and not to the volume of standing stock. Consequently they are focusing their exploitation on the prime pieces of a tree leaving huge amount of wood residues onsite. This can make easily up to more than one third of the tree volume.

Sinnott et al (2011) estimate that there is a potential of using plantation forestry waste for energy production through biomass co-generation up to an amount to 530GWh of energy by 2022 [9]. The document is referring to large scale plantations of the Portuguese paper producer Portucel.

Table 28: Estimated wood residues from timber processing activities (assumed conversion rate 40%)

	Sawn timber production (m3)	Volume of logs needed (m3)	Amount of residues (m3)
Maputo	9,588	23,970	14,382
Gaza	313	783	470
Inhambane	442	1,105	663
Sofala	6,080	15,200	9,120
Manica	22,980	57,450	34,470
Tete	-	-	-
Zambezia	15,311	38,278	22,967
Nampula	21,478	53,695	32,217
Cabo Delgado	18,758	46,895	28,137
Niassa	1,451	3,628	2,177
Total	**96,401**	**241,003**	**144,602**

There are also biomass potentials from agricultural harvesting and processing residues. However, similar to the logging residues they are dispersed and logistics for collecting and processing such scattered resources would be very costly.

4.2.1.7 Total available biomass supply per province

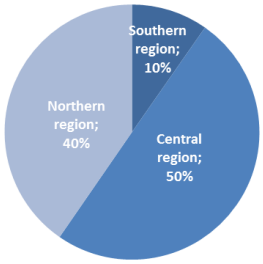
Having estimated the potential of woodfuel supply for each land cover type incl. residues originating from timber processing activities it is possible to provide supply figures by province and for the country as a whole (cf. Table 29).

Table 29: Total available biomass supply per province (,000 m^3)

	Natural forests	Plantations	TOFs	Residues	Total	
Maputo	351	1	135	14	502	1.5%
Gaza	780	0	435	0	1,216	3.6%
Inhambane	778	1	820	1	1,599	4.7%
Sofala	1,300	6	793	9	2,108	6.2%
Manica	1,835	17	794	34	2,680	7.8%
Tete	1,837	4	1,145	0	2,986	8.7%
Zambezia	6,884	29	2,340	23	9,276	27.2%
Nampula	2,295	2	492	32	2,821	8.3%
Cabo Delgado	3,030	3	707	28	3,768	11.0%
Niassa	6,260	129	809	2	7,200	21.1%
Total	**25,350**	**191**	**8,470**	**145**	**34,156**	**100%**

It is estimated that 34.1 million cubic meter of wood can annually be made available for woodfuel purposes country wide. Natural forests contribute with more than 74% and trees outside forests with 24.8% to the potential woodfuel supply. Plantations and residues combined make up for only about 1%. Zambezia, Niassa and Capo Delgado province alone contribute with more than 59% to the national potential. It does not come as a surprise that the provinces of the southern region account only to 11% due to their poor production potential. The central region with a supply potential of around 51% is mostly due to high productivity of the Zambezia province.

Figure 18: Biomass supply potential per region

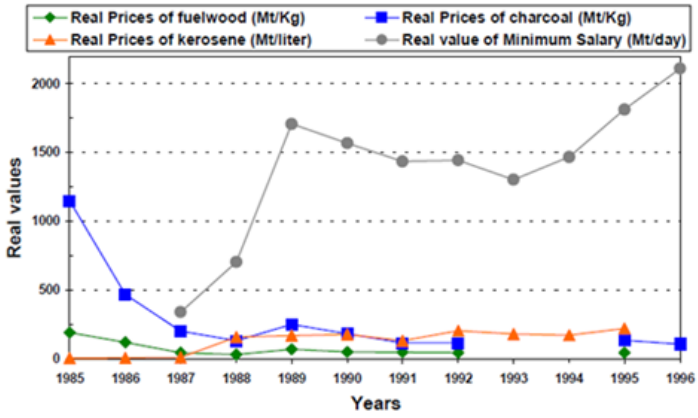


4.3 Energy Prices and Household Cooking Costs

4.3.1 Price Development

There are few reliable statistics available on the price of cooking fuels including woodfuels. Below are two figures, one from 1985 – 1996 (in old Meticals), showing that (i) the real prices of kerosene, fuelwood and charcoal declined and are approximately stable; and (ii) real prices declined substantially compared to the increase in minimum salary after the war.

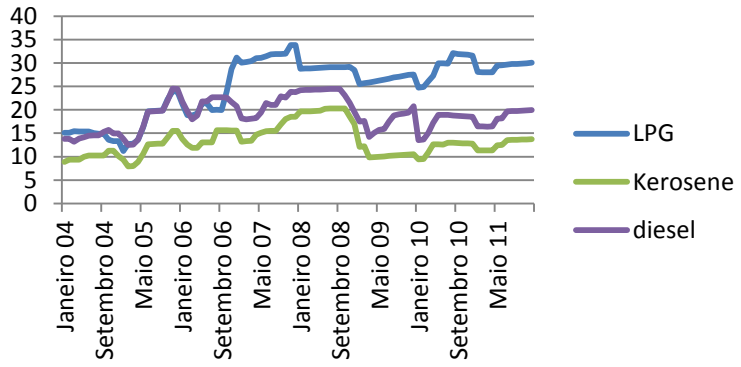
Figure 19: The real prices of three sources of energy and minimum salary paid in Mozambique



Source: Price Analysis of Fuelwood and Charcoal in markets of Maputo, Falcão, 1999 [35]

Figure 20 shows the price development in real terms for kerosene, diesel, and LPG over the period 2004 – 2011, showing that price development is roughly similar for the three fuels, while diesel fluctuates more than kerosene and LPG. This can be explained that diesel prices follow market trends more closely, while LPG and kerosene prices are subsidized which may dampen some of the fluctuations.

Figure 20: Price of LPG, kerosene, and diesel in real terms (Mt) (Jan 2004 - Dec 2011)



Source: Ministry of Energy

Two data points are available for nominal kerosene, charcoal and firewood prices in 1996 and 2012[50], showing that firewood prices (per kg) increased by 20% per year in nominal terms, charcoal prices by 37% per year, and kerosene prices by 521% per year. Kerosene is hardly used for cooking, mainly for lighting.

4.3.2 Costs of cooking

Households use different sources of energy for different reasons. The three factors that play a role and also determine the actual consumption for cooking are: the energy type or the fuel, the type of equipment used, and the user him/herself:

- Convenience of acquiring the energy or fuel, its quality, energy content, easiness to use, safety, pollution, and costs
- In terms of equipment, some stoves are more efficient than others, and this determines also how much energy is used for a specific cooking task; some stoves are also more polluting than others; it is clear that the choice of fuel and choice of stove are closely related. As an example, the energy content of LPG is much higher than that of firewood, and in addition, the efficiency of an LPG stove is much higher than that of a firewood stove, so a meal cooked on LPG uses less energy than on firewood – but since the price of LPG is much higher, the cost of cooking with LPG can still be higher than with firewood
- Users also play an important role, as they have preferences and sometimes acquired practices for how to use it; the fuel consumption for a certain fuel-stove combination can be quite different between two different users (e.g., if one is carefully monitoring the process, and the other is multi-tasking and does other chores at the same time; this can increase fuel consumption sometimes by 30%).

In Mozambique households have a choice for the type of energy they use. For lighting and information, computer, and telecommunications services, (ICT) the choices are simple. For cooking the situation is a bit more complex; households living in apartments can't use charcoal or firewood, but must rely on electricity, LPG, or kerosene; households living in detached houses could use charcoal (and some actually do), even though their standard of living would suggest they use electricity or other. Several models of electric cookers and ranges are available, different kerosene and LPG stoves are available too, and there are several models of charcoal and firewood stoves.

The Table below shows the different fuels used in Mozambique and the prevailing energy prices in early 2012. The cost of cooking is determined by the amount of fuel used and the efficiency of the stove. The cost of cooking with charcoal is taken as the reference point, whereby charcoal is purchased per bag (and not daily in small quantities). Ethanol, firewood and electricity provide lower cost options than charcoal; LPG, kerosene, and charcoal purchased in small quantities all provide higher cost options.

Table 30: Cost of cooking (Maputo, 2012)

	unit	measure	price/unit (Mt) as purchased	price/kg, l, kWh Mt per unit	in US$	MJ/unit	Mt/MJ	eff	Mt/Mj eff	relative costs
Wood	10	Kg	20	2.0	0.07	16	0.13	17.5%	0.71	-42%
Charcoal										
- tin	2.5	Kg	30	12.0	0.45	29	0.41	30.0%	1.38	11%
- bag	65	Kg	700	10.8	0.40	29	0.37	30.0%	1.24	0%
Kerosene	1	Liter	25	25.0	0.93	35.5	0.70	55.0%	1.28	3%
LPG	11	Kg	610	55.5	2.07	42.7	1.30	65.0%	2.00	61%
Electricity	1	kWh	3	3.0	0.11	3.6	0.83	80.0%	1.04	-16%
Ethanol	1	Liter	16	16.0	0.60	22	0.73	65.0%	1.12	-10%

Source: mission estimates

[50] For the analysis, prices are converted into new Meticals.

Compared to prices in other countries[51], charcoal in Maputo at around $400/t seems reasonably priced: in Rwanda (Kigali) the price is $470/t, in Tanzanian (Dar es Salaam) $555/t, and in South Africa (KwaZulu-Natal) $732/t.

4.4 Demand for Biomass Energy

4.4.1 Introduction

The bulk of biomass use in the country is for cooking by households; (small-scale) industries also use biomass energy, but to a lesser extent. The focus of the analysis will therefore be on the energy use of households, and mainly for cooking. The biomass energy data presented in this section are based on survey data[52], reported energy consumption in Mozambique as found in the literature, and related experience of the consultants in other countries in the region. Surveys were conducted in Maputo and Matola, Beira, and Nampula. A generic picture describing national energy consumption practices is given as well. Extrapolation to other areas is carried out, using anecdotal evidence and BEST experience from comparable countries in Eastern and Southern Africa such as Malawi, Rwanda and Tanzania.

In rural areas, people mainly use biomass: fuelwood, agricultural residues, and sometimes some charcoal. The fuelwood is usually gathered from the fields or around the house. It is unlikely that a large amount of trees are cut to satisfy cooking needs. In urban areas, some households may also use non-biomass fuels such as LPG and electricity, but biomass remains the main fuel used: charcoal in large towns, and firewood in smaller towns.

4.4.2 Fuel use dynamics

The data collected in the Maputo – Matola corridor showed a relatively rich picture: households use multiple fuels and cooking stoves to best suit the needs of the moment. Households sometimes have 3-4 different cooking stoves and could switch between fuels instantaneously. Nevertheless, the preference is for charcoal Households generally are unaware about their approximate weekly or monthly energy expenditures. Today, charcoal is the main energy source, followed by LPG and electricity, even though he cost of cooking with electricity is cheaper than with charcoal. Two-thirds of the households use at least a second source of energy, to complement their primary choice.

Some 53% of the households use charcoal as their primary fuel and another 33% as their secondary fuel; for LPG this is respectively 19% and 12%. Electricity is used by 16% and 10% respectively. Some 10% and 6% of the households use firewood. This choice does not follow least-cost cooking options as presented in Table 30: firewood is the cheapest option, followed by electricity and charcoal; LPG is the most expensive option. Reasons that could explain this are:

- firewood is used only in the outskirts of town, and households are looking for more modern cooking alternatives
- electricity may be the cheapest option, but if there are power cuts or brown-outs during cooking time (which coincide with peak hours), households have to rely on other sources of energy
- LPG may be more expensive, but it is a very convenient fuel, and it is mainly used for certain specific tasks, such as quickly heating water for coffee or tea
- Charcoal still seems to be the preferred fuel; it has traditionally been used by parents and grandparents; only when people move into apartment buildings it cannot be used any longer.

The following tables (Source: EuropeAid/127640/SER/MZ)[36] provide city-level information for household cooking energy use amongst the sampled population. Two categories of fuel users are distinguished. Those which rely exclusively on one energy source (for all cooking needs); and those which rely on multiple fuel sources (fuel mixing). The tables further include the daily amounts of the respective fuels used by household within each category. The third column within the table indicates the percentage of households within the entire sample which use the specified fuel/s.

[51] Rwanda: own observations; other data: http://www.charcoalproject.org/

[52] Collected under the Europe Aid project /127640/SER/MZ: Capacity Building in Energy Planning and Management in the Maputo-Matola, Beira, and Nampula region.

Table 31: Maputo/Matola Fuel Use Dynamics

One energy source	N	% of sample	Charcoal (Kg/day)	Firewood (Kg/day)	LPG (Kg/day)	Electricity (Kwh/day)
Charcoal	175	35	2.640			
Firewood	28	5.6		4.456		
LPG	14	2.8			0.386	
Electricity	11	2.21				2.71
Total	228	45.6				
Two or more energy sources	**N**	**% of sample**				
Charcoal – Firewood	47	9.5	1.679	2.918		
Charcoal – LPG	95	19.2	1.844		0.391	
Charcoal – Electricity	72	14.5	2.173			1.311
LPG – Electricity	10	2			0.427	1.389
Charcoal - LPG – Firewood	3	0.6				
Charcoal - LPG – Electricity	34	6.9	2.000		0.503	0.149
Charcoal - Electricity – Firewood	7	1.4				
Total	268	54.1				

Table 32: Beira Fuel Use Dynamics

One energy source	N	% of Sample	Charcoal (Kg/day)	Firewood (Kg/day)	LPG (Kg/day)	Electricity (Kwh/day)
Charcoal	268	63,7	2.495			
Firewood	31	7,7		2.902		
LPG	15	3,7			0.367	
Electricity	5	1,2				1.65
Total	309	76,3				
Two or more energy sources	**N**	**% of Sample**				
Charcoal - Firewood	12	3,0	1.633	1.120		
Charcoal - LPG	28	6,9	1.810		0.393	
Charcoal - Electricity	35	8,6	2.301			1.356
LPG - Electricity	11	2,7			0.367	0.194
Charcoal - LPG - Electricity	10	2,5	1.324		0.448	0.746
Total	96	23,7				

Table 33: Nampula Fuel Use Dynamics

One energy source	N	% of Sample	Charcoal	Firewood	LPG	Electricity
			(Kg/day)	(Kg/day)	(Kg/day)	(Kwh/day)
Charcoal	342	77,0	3,00			
Firewood	32	7,2		3,94		
Electricity	1	0,2				0,68
Total	375	84,5				
Two or more energy sources	**N**	**% of Sample**				
Charcoal - Firewood	29	6,5	1,24	2,22		
Charcoal - LPG	25	5,6	1,81		0.44	
Charcoal - Electricity	15	3,4	3,89			0,68
Total	69	15,5				

Table 34: Summary fuel use dynamics

Summary	Maputo/Matola	Beira	Nampula
Charcoal in fuel mix	**87%**	**85%**	**93%**
charcoal alone	35%	64%	77%
charcoal + modern	43%	18%	9%
charcoal + firewood	10%	3%	7%
charcoal, firewood + modern	2%	0%	0%
Firewood in fuel mix	**17%**	**11%**	**14%**
firewood alone	6%	8%	7%
Modern energy in fuel mix	**50%**	**26%**	**9%**
Lpg alone	3%	4%	0%
Electricity alone	2%	1%	0%
mix modern alone	2%	3%	0%
mix modern / traditional	45%	21%	9%

Maputo, Beira, and Nampula are true charcoal using towns – and indeed, this is valid for the rest of Mozambique as well; around 90% of the population use charcoal, either as one of the fuels they use or as their exclusive fuel for cooking and water heating. Charcoal as the main fuel is used in Beira and Nampula by the majority of the population (64-77%). In Maputo only 35% use charcoal as their main fuel although the majority uses in addition to charcoal also a modern fuel: the transformation from traditional fuels only from the past to more modern fuels in the future has started. Firewood is not used as the main fuel in these towns as only around 7% use it exclusively. Even when firewood is part of the mix of fuels, there are only a limited number of households which use this.

Modern fuels as part of the fuel mix are used by at least 50% in Maputo, 26% in Beira, and 9% in Nampula. Modern fuels are mainly used to complement traditional sources of energy: only 3-4% of the population in Maputo and Beira use LPG as their main fuel or 1-2% use electricity while 2-3% use both LPG and electricity as their main source of energy.

This means that modern fuels are starting to get used, more in Maputo/Matola, but they are far from taking over from biomass as the main source of energy: in Mozambique, biomass fuels remain for now the main source of energy.

Table 35: Charcoal use habits

Charcoal use habits	Maputo/Matola	Beira	Nampula
For all meals	65%	83%	89%
At least once a day	4%	5%	3%
At least 3 times/week	15%	3%	7%
Once a week	7%	9%	1%
Other	9%	0%	0%

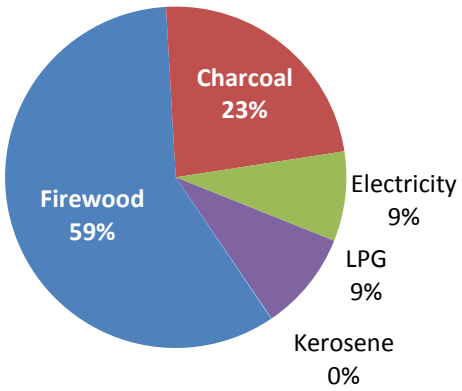
Source: EuropeAid/127640/SER/MZ [36]

4.4.3 National Biomass Energy Demand

The national cooking energy fuel use patterns have been developed by extrapolating the urban figures, estimating rural consumption patterns and applying suitable urban-rural weightings. A summary result is presented in the pie chart below.

This shows the predominance of wood-based cooking fuels and in particular rural firewood. Whilst the extensive use of firewood represents a huge potential for modernization, the real environmental and economic strain is created by the 23% charcoal use which is almost all transported from rural areas to urban centers. The charcoal value chain incurs not only the inefficiency of logistics and transport, but also the losses inherent in

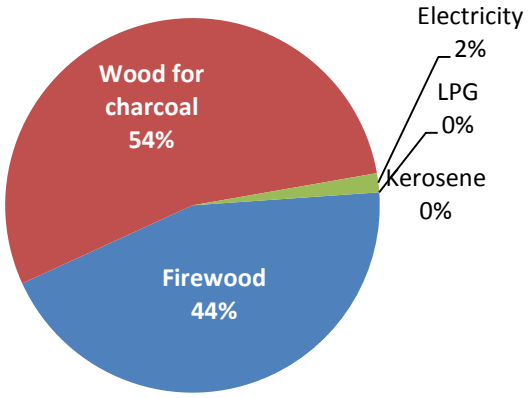
Figure 21: Household cooking energy mix by number of households (2011)



converting wood to charcoal in inefficient kilns.

This becomes even more obvious when the energy use is presented in primary energy terms (Figure 21) rather than in end-use terms (Figure 20): the main difference is with charcoal, which now takes into account the volume of wood used to make charcoal. Although only a portion of the population uses charcoal, they cause the largest exploitation of forest resources in the country for energy purposes. This shows why it is justified to focus largely on the consumption of charcoal when developing a biomass energy strategy. Not only is charcoal already the largest user of wood (for energy purposes), its use continues to increase because of population growth, urbanization, and economic development.

Figure 22 : Primary cooking energy consumption in GJ (2011)



Local building codes dictate that charcoal and firewood cannot be used in apartment buildings; instead, kerosene, LPG or electricity must be used. For households living in detached houses there are no such restrictions, and LPG and electricity are sometimes used to complement charcoal use for short cooking tasks such as the reheating of food or boiling of water for tea in the morning. However, charcoal remains the fuel of choice for most of the urban population. Nevertheless, there is a growing wealthy urban population which is also using non-biomass fuels as their main source of cooking energy. Indeed, LPG and electricity offer two very attractive non-biomass cooking fuel alternatives for urban areas. The infrastructure required, both in terms of fuel logistics and in terms of cooking equipment make these fuels expensive to deploy in rural areas.

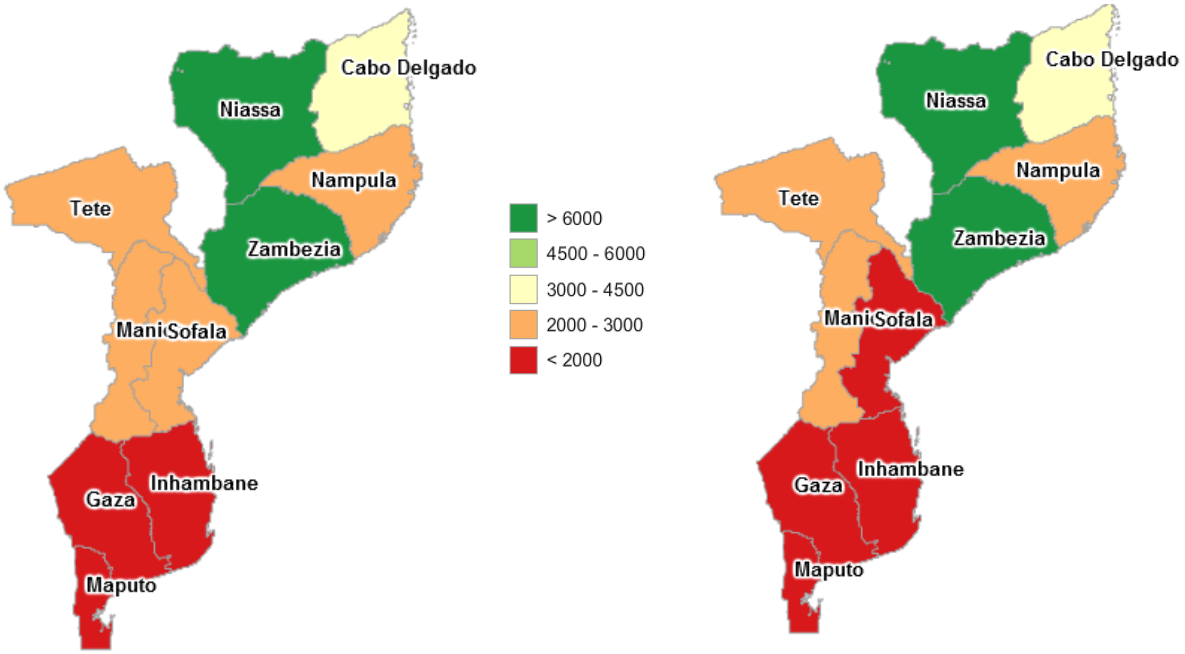
4.5 Woody Biomass Supply-Demand Balance

Most of the wood demand is met from the annual available yields provided by the productive forests as well as from trees outside forests. In provinces where the demand cannot be met by the sustainable yields the standing tree stock is gradually being depleted leading to degradation and finally deforestation. This is currently certainly the case for the Maputo and Nampula province and very likely for certain parts in Inhambane, Gaza and Sofala province. If no actions are taken Tete and Manica province will also experience localized shortages and signs of degradation by 2020.

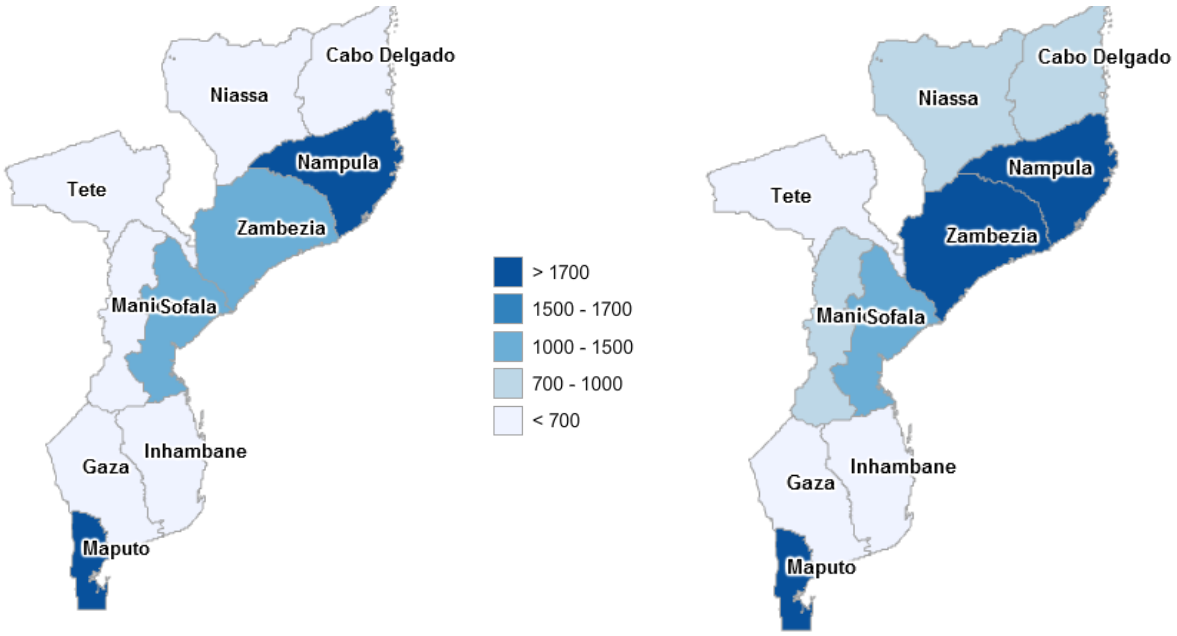
It has to be noted that, the poor forest data situation does not allow precise predictions but the projections illustrated by Figure 23 at least provide some tendencies under a “business as usual scenario”.

Figure 23: Woodfuel supply and demand projections 2011-2020

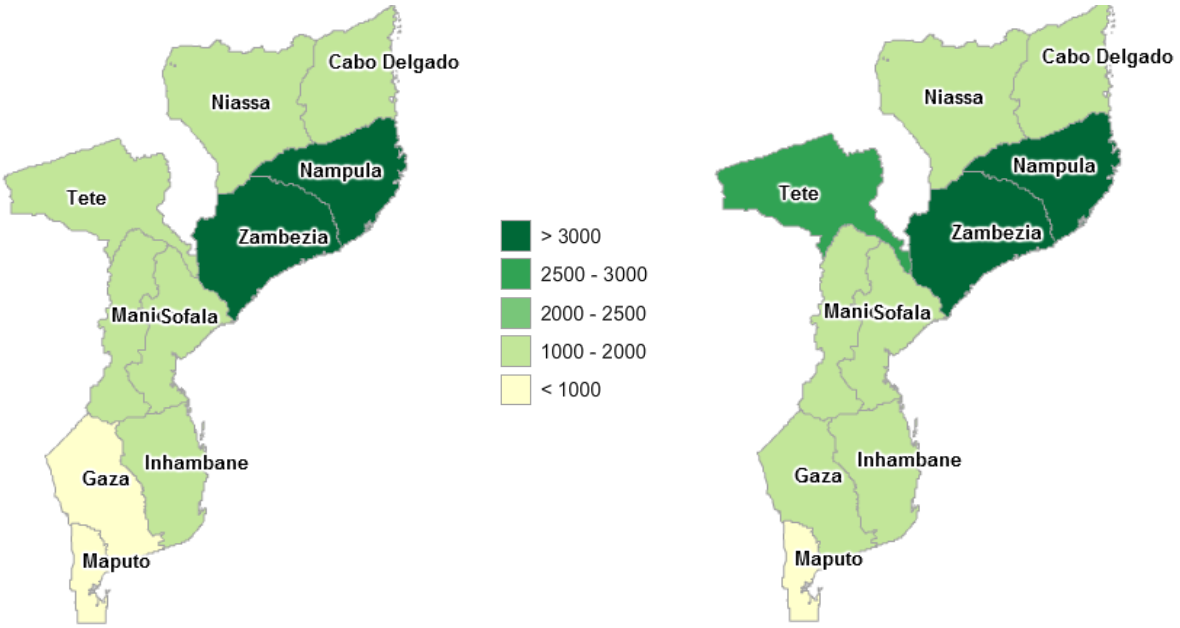
2011 Sustainable woody biomass supply ('000 m^3) 2020



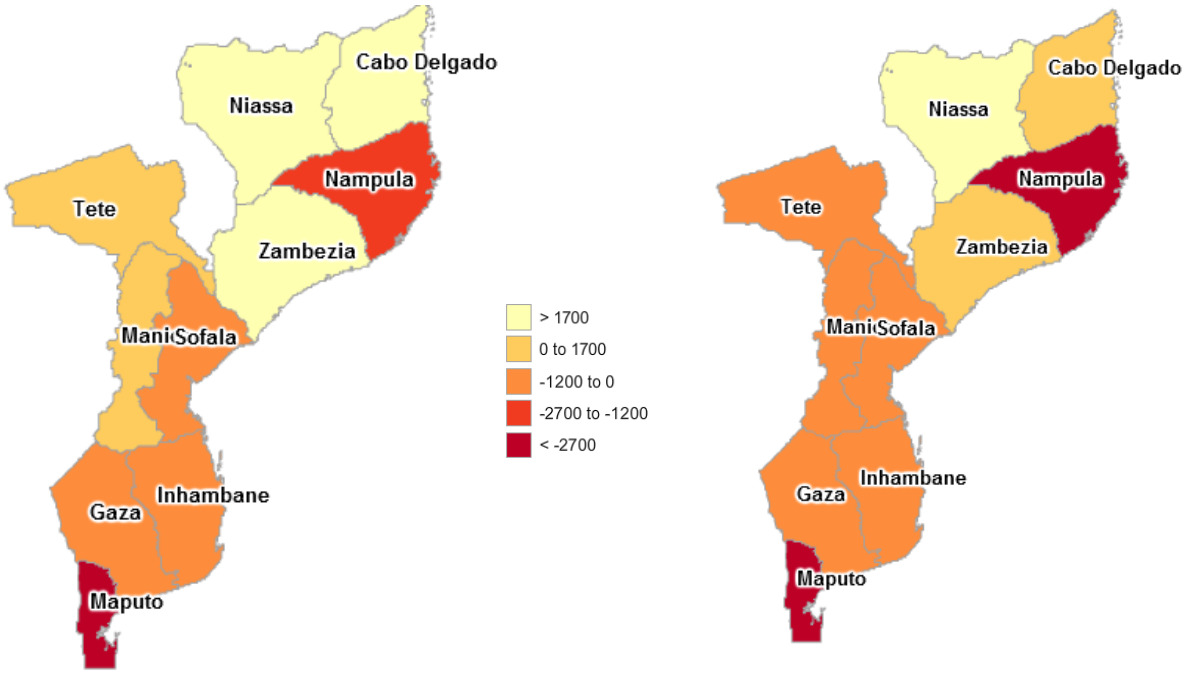
2011 Urban woodfuel consumption ('000 m^3) 2020



2011 **Rural woodfuel consumption ('000 m^3)** **2020**



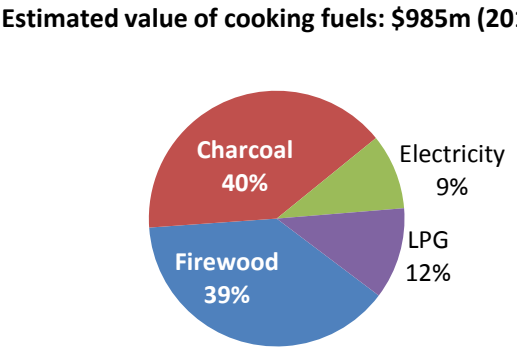
2011 **Supply-Demand Balance ('000 m^3)** **2020**



4.6 Costs and expenditure

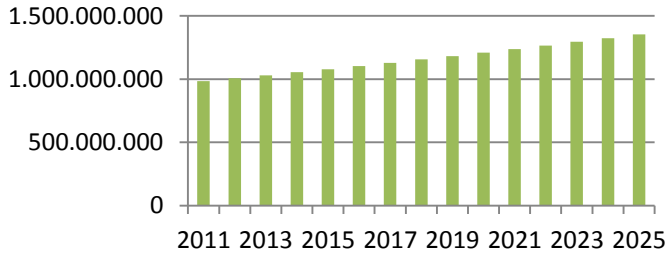
The huge transport and logistics operations created by the charcoal value chain are energy intensive and inefficient in the conversion of firewood to an urban fuel. The full cost of these logistics and inefficiencies can be seen in the price difference between Maputo charcoal and rural firewood: At 37 USc/MJ, charcoal costs almost three times as much for the same amount of firewood by energy content (13 USc/MJ). This is also reflected in the high share of charcoal in the energy expenditures by households: around 40%.

Figure 24 : National cooking fuel expenditures by fuels type (2011 US dollars)



The national cooking energy market is almost $1bn per year - this is a hugely important economic sector[53]. The weak regulation and informality of the charcoal sector needs to be addressed now to correct this, as it results in lost revenue and potential unsustainable exploitation of a key economic resource. In addition, a modernization and improved competitiveness in this sector also carry the potential of creating jobs, stimulating economic growth and creating new energy export products. Population growth and economic growth both will mean that this market will continue to gain in importance and economic weight.

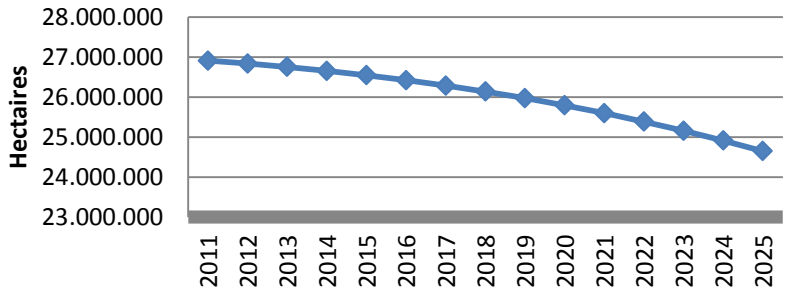
Figure 25: Household energy expenditure projections under Business as Usual (2011 US dollars)



Without sustainable forestry sector management this growing demand for energy in general and for charcoal and woodfuels in particular will lead to an increasing pace of deforestation. Pressure on the remaining forests than can contribute to the energy supply will therefore increase. The graph below attempts to project deforestation by adding energy use trends current deforestation estimations due to population growth, agriculture and illegal logging. Although this is a rather simplistic way of regarding the issues, it does reflect the current trend. The report Mozambique urban biomass energy analysis 2012 shows that for Maputo/Matola, Beira and Nampula alone, the total forest area that needs to be clear cut annually for charcoal making would be around 180,000 ha. Not all charcoal is produced by clear cutting natural forest area, but the sheer magnitude of this is a clear sign that changes are needed to avoid large-scale destruction of forests simply from charcoal production.

[53] Please note that firewood has been valued at the average retail price, even though a large part of the rural consumption is not purchased but collected.

Figure 26 : Projection of productive natural forest stock under Business as Usual



4.7 Characteristics of the sector

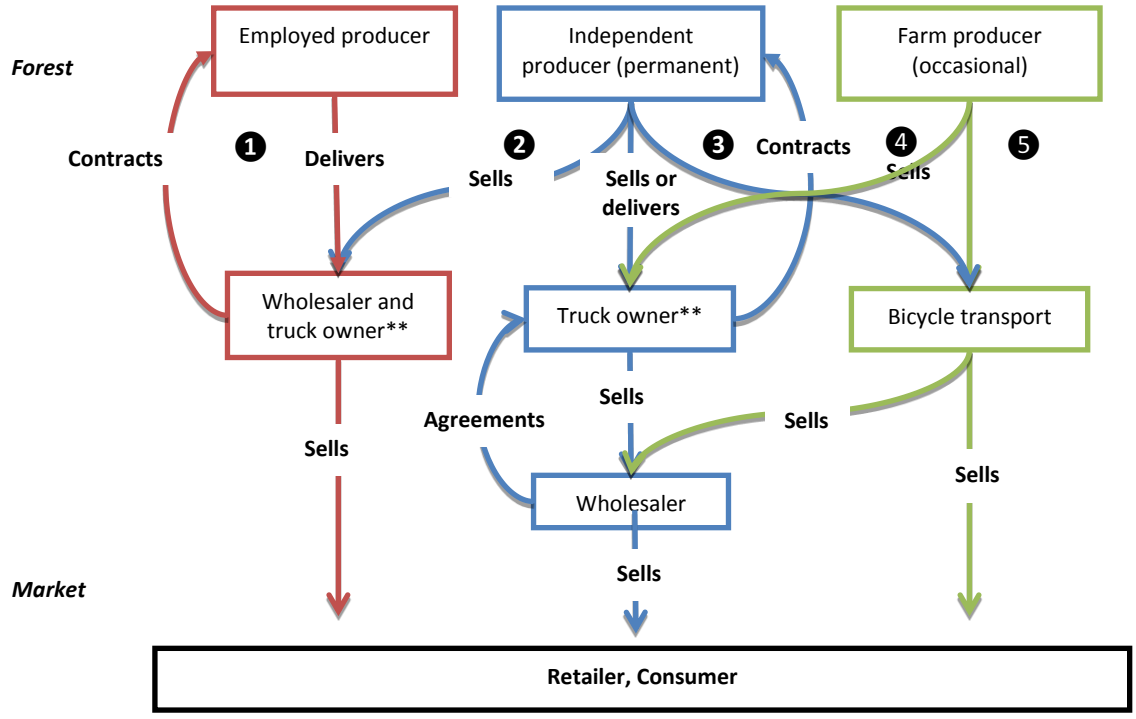
4.7.1 The woodfuel supply chain

The woodfuel supply chain is under the responsibility of the forest service, particular because the licensing process is controlled by this sector. Besides the forest service, the main stakeholders involved in the charcoal supply chain are: producers, transporters/wholesalers, retailers and consumers. Wholesaler and transporters normally function as powerful intermediaries between the producer and the retailer/consumer as they are the license holder or able to bribe the patrolling forest officers.

4.7.1.1 Structure of the woodfuel supply chain

In discussion with stakeholders the BEST team revealed a number of ways the different actors of the woodfuel supply chain are interlinked (cf. Figure 27). On producer level there are basically two types of charcoal and firewood producers: those who are members of the local community where the harvesting of the product takes place, and those who are outsiders. Among the community based producers we can distinguish between permanent producer and farmer who occasionally produce charcoal mainly during the agricultural off-season.

Figure 27: Different structures of the woodfuel supply chain



** may have a license

Source: BEST mission

Outsiders are often contracted by the middle man (wholesaler owing trucks) receiving a monthly payment or being paid by charcoal sack produced. This structure is common when it comes to deliver big consumption centers such as Maputo, Beira etc. According to Atanassov et al [37] this kind of middlemen are in general literate people, some having attained secondary school. Due to the size of their business (about 500 sacs per month) they generally request for licenses (cf.Box 2). They have approximately 10 – 30 or even more employees under their responsibility, basically wood cutter, charcoal maker and sack packers. Although trees are normally cut by using machetes and axes some of the wood loggers are even provided with chain saws reducing the production time from 45 to 30 days [38]. The activities of this type of middlemen, mainly consists of managing human resources, caring for the logistics, the production process and sales. Some of them are even in possession of trucks. These professional businesses are operating under the simple license regime. Due to their size of the business they should be compelled to get a concession so as to oblige them to present a management plan for the area and manage it sustainably.

Independent charcoal producer migrate from one area to another seeking adequate forest resources mainly in open access areas. They either sell their products onsite or at the roadside to wholesaler and transporter or enter into contractual agreements with them to ensure an outlet for their produce.

The permanent or occasional charcoal producers on community level either sell their produce to wholesalers and/or transporter at the roadside or care for self-marketing mostly by bicycle. This is the case when the production site is in reach of the urban market (e.g. Nampula, Nakala).

However, there are also a few exceptions of organized communities (e.g. Mucombedzi community in Sofala, Pindanyanga in Manica, Goba in Maputo,) that operate as associations and have acquired their own license to produce and transport charcoal and other forest products.

Wholesalers often enter agreements with transporter to ensure their supply. It is a business dominated by women. Besides the costs for purchasing the charcoal the main costs involved are the market fees. On average, wholesalers earn monthly net incomes between 3,650 and 12,200Mt which is still significantly over the minimum wages in the country and more than the producers' net income.

In conclusion the de facto control over the charcoal sector is largely in the hands of influential charcoal transporter-wholesaler networks. In contrast, most producers are not licensed, giving them less leverage to negotiate the charcoal prices.

4.7.1.2 Urban wood supply zones

As an analogy to "watershed", FAO introduced the term woodshed to define, describe and map the territory needed for the sustainable supply of the woody biomass demanded by cities[39]. Due to the scanty data in the country regarding growth of the different forest types as well as limited information on spatial distribution of species it was not possible for the BEST team to define urban woodshed delineation for the major urban centers in Mozambique. However, according to several studies ([22], [40], [38]) some indications can be provided.

Besides charcoal coming from districts surrounding Maputo city (Moamba, Matutuine, Namaacha, Goba, Boane, Manhiça), the majority of charcoal that feeds Maputo urban originates from production sites located some 120 to 500 km north from the capital, in the neighboring province of Gaza namely the districts of Mabalane, Massingir, Mapai, Chicualacuala and Guijá. It is mostly transported by truck or train.

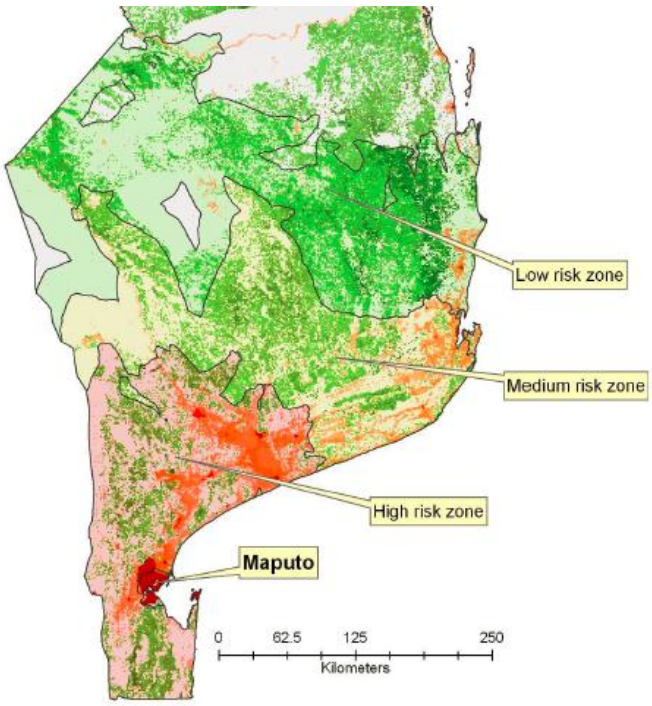
In 2011, 15,330 tons of charcoal and 8,580 tons of fuelwood were transported by train twice the amount of 2007[40]. This increase can be attributed to the increases in petrol prices that led to a shift from the usage of trucks to trains. Trains are cheaper costing 20.5 Mt/sack while the truck costs may reach up to 260Mt/sack depending on the area and the truck capacity. Compared to the annual estimated charcoal consumption of Maputo only about 1% are transported by train.

The WISDOM study [11] states, that the woodsheds for Maputo and Beira-Chimoio already overlap. Furthermore the risk of overexploitation is especially high in the densely populated coastal areas north of Maputo (cf. Figure 28).

The head of SPFF, in Nampula also confirmed that the increasing pressure on forests led to a continuous expansion of the woodshed exceeding the 100 km and at the same time shifting exploitation of high density miombo wood (around 800 kg/m^3) to fruit trees (cashew nut, mango) of lower density (500 kg/m^3).

Furthermore, due to the absence of law enforcement charcoal maker do not hesitate from using more precious native species (1st to 3rd grade) banned by law for charcoal making.

Figure 28: Degradation risk zoning within Maputo's woodshed



Source:[11]

4.7.1.3 Forest management regime

According to the forest regulation it is the responsibility of the Ministry of Agriculture, through their national (DNTF) provincial (SPFFB) and district (SDAE) authorities to manage and supervise the forest resource and activities. The state and community forest guards are the ones who do the law enforcement to ensure the correct implementation of the rules established under the current law.

All forest (and other) lands are publicly owned and therefore all forestry activities are based on land leasing (concession) or a licensing system. Forestry in Mozambique is more or less seen as a mining operation, where outside interests are granted the rights to exploit a resource on payment of royalties, but have no responsibility to encourage sustainable production.

Besides promoting private sector involvement in forest management and industrial plantation development a key strategy of the Mozambican forest policy is the involvement of local communities in forest management so as to achieve the overall objective towards sustainable forestry management. Important policy and legal reforms have created the conditions for recognition of community rights over land, forest and wildlife resources (cf. chapter 5). This recognition has been translated into a number of large scale efforts to secure community rights over natural resources. According to Brouwer et al. (2001) [41] a total of 229 communities have had their land demarcated and certified, covering an area of 6.7 million ha, with another 5.9 million ha in process of certification. These communities receive 20% of the forest and wildlife levies applied by the government on commercial operators. Since 2005, MINAG has transferred almost 74 million Mt to 631 communities in 89 districts in all provinces, except for Maputo City. The returns from charcoal licensing however, remains negligible as merely no control over the charcoal flux to the consumption centers exists.

As mentioned in the R-PP document [8] the country has only 1,069 law enforcement officers of whom only 489 are responsible for controlling the harvesting of timber and wildlife products outside protected areas. Therefore, one officer is responsible for over 83,000 ha of forests contrary to the recommended 1:5,000 ha. This, combined with poor means of transport and communication, makes the control of illegal practices ineffective. There is also limited capacity to monitor implementation of management plans and harvesting

practices as well as implementation of environmental management plans. There are no sufficient dedicated qualified staff to monitor harvesting and forest management practices.

The poor law enforcement practiced in regard to woodfuel production also jeopardizes the implementation of the 20% benefit sharing arrangement[54]. This has been confirmed by the BEST team making a rough calculation of the estimated amount of charcoal commercialized in urban areas of the Nampula province. In 2010 the urban charcoal consumption for Nampula province was equivalent to about 930 thousand m^3. Tax revenue amounted to 502,308 MT (official statistics 2011 [42]), of which 87,300 MT should have been disbursed to the communities, a fraction of the 5.24 million MT due under normal regulatory conditions.

In addition, the possibility provided to local communities to explore and use biomass energy within their own household without license opens room for certain commercial operators to transport large quantities in small portions (in bicycles or public transports) simulating transport of products for own use. This phenomenon is well known in all urban centers where hundreds of bicycles enter one town each day, each carrying 2-3 charcoal bags for commercial purposes.

There are few community associations established with the main purpose to manage their forests to produce charcoal in a sustainable manner. These associations (such as the Mucombedzi community in Sofala, Pindanyanga in Manica, Goba in Maputo, among others) have been assisted to conduct participatory forest inventories and forest management plans during the early decade of 2000 [43]. For some time these communities worked as good examples of sustainable management of forest resources, however, little has been reported recently from these areas, but the pressure from neighboring towns may be jeopardizing the continuity of the agreed sustainability principles.

An evaluation of a CBNRM pilot project [44] supported by GTZ that ran from 1998-2008, to improve charcoal production in Combumune, Mabalane District found that the community surpassed the allowable cut set in the management plan. This can be seen as a reaction from moving the transfer of charcoal licensing fees from the transporters to the producers, imposing an extra cost per bag to the producers. In fact, charcoal producers which represent the most vulnerable group with less price negotiation maneuver and willing to preserve the resources were punished through an extra tax and a complicated bureaucratic system. As the control on charcoal production was not simultaneously increased by the forest service the charcoal originating from supposed sustainable production was not competitive in regard to the uncontrolled produced charcoal when arriving on the market. In addition, not enough external (government) support was provided to uphold the community forest against intruders.

Although the legal regime for CBNRM can be seen as progressive, a major outstanding problem relates to its implementation: (a) absence of law enforcement to protect communities employing sustainable management, (b) no incentives rewarding communities that engage in sustainable woodfuel production and penalizes those that permit or practice destructive resource use, (c) excessive bureaucracy (d) weak civil society.

The payment of the 20% shares from forest exploitation to communities the GoM recognizes a relationship between the resource base and the communities however, the amount of 20% is too small and payments are too irregular to provide incentives for sustainable forest management.

4.7.1.4 Charcoal conversion technology applied

The technology used is typically the traditional charcoal kiln, locally designated as boat-like (see Pereira 2002 [45]). This is an earth mound kiln where the wood can be arranged longitudinally (with 14% efficiency) or transversally (with 16% efficiency). Earth kilns are common due to the low capital required. Assuming an average efficiency of 15% means, that out of one ton of wood only 150 kg of charcoal is recuperated. An increasing shift to charcoal implies therefore a significant increase in the level of forest exploitation.

According to Falcao [40] charcoal making with earth mound kiln comprises following steps: (i) locating suitable trees; (ii) choosing the right place to build the kiln i.e. flat and sandy soils and closer to the trees; (ii) cutting the trees and transporting them to the kiln site; (iv) gathering material necessary for kiln construction (grass,

54 Decree No. 12 of 2002 stipulates that 20% of the value of access, exploitation and utilization fees of forest products should be channeled to local communities.

clay/sand, and stones when available); (v) constructing the kiln; (vi) operating the kiln; (vii) unloading the kiln; (viii) putting the charcoal into sacks. On average, producers may be able to burn one kiln producing 20 to 30 sacks of charcoal per month. Assuming an average producer price for charcoal of 100Mt/sack, the producers' income can vary between 2,000 and 3,000 Mt/month per person which is above the minimum wage in the country. However, due to the high price disparities between the provinces (cf. chapter 4.7.1.6) there are also cases where the average income drops significantly below the minimum wage of 1,800 Mt per month.

Improved kilns (casamansa) have been experimented in Licuati forest, yielding no more than 18% efficiency. The latter, apart from having increased only very little in terms of efficiency, it also increased the labor demand and working time. Pereira (2002) concluded that the local preference for boat-like is not associated to its wood conversion efficiency but to the labor demand. In areas where forest resources are still abundant, the yield may not be an important parameter for the selection of the kiln type.

4.7.1.5 Licensing

According to the Forestry and Wildlife Law 10/99 any person making charcoal for commercial purposes must be licensed (cf. chapter 5.4). There are two types of harvesting permits. The first is the simple harvesting license and the second is the concession license[55]. The duration of simple license is one year, but this rule has changed in the last regulation revision in December 2011 to five years. Whereas at present no forest concession has been given for the production of wood fuels in Mozambique, the lack of capacity to monitor the granting of simple permits means that the majority of charcoal that enters towns is illegal.

Box 2: Procedure to obtain a license in Gaza province

Charcoal producer contact the local community people and ask for a piece of forest in exchange for a certain amount of money and wine. Once their request is satisfied, some kind of written agreement is prepared and signed by witnesses – this serves as an approval of the community to concede the land to the producer. Hereafter, the producer applies for a license to the Department of Agriculture in Xai-Xai, the capital of Gaza province, by filling an official form and handing it in jointly with the signed agreement. It takes then about one month to issue the license by the forest service.

Source:[37]

The provincial level has the responsibility to govern the charcoal business (licenses issuing, monitoring and control). The major interaction between the forest service and the supply chain is through the middle man. However, the 2002 Forest and Wildlife Regulation creates the obligations to consult communities prior to the issuing of forest exploitation licenses as an instrument for the harmonization of business and community interests (see Box 2). It is the middle man who then approaches the forest service to request a charcoal or firewood license. The licenses issued permit the production of a certain amount of sacks in a defined area and amount to 11.5 Mt/sack. Out of the 11.5 Mt/sack 1.5 Mt are destined for the Agrarian Development Fund a government agency which is financing afforestation programs for conservation and protection purposes. From the remaining amount of 10.0 Mt a total of 2Mt/ sack have to be passed to the communities (20% rule) leaving 8 Mt/sack to the GoM. It has to be noted, that the amount of the entire fee of 11.5 Mt/sack are much lower than the true opportunity cost of the resource or any replacement costs. These factors lead to an underpricing of the resource and reduce incentives for investments in sustainable charcoal production or trade, either by the government, communities or private entrepreneurs. A rough calculation of the replacement costs through plantations reveals that the license fee would have to be more than the double[56].

Furthermore, the license is mainly used to facilitate transport of the woodfuel as it is required at the check points to enter the main towns. This practice leads to the fact that the producer in the field is not supervised and hence does not feel obliged to comply with the principles of sustainable forest management.

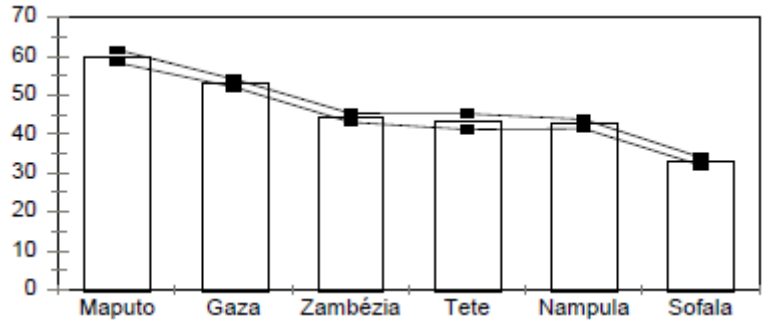
The informality of the sector entails that no uniform standards are applied. Every actor of the value chain tries to draw personal advantages. As license fees are related to the volume (amount of sacks) and not to the weight

55 Forest concession requires a long term management plan with duration up to 50 years, while simple license requires simplified management plan (see below on Policies).

56 A plantation with an average MAI of 10 m3/ha produces 280 m3/ha during its lifetime (4 rotations @ 7 years). Converted to charcoal (conversion rate of 0.7, kiln efficiency 15%) 588 sacks of charcoal (weight 50 kg) can be produced. Assuming average plantation costs of 500 USD replacement costs of nearly 23 Mt/sack are calculated.

it is advantageous for the license holder (transporter/wholesaler) to require sacks of higher weight from the producer. We also assume that there is a correlation to the degree of law enforcement applied. As in Maputo province the network of check points is more intense than in other provinces the average weights of the sacks are also highest.

Figure 29: Average weight of a sack of charcoal in six different provinces (in kg)



Source:[23]

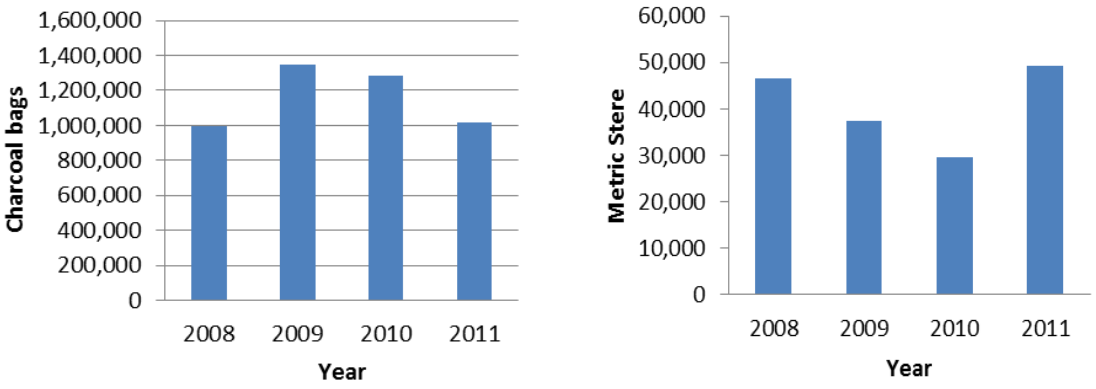
Charcoal sacks being transported by train are subject to a more rigorous control compared to truck transport. Therefore it is not surprising that the average sack transported by train weighs around 76 kg, whereas the sack transported by truck is only around 50 to 60 kg due to circumventing check-points or bribing [40]. This kind of practice represents substantial losses to both the producer and the Government as the middlemen pay the producer and the license per sack.

Furthermore, the forest regulation provides free access to forest products (including firewood and charcoal) for local people as for own consumption within the household (not for sale). This exception opens the possibility to produce and transport "small" (unspecified) quantities of forest products as for household consumption. Several commercial operators have been using this window of opportunity to carry 2-3 charcoal sacks or head loads of firewood on a bicycle or a passenger bus to carry 5-10 charcoal sacks (as if they belong to the passengers) to be transported "legally" and pass the forest service check points into the urban markets.

When looking at the statistics from the DNTF indicating the licensed charcoal and firewood from natural forests no clear trends are shown (cf. Figure 30). This may be explained by the fact that the figures respond more to the low level of law enforcement rather than to the demand for energy biomass.

Assuming an urban population of 7.1 million people in 2011 that consume at a share of 70% an average amount of 123 kg/person/ year, licenses for an amount of more than 122 million sacks with an average weight of 50kg should have been issued. In reality the amount licensed in 2011 was less than 1 % of what could have been licensed. This amounts to an annual loss for the GoM of about 1.4 billion MT per year.

Figure 30: Amount of licensed charcoal (a) and fuelwood (b) for the period 2008-2011



Source: Annual report 2011 of DNTF

The above mentioned reveals the fragility of the forest sector (institutions and regulations as well) keeping control of wood biomass licensing process. In 2001, just before the new Forest Regulation entered into force, Pereira et al [22] reported already that of the charcoal consumed in Maputo and Matola, only 10% was licensed. Ten years later, and under the Forest Regulation of 2002, from which there was high expectation to increase the performance of the sector, there are no updated studies, but staff of the Forest Service believe that this figure did not improve significantly which is confirmed by our rough calculation above. Sitoe et al[46] analyzing the performance of the forest concession system in Mozambique in the timber sector observed that the poor collection of revenues had a negative effect on the institutional capacity to operate efficiently. This might be true for the wood biomass as well since most of the revenue dissipates in the informal business.

The key to implementing changes to the system is to revise and enforce the licensing and fee system for the charcoal trade. This will lead to increased prices for consumers, but should create resources for forest management and incentive for improvements and fuel substitutions on the user side.

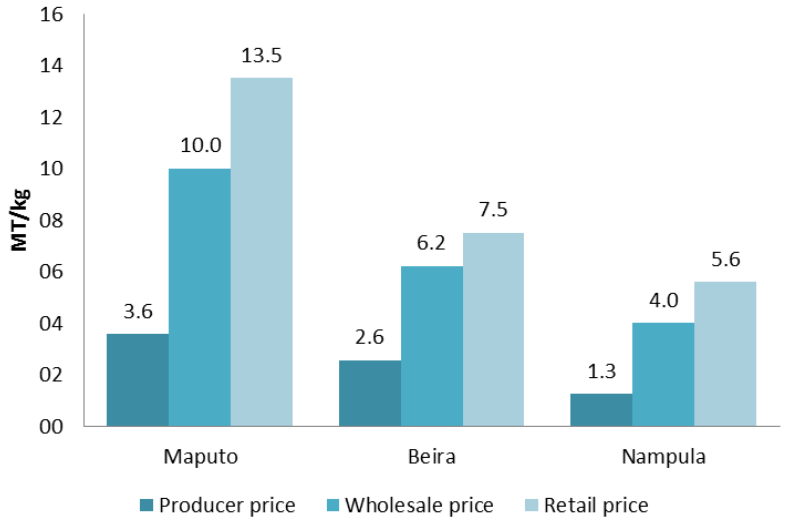
4.7.1.6 Prices and income structures along the value chain

The price per sack of charcoal varies from south to the north. Spot checks made by the BEST team for three urban centers revealed an average market price of about 700 Mt/sack for Maputo, 280 Mt/sack for Beira and 160 Mt/sack for Nampula.

When relating the price to the weight of a sack the gradient from south to north is maintained (cf. Figure 31). This reflects the scarcity of forest resources in the southern region where the input for producing woodfuel and the transport distances (wholesaler price) are valued at a rate of about 2.5 times higher than for the northern regions. Highest retailer prices are being paid in Maputo (13.5 Mt/kg), lowest in Nampula (5.6 Mt/kg). In regard to the retail prices great variations are reported as retailers are selling the small quantities in different containers (tins, plastic bags etc.) or unbagged leaving room for cheating[47].

The income opportunities for the different actors depend on a number of factors: distance to production site, weather conditions, competition, market site etc. However, in the following a rough estimate on the income opportunities for the main actors of the value chain (producer, transporter, wholesaler, and retailer) is forwarded. Well knowing that there are different structures of value chains operating in the charcoal business (Figure 27).

Figure 31: Average producer, wholesale and retail price for three urban centers



In order to obtain an overall view of the income situation of the major actors, the high price conditions in Maputo are compared to the low-price conditions prevailing in Nampula province. The figures used are based on spot checks and discussion with stakeholders by the BEST team and the support-reports provided by the EuropeAid Energy capacity building project[37, 40].

Table 36: Income estimates for the main actors of the Nampula charcoal value chain

Nampula (average size of sack 40 kg)	Unit	Producer	Transporter	Wholesaler	Retailer
Prices per sack	Mt	50	90	160	223
Expenses per sack					
Cost for sack	*Mt*	*10*			
Cost for labor	*Mt*	*-*			
Transport to roadside			*20*		
License	*Mt*		*11.5*		
Truck loading labor	*Mt*		*3*		
Cost of transport	*Mt*			*45*	
Truck unloading labor	*Mt*			*3*	
Market fee	*Mt*			*5*	
Margins per sack	Mt	*40*	*5.5*	*17*	*63*
Volume of production/sales	sacks	45	1000	200	10
Average net income per month	**Mt**	**1,800**	**5,500**	**3,400**	**630**

In Nampula most charcoal producers work independently and do not hire additional labor. Trees are often harvested from open areas at no cost to the producer. Only a smaller number of people consider charcoal production to be their main economic activity, while a majority engage only occasionally as a means to generate income. Their income attains hardly the minimum wage of 1,800 Mt/month. The main profits are made by the transporter and wholesalers with 5,500 and 3,400 Mt/month respectively. It has to be noted that often transporting and wholesaling is concentrated in the hand of one middlemen. Retailers, especially domestic retailer selling at their homes have the smallest income share. Out of the 700 Mt for a bag of charcoal, some 295 remains in rural areas, or 42%.

Table 37: Monthly income estimates for the main actors of the Maputo charcoal value chain

Maputo (average size of sack 60 kg)	Unit	Producer	Transporter	Wholesaler	Retailer
Prices per sack	*Mt*	250	360	625	700
Expenses per sack					
Cost for sack	*Mt*	10			
Cost for labor(woodcutter/packer)	*Mt*	*170*			
Transport to road side	*Mt*		*50*		
License	*Mt*		11.5		
Truck loading labor	*Mt*		*5*		
Cost of transport	*Mt*			150	
Truck unloading labor	*Mt*			5	
Cost for hand-carriers or trolleys	*Mt*			20	
Market fee	*Mt*			5	
Margins per sack	*Mt*	*70*	43.5	85	75
Volume of production/sales	*sacks*	30	800	150	10
Average net income per month	***Mt***	**2,100**	**34,800**	**12,750**	**750**
Value Remaining in rural areas	***MT***	**240**	**55**	**-**	**-**
(Figures in italics refer to rural)	**%**	**96%**	**50%**	**0%**	**0%**

Source: BEST mission + Atanassov

The income estimates for the Maputo charcoal value chain displays a similar picture -profits are concentrated in the hands of a few intermediaries - only on a higher income level compared to Nampula. Especially the profit margins for transporters and wholesalers achieve a multiple of that of their colleagues in Nampula, while producers and retailers earn the lowest incomes.

4.7.1.7 *Employment generated by the charcoal sector*

The amount of employment generated by the charcoal sector is not easy to estimate as probably one half of the woodfuel producers operate as a part time business. However, we can deduct a rough estimation by applying the figures for volume of production/sales applied for the income calculations in Table 36 and Table 37 and divide it by the assumed urban charcoal demand of the country which can be estimated at roughly 611 thousand tons equivalent to 122 million sacks of in average weight of 50 kg. As Maputo and Nampula seem to reflect the extremes of value chains existing in the country we take the average volume of yearly productions of each actor in the value chain.

Table 38: Number of people engaged in the charcoal business

	Unit	Producer	Transporter	Wholesaler	Retailer
Average volume of production/sales per year	sacks	450	10,800	2,100	120
Amount of people engaged*	Nbr.	27,169	1,132	5,822	101,885

*to meet the national urban demand of around 122,260,000 **sacks**

A total of 136,000 -214,000 people are estimated to be involved on a full-time basis as main actors of the value chains (producer, transporter, wholesaler, and retailer). Furthermore, added to this should be the number of people providing services to these main actors such as woodcutter/packer, transporter to roadside, truck (un-)loading labor, hand-carriers/trolleys in town. Their labor costs are listed in the above income calculations (Table 36 and Table 37) and paid by the main actors. It is assumed that they are remunerated at the official minimum wage paid in the agricultural sector of 1,800 Mt/month. Multiplying the amount spent per sack for their services with the total urban demand of 122 million sacks and dividing it by the annual minimum wage (21,600 Mt) we can estimate the number of people engaged as service providers on a permanent base.

Table 39: Number of service providers engaged in the charcoal business

Service provider	Average costs per sack	Total amount spent to service provider (million Mt)*	People engaged**
Cost woodcutter/packer	85	1,039	48,112
Transport to roadside	35	428	19,811
Truck (un-)loading labor	8	98	4,528
Hand-carriers/trolleys in town	10	122	5,660

* to meet the national urban demand of around 122,260,000 **sacks**
** on the basis of a minimum annual wage of 21,600 Mt in the agricultural sector

It is estimated that the charcoal sector only, provides full-time jobs for 214,000 people of which 78,112 service providers who support a total of around 1.2 million dependents. In addition to these figures people involved in the commercial fuelwood value chain have to be added. This number is validated by other studies, notable the recent WISDOM study in Rwanda (Drigo, 2012).

When relating the income figures of the previous chapter with the number of people engaged in every link of the value chain, we observe that around 53% of the total income is generated by the charcoal production and 9%, 17% and 21% can be attributed to transport, wholesaling and retailing respectively. This shows that the majority is generated in rural areas thus contributing substantially to rural poverty alleviation. However, we have to note that communities whose forest areas are being harvested may receive no benefits whatsoever, as wood is generally harvested illegally or without direct payments resulting from the 20% rule.

Table 40: Total annual income generated through the charcoal value chain

	Nbr. of people	Average net monthly income per person	Total income generated per year (million Mt)	Gender share	Income generated by women (million Mt)
Production					
Charcoal producer	27,169	1,950	636	20%	127
Woodcutter/packer	48,112	1,800	1,039	25%	260

	Nbr. of people	Average net monthly income per person	Total income generated per year (million Mt)	Gender share	Income generated by women (million Mt)
Transport to roadside	19,811	1,800	428	0%	-
Transport			-		-
Transport agents	1,132	20,150	274	1%	3
Truck (un-)loading labor	4,528	1,800	98	1%	1
Wholesaling			-		-
Wholesaler	**5,822**	**8,075**	**564**	**55%**	**310**
Hand-carriers/trolleys	**5,660**	**1,800**	**122**	**0%**	**-**
Retailing			-		-
Retailer	101,885	690	844	90%	759
Total	**214,120**		**4,004**		**1,460**

4.7.1.8 Gender aspects

The share of women involved in the charcoal business as shown in Table 40 results from reports and stakeholder interviews and represents a best guess only. However, it illustrates that around 36% of the total income can be allocated to the activities of women.

The amount of women involved in charcoal producing is estimated to be less than 25% [38] often due to the fact that they became widow or their husband is absent and they have to care for additional household income. Their age is generally over 30 years. The male charcoal producers have an age of 20 to 40 years, sometimes supported by their wives to cover the kilns or to pack the charcoal.

It is noticeable that many of the wholesalers are female [37] assumed with a share of 55%. They are either travelling to the production sites bringing back their merchandise by truck or in case of Maputo by train or have respective agreements with transporters to ensure their supply. Atanassov et al (2012) also mentions that wholesalers from supply areas enter Maputo to sell charcoal sacks and return to their places of origin once they finish selling their load.

Retailers are females, mostly in the age between 30 - 60 years. They sell small quantities to consumers, usually in tins, bundles or small plastic bags and operate in market places or sell the charcoal at their homes (domestic retailers). Both get the charcoal from wholesale yards. Most of them have a common feature: they borrow one or two sacks of charcoal from wholesalers, and only after selling these they refund by keeping their profit.

4.7.1.9 Health aspects

There are impacts on human health at each stage of the life cycle of charcoal. The impacts vary considerably in magnitude and significance in respect to the management practices and technologies employed. These impacts are related to the emissions of gases and particulate matter (dust) into the indoor working and living environments: during the production management, unloading of kilns, collection of charcoal ashes for charcoal-briquettes production and burning of charcoal in households. Long term inhalation of particulate matter, carbon monoxide, nitrogen and sulphate oxides as well as other volatile compounds that are emitted during the charcoal burning may lead to respiratory problems and ultimately diseases such as acute respiratory infection (ARI), otitis media (middle ear infection), chronic obstructive pulmonary disease (COPD), asthma, lung cancer, low birth weight and others[48].

The biomass value chain analysis [37] states that most of the people involved in the charcoal production business were not really aware of the risk they are exposed to. However, some of them, especially sack carriers, report to suffering from respiratory problems and stated that they drink milk to combat adverse impacts on their health. In addition, accidents of wood loggers were reported as well as chronic back pain of sack carriers as some of the sacks weigh up to 100 kg's.

4.8 Sectoral contribution to the economy at national and local levels

It is estimated that the annual turnover from charcoal alone is about 250 - 300 million USD, equivalent to more than 2.2 % of GDP. With VAT standing at 17%, the potential level of revenue that is foregone by not regulating the industry is at least 50 million USD per year. Added to this should be the forgone revenue from licenses due to the lack of law enforcement of around 4.8 million USD per year. Some 40% of this value remains in rural areas, but, if the sector were modernized, could be much larger. Indeed if organized well, charcoal can be an engine for rural development.

The current study has found that the commercial charcoal sector only, provides full-time jobs for 214,000 people who support a total of around 1.2 million dependents equivalent to more than 5% of the population in Mozambique. Despite its unregulated status the charcoal trade is a clearly significant area of informal sector employment.

It is estimated that the total amount of charcoal produced in Mozambique is 610 thousand tons of charcoal per year equivalent to about 5.5 million m3 of wood to be cut. To produce this quantity of charcoal, around 137.000 ha of standing forest would have to be clear-cut annually.

Given the charcoal sector's robust economic impact on national economy, proactive policies can result in the implementation of sustainable forestry practices that deliver low-carbon economic growth and spur the growth of a new energy economy centered on sustainable forestry industry, clean burning technology, and renewable fuels. Significant policy reforms must occur to create the environment necessary for the growth of a sustainable charcoal industry at national and regional level.

A biomass energy matrix is presented in Annex 0, giving an overview of the main issues and ongoing activities by type of biomass used in the country.

5 Policy, Legal and Regulatory Context of the Sector

5.1 Overall policy strategies and planning frameworks

5.1.1 Agenda 2025

The Agenda 2025 is an umbrella document prepared in 2003/4 providing the long term vision development and strategy for Mozambique. It is interesting to note that in regard to woodfuel the Agenda 2025 proposes to "*substantially reduce the consumption of firewood …, to prevent the already visible desertification in peri-urban areas*". In the strategic options however, not much concrete action is foreseen over and above a change in the Land Act to more easily revoke land-use titles in case of improper use or failure to use of the intended purposes.

5.1.2 Government 5-Year Program (PQG 2010-14)

The Five Year Plan adopted in April 2010, presents the goals and priorities of national development policy and the strategies for achieving them during the period 2010-2014. It provides the framework for government actions to fight poverty and improve the welfare of Mozambicans. This will be achieved through the promotion of socio-economic growth, with emphasis on development of rural areas, services and basic social infrastructure, creation of employment opportunities, and creating an enabling environment for private investment and development of domestic entrepreneurs. The plan comprises several strategic objectives in the environmental area and the commitment to promote the inclusion of environmental issues in the formulation of policies, plans, programs and development projects, ensuring the rational use of natural resources.

Relevant key actions in this document include: i) ensuring sustainable use of natural resources ii) creation of capacity in coordination mechanisms on sustainable development issues iii) inclusion of issues of environmental education curricula iv) Promotion of mechanisms for integrated environmental management of forest fires, erosion and rehabilitation of arid and semi-arid areas.

5.1.3 Poverty Reduction Plan (PARP) 2010-2015

The latest Poverty Reduction Action Plan for Mozambique, 2011-2014, is dated, May the 3rd and it describes the country's macroeconomic, structural and social policies in support of growth and poverty reduction as well as, external financing needs and major sources of funding.

The PARP 2011-2014 is the Mozambican's government medium-term strategy for putting into operation the Five-Year Government Program (2010-2014), focused on the objective of combating poverty and promoting a culture of work, in order to achieving inclusive economic growth and reducing poverty and vulnerability in the country. The PARP 2011-2014 represents the continuation of the PARPA II, which was implemented with a timeframe of 2006-2009 and extended into to 2010, and had as its principal goal to reduce the incidence of food poverty from levels of 54.7 percent to 42 percent by 2014. This medium-term instrument is part of the National Planning System (SNP) and is aligned with the vision of Agenda 2025, designed to help achieve the Millennium Development Goals (MDG). In this connection, the Medium-Term Fiscal Framework 2010-2014 (CFMP) will reflect the budgetary allocation for PARP objectives, which will be pursued each year through the Economic and Social Plan and the State Budget (IMF Papers, Mozambique's PARP 2011-2014).

The PARP 2011-2014, has at the core of its strategy, three distinct points:

- First, increasing agricultural and fisheries production and productivity, with the attendant impact on food supply, which is a determining factor for reducing the incidence of poverty, and plays an important role as a source of income for around 80 percent of the country's population.
- Secondly, promotion of employment, as a way of facilitating and developing micro, small and medium-sized enterprises. The level of education and the well-being of the workforce is of utmost importance in order to boost agricultural output and productivity and to create more jobs. Access to quality health and education services as well as to social security programs.
- Thirdly, fostering human and social development. In this regard, it is worthwhile noting that Mozambique´s social and economic development has not accompanied the often praised

macroeconomic boom the country has been experiencing in the last decade. In the 2010 HDI, the country rates only 165 out of 169, leaving only Burundi, Niger, DRC and Zimbabwe behind. The life expectancy of 48 years is below the sub-Saharan average of 52 years, and literacy runs at 44% (sub-Saharan 62%). While the recent household survey conducted by the Mozambican government (JOFF) and published in October 2010 suggests that there has been real progress in access to health and education, the overall poverty rate has not improved, and has even worsened slightly (Transformation Index BTI 2012).

5.1.4 Strategy of Green Revolution

The Council of the Ministries approved a Strategy of Green Revolution in 2007. It considers natural resources management as one of its five main pillars. The Green revolution strategy prioritizes access and sustainable management of natural resources; zoning for facilitating investments in the forestry sector; establishment of plantations for energy use, promoting local processing of wood products; preventing forest fires and reducing human-animal conflicts.

As an implementation plan for the Green Revolution Strategy and responding to the increase of the food prices in the world's market, the Council of Ministries approved in June 2008 a Food Production Action Plan (FPAP). This plan concentrates in increasing food production and productivity, leaving forestry and natural resources out.

5.1.5 PEDSA (Plano Estratégico de Desenvolvimento do Sector Agrário)

A new Strategic Plan for Agriculture Sector (PEDSA) has been adopted in 2011. This plan covers all the sectors under the Ministry of Agriculture and has a 10-year perspective, from 2010-2019 and is supposed to enrich the Green Revolution strategy. It will be implemented through 5-year Plans.

It also considers sustainable natural resources management as one of the five main pillars of the plan. However, the PEDSA is rather weak in analyzing and setting up priorities for the woodfuel sector and titles the excessive consumption of woodfuel as a major threat to agriculture. In addition the strategy envisages increasing the cultivated area by 25% for basic food production up to 2019, which will definitely be at the expense of the forested area.

5.2 Sector policies

5.2.1 Policy on Energy

In the context of energy sector development an **energy strategy** was adopted in 2000 under the auspice of the Ministry of the Energy [49]. The strategic approach adopted is to integrate the utilization of different sources of energy including biomass and other renewable sources of energy. Biomass energy is particularly emphasized in recognition that in the medium term, biomass will continue to be a major source of energy for urban and rural, as well as household and industrial users.

Among the strategic options adopted, the strategy defined for biomass energy strategic lines the following: (i) to implement community management of natural forests, (ii) to stimulates the establishment of forest plantations to increase supply of the energy biomass, (iii) to promote the development and dissemination of technologies for efficient and sustainable use of energy resources for household and industrial purposes, and (ii) to promote investments in the public and private sector to increase the efficient use of the energy resources.

The energy strategy recognizes the complexity of the biomass sector, therefore, the need to perform operations including restructuring the biomass production sector, improve the quality of information on consumption, production and availability of biomass, protection of the environment, among other specific actions. Given the nature of the governance of the biomass sector, mainly done by the Ministry of Agriculture through the Forestry Service, it is also emphasized the need to increase inter sectorial coordination to improve performance and the quality of service.

The **National Strategy for Energy** from June 2009 [50] asserts that renewable energies have to assume a more prominent role in the national energy balance in order to contribute to the reduction of the national economy from fossil fuels and in order to allow a transition to a more diversified energy matrix.

By resolution 62/2009 [51] the new policy for the development of new and renewable energies was adopted. The resolution develops seven types of new and renewable energies: human and animal energy, biomass, hydropower, solar, wind, geothermal, and ocean energies. One of the challenges that the policy aims to tackle is to convert the traditional technologies like biomass and animal and human force into modern energy systems, with great efficiency and of better quality. The policy also commits to produce several strategies and instruments inter alia: a strategy for biomass energy (current study), a strategy for off-grid systems, and specific regulations for biomass energy, wind energy, solar, geothermal, ocean and mini-hydro.

A **strategy on biofuels** has also been adopted by the GoM in 2009 [18] essentially focusing on in the promotion of ethanol and biodiesel produced from agriculture raw materials for the production of liquid fuels to be used mainly in the transport sector. The crops selected for the production of biofuels in Mozambique comprise sugar-cane and mapira doce for ethanol, and jatropha curcas and coconut for biodiesel.

5.2.2 Policy on Environment

The GoM adopted in June 2004 a National Strategy for the Environment covering the period from 2005 to 2015. The strategy makes reference to a strong inter-sectoral coordination on environmental issues and the importance of linking the environment to poverty reduction.

The vision of the strategy is to lead the country in promoting a healthy environment, to achieve a good quality of life and social development, environmental and economic playing field. Among the main actions mentioned the following activities are relevant to the biomass sector:

- Achievement of formal and informal environmental education and awareness about environmental protection and management of resources.
- Promotion of job creation and self-employment through the facilitation of programs and activities of community-based environmental management.
- Promoting public-private partnerships for the effective management of natural resources in a mutually beneficial manner.

5.2.3 Policy on Rural Development

The Rural Development Strategy (EDR) approved in 2007 aims to improve the quality of life and develop the rural areas, through: (i) competitivety, productivity and the accumulation of wealth, (ii) productive and sustainable management of natural resources and the environment, (iii) diversification and efficiency of social capital, infrastructures and institutions, (iv) expansion of human capital, innovation and technology, (v) good governance and planning for the market.

5.2.4 Policy on Forests

The Policy for the Development of the Forestry and Wildlife Sector (1997): the underlining assumption of the forestry and wildlife policy is that forest resources should be managed so that they contribute to economic development, and therefore poverty alleviation, while ensuring sustainability and the supply of goods and services. It establishes four objectives:

- **Economic** – promote the engagement of the private sector in sustainable management and generation of income by adding value to forest products
- **Social**—encourage communities to participate in the sustainable management of forest resources through the adoption of good practices and derivation of tangible benefits
- **Ecologica**l—conserve a forest resource rich in biodiversity and provide environmental services such as watershed and soil protection
- **Institutional**—equip all levels of forest administration with the capacity to formulate policy and ensure its implementation through monitoring.

As a part of the Forest Sector Support Program between the Finnish and Mozambique Government it is envisaged to improve the National Forest Program (NFP) and to better integrate it into the strategic plan of MINAG. It should display the potentiality of the forest sector for poverty reduction, social and economic development and environmental benefit.

Noteworthy among the strategies drafted by MINAG are:

The **strategy on participative law enforcement for lands and forest** strategy drafted in 2005 addresses the need to develop a participative law enforcement that integrates, strengthen and consolidates law enforcement activities in order to reduce illegal activities in the forestry sector and minimize its social, economic, and environmental impacts.

The **national reforestation strategy** adopted in 2006 includes plantations of different kinds, including industrial, energy, and protection plantations. The Ministry of Agriculture, through the Forest Service and the Agricultural Development Fund, is the main responsible to implement the strategy. Reforestation for energy biomass production is one among three major strategic actions. The justification to include biomass energy production is based on the high demand for wood biomass for household and industrial use, and the need to reduce pressure over the natural forests and the environmental degradation.

The reforestation strategy is in line with the Forest Law and Forest Regulation as well as the Energy Strategy in the sense of promoting the production of biomass for industrial uses, particularly for tobacco, tea, and ceramic industries, to promote sustainability use of resources, to reduce environmental degradation, and to include private sector and local communities as implementing agents.

There are challenges in the reforestation for biomass energy production. During the decade of the 1980´s, Mozambique had three major reforestation projects for biomass energy for Maputo, Beira and Nampula. All these projects have failed. Among the reasons is the production cost. While biomass from native forests and woodlands remains “free access”, the cost of producing biomass from managed forest plantations will always be seen as prohibitive. The reforestation strategy recognizes this weakness and includes an action that consists of improvement in the valuation and appropriate valorization of the natural forests and woodlands to make forest plantation competitive.

5.3 Other relevant policies and regulations

In 2000, the Council of Ministers approved a decree that opens the road to the formal recognition of local leaders, including traditional chiefs and headmen, as authorities within the government's administrative framework (Decree 15/2000). In the same year, the Minister of State Administration issued a decree (diploma) that calls for the creation of local consultative councils (Ministerial Diploma 107-A/2000)

The 2003 **Law on the Organization of the Local State** (LOLE) and its 2005 Regulation strengthen the position of the district administration in the state hierarchy. Contrary to previous legislation, LOLE attributes executive competences to the district government with its own budget.

The 2005 Regulation of LOLE also formalizes people’s participation in the elaboration of the District's Strategic Development Plan (PEDD). The participation of the communities is channeled through consultative councils at the village, administrative post and district levels. Although there are no clearly established means for guaranteeing that the composition of these councils is representative, they are an important avenue for the channeling of local concerns into the district development planning and budget making processes.

Another important innovation in the framework of decentralization is the attribution of so-called Budgets for **Local Investments and Initiatives** (OIIL) or the District Development Fund of an amount of 9,000,000 Mt to the districts in support of local development. The OIIL are basically perceived as rotating funds to support local initiatives.

In summary, laws such as LOLE and the allocation of District Development Funds managed with the participation of the local consultative council can create a dynamic towards greater local empowerment supporting the introduction of sustainable forest management activities.

5.4 Laws governing woodfuel exploitation

Mozambique avails of a closely knit framework of statutory laws and regulations of comparatively recent origin governing environmental protection, nature conservation and the use of natural re-sources. Only a minor number of these legal sources refer directly to the production and use of wood-based fuels, while a larger body of laws and regulations address resource use and environmental governance in general terms. Pertinent legal sources include

- Environmental Law (Law 97/1997)
- Land Law (Law 19/1997)

- Law on Forestry and Wildlife (Law 10/1999)
- Land Law (Law 19/1997)

Only the foregoing laws (including accessory regulations) were therefore assessed in regard to their relevance and applicability for the sustainable production of wood-based fuels. The tabular presentation overleaf summarizes salient provisions of the foregoing laws as well as the Regulations on the Law on Forestry and Wildlife.

Table 41: Compilation of legal provisions pertaining to the production and use of fuel-wood and charcoal in Mozambique

Source	Article	Provision
Law 97/1997 Environmental Law	Art. 9 (1)	Any activity leading to "… *erosion, desertification, deforestation or any form of environmental degradation* …" in excess of legally prescribed limits for the use of natural resources are prohibited throughout Mozambique.
Law 19/1997 Land Law	Art. 9	No land use rights (save exceptional licenses for specific purposes) may be established within protected areas.
	Art. 20	The exercise of land use rights remains bound by the legal framework and land use plans, irrespective of individual licensing provisions.
Law 10/1999 Law on Forestry and Wildlife	Art. 2	Law 10/1999 provides a unified and comprehensive basis for "… protection, conservation and sustainable utilization of forest resources and wildlife …" with a focus on economic and social development.
	Art. 3	Principles governing management and use of natural resources include: (i) state ownership of forests and wildlife, (ii) sustainable management with local and private participation, (iii) evidence based management in recognition of EIAs, (iv) protection of third parties' rights, (v) decentralization and recognition of indigenous / local use practices, (vi) research and data collection / information management prioritizing native species for sustainable development, (vii) environmental education and awareness creation regarding sustainable management at community level, (viii) international cooperation
	Art. 4	The Law's stated purpose is to "… *protect, conserve, develop and use … forest and wildlife* …" with balanced regard for economic, social and ecological parameters and in pursuit of inter-generational equity.
	Art. 5	Classification of the Permanent Forest Estate as either conservation forests (located within protected areas), production forests (for commercial purposes) or multiple use forests (dedicated to low-intensity management).
	Art. 9	Land use rights may be established by way of either "… occupation or by authorization …", their exercise requiring public licenses for all but subsistence purposes.
	Art. 14	Law 10/1999 establishes a two-tier system of simple licenses and (commercial) concession contracts, subject to terms and conditions approved by the Council of Ministers.
	Art. 15	Simple licenses establishing commercial use rights in regard to production and multiple use forests for "… *commercial, industrial and energy* …" purposes apply to nationals (including local communities), subject to approved management plans and conditional on proof of adequate technical capacity. Communities are at liberty to self-govern forest management for subsistence purposes.
	Art. 16	Concession contracts with a maximum term of 50 years (subject to renewal) may be awarded to natural and legal persons as well as local communities in regard to productive and multiple use forests for the purposes of industrial timber supply and energy pursuant to a sectoral energy management plan. The exercise of concession rights is

Source	Article	Provision
		conditional on demonstrated processing capacity, including of products sourced through simple licenses.
	Art. 17	Identification of concession areas is based on sets of criteria, including availability of processing capacities. Granting of concession contracts is to be preceded by consultation of local communities and decentralized government bodies.
	Art. 18	Forest use for "… commercial, industrial or energy …" purposes must observe third parties' rights, including free access of local communities for subsistence purposes.
	Art. 19	Production of fuelwood and charcoal is restricted to approved tree species. Holders of simple licenses and concessionaires "… *enjoy preference in acquiring a license for the production of firewood and charcoal* …" made from residues of commercial logging.
	Art. 27	State promotion of plantations as a means of recovering degraded areas, with the proviso that protected areas affected by deforestation must be returned to their previous state.
	Art. 28	State promotion of plantations, including by means of special incentives, for "… *commercial, industrial or energy* …" purposes, subject to site characteristics.
	Art. 31	Establishment of local councils as consultative and governance bodies for sustainable forest management, subject to public, civil society and private participation, and for the purpose of promoting stakeholder participation in natural resource management and use.
	Art. 33	Devolution of management authority to "… local communities, associations or the private sector …" subject public supervision.
	Art. 34	Procurement, transport and sales of forest products require authorization pursuant to law.
	Art. 35	Fees and charges are levied on the use of forest resources, including on tourism within protected areas. Rates are determined by decree of the Council of Ministers, including licensing procedures. Subsistence use by local communities remains exempt. Surcharges are levied for reforestation. Proceeds are to be shared for the benefit of local communities, subject to fixed ratios.
	Art. 36	Governance instruments giving effect to Law 10/1999 include (i) inter-institutional coordination, (ii) international law, (iii) licensing procedures, (iv) EIAs, (v) the forestry and wildlife development fund, (vi) regulatory provisions, (vii) forest and wildlife inventories, (viii) species' lists, (ix) compensation and environmental rehabilitation, (x) management planning, (xi) fire prevention, (xii) zoning, (xiii) the National Program on Forestry and Wildlife.
	Art. 37	Public supervision of forest management, backed up by a general obligation to report legal infringements to competent authorities. Forest governance vests in Inspectors of Forests and Wildlife authorized to monitor forest resources and to prosecute offenders (including rights of search & seizure).
	Art. 38	Law 10/1999 provides for stationary and mobile surveillance charged with the operation of roadside checkpoints and patrolling, to be effected by Inspectors of Forests and Wildlife.
Decree 12/2002 Regulations on the Law on Forestry and Wildlife	Art. 9 (2)	Classification of forest products explicitly recognizes "… *ligneous fuel: firewood and charcoal* …"
	Art. 24	Wood-based fuels must not be sourced from rare & protected species or commercially significant timber species providing quality timber of grades 1 to 3. Residual or defective logs with no commercial value may

Source	Article	Provision
		be used, subject to public approval. Energy-intensive industries dependent on wood-based fuels are obliged to ensure their supply from concession areas or specially dedicated plantations. Export of wood-based fuels originating from concession areas is conditional on public approval.

Scrutinizing the foregoing legal sources, some observations seem pertinent:

1. Qualifying as regular forest products, the procurement of wood-base fuels must observe all legal provisions governing sustainable natural resource management and use. The Environ-mental Law in particular prohibits any practice or action leading to forest degradation and deforestation, thereby creating a minimum standard to which all forestry operations irrespective of their scale or purpose must conform.
2. All forest production, except when done for subsistence purposes, requires formal approval by means of either simple licenses or concession contracts, based on evidence-based management plans with varying degrees of resolution and procedural complexity.
3. The award and exercise of land use rights must observe third parties' rights and is subject to institutionalized stakeholder consultation and participation.
4. Wood-based fuels are regarded as by-products of timber-based forest use, with restrictions on the use of commercially more valuable tree species.
5. Special provisions apply to energy-intensive industrial consumers who are under an obligation to ensure sustainable supplies of their wood-fuel.
6. The legal framework provides for plantation management with public support, including funding, for the purpose of relieving pressure on natural forests and complementing sustainable forest management.
7. The legal sources establish an interlocking forest governance framework, stipulating resource monitoring, supervision of management and use, and prosecution of transgressions by specially authorized governance bodies, and stakeholder participation.

The foregoing observations say little about the realities of management, use, and forest law enforcement. Recent studies are indicative of significant shortfalls regarding licensing procedures and the allocation of use rights as well as ineffective supervision and enforcement. Statistical estimates suggest annual relative shares of illegally sourced wood on the order of approximately 55 percent [52].

Comparing the legal framework with observations of the foregoing kind, it would seem that underlying the apparent lack of governance is a significant enforcement deficit – rather than lacking or inappropriate normative provisions.

5.5 Land tenure

Land ownership in Mozambique is vested in the government. In rural areas at a local level land tenure rights have been allocated to individuals under a quasi-traditional system by local regulos (chiefs). Recent land tenure reform (1997) has enabled land occupiers to claim long term land use rights for up to 98 years under a system of DUAT (Rights of Land Use). However the process for acquiring these rights is somewhat complicated and has legal costs which often cannot be afforded by small land holders.

The land law plays an important role in the accessibility and production of biomass. The national constitution defines land as state property. It cannot be sold, but users are granted land use rights (DUAT) to implement their projects. Land users pay an annual symbolic fee that varies from 2 meticais/ha for livestock and game farm, through 15 meticais/ha for agriculture to 200 meticais/ha for housing. This definition of land is also extensive to the forest resources, also defined as state property. Local communities have free access to the land and forest resources based on customary rules.

While institutional capacity to enforce the management of land and forest resources is weak, there are reports of overlapping attribution of DUATs, invasion of forest resources by people from outside the community. The major role of land management is on the Ministry of Agriculture (see section on institutions below), however, there are other sectors such as the Ministry of Tourism (MITUR), which manages the land and resources on conservation areas, the Ministry of Mining managing the land where there are mineral resources, among others.

The interaction between formal (written law) and the customary (local costumes) regulations on land is not clear, sometimes raising conflict on use rights. It is common that the formal law displaces the rights based on customary rules by formalizing the legal environment, and this is so not just in Mozambique alone but elsewhere as well. The down side is that this creates an environment where local communities do not have security on the land and forest resources. They do not have the right to restrict access to the land and forest resources to outsiders and find it difficult to manage or protect these lands. In addition, ownership rules of community plantations are not clearly defined, it is uncertain whether they belong to state or to community, and in addition the rules for their use are unclear as well. In practice, this results most of the times in negative incentives for local communities to engage in long term community forestry[43]. This is exactly the opposite of what should be the case.

Box 3: Land tenure types

The Land Law recognizes a use right to land, known by the Portuguese acronym, DUAT (direito de uso e aproveitamento dos terras). DUATs can be held individually or jointly. Two types of DUATs are available. The rights are classified according to the means by which they are obtained:

DUAT obtained by occupancy. DUATs can be obtained through: (a) occupancy of land according to customary norms and practices; or (b) good faith occupation of land for 10 years. Local communities have DUATs to their traditional territory. DUATs obtained by occupancy are perpetual and do not require plans for exploitation of the land. Delimitation and registration is voluntary: communities are not required to delimit or register their land to assert their DUAT. However, pursuant to a 2008 resolution, if local communities want to register their DUAT, they must prepare an exploitation plan. Members of local communities can also obtain DUATs for individual plots within the community land. Local communities can also grant third parties, such as investors, rights to use land within their territories

DUAT obtained by grant. The state grants DUATs for renewable periods of 50 years. There are no minimum or maximum sizes of land available by government grant. Grant applicants must prepare an exploitation plan. The state reviews the application and issues a provisional grant for either two years (to foreign persons or entities) or five years (to nationals). The level of state review is based on the extent of land sought: for parcels up to 1000 hectares, the Provincial Governor issues the approval, the Ministry of Agriculture approves grants of 1001 – 10,000 hectares, and grants of more than 10,000 hectares are approved by the Council of Ministers. If the exploitation plan is fulfilled, the grant becomes final. If the exploitation plan is not fulfilled, the land reverts to the state. In that event, the state receives rights to any improvements made to the land; the grantee has no right to compensation.

Any investment made on the land, as opposed to the land itself, is private property, and can be bought, sold or mortgaged. Urban tenements (defined as the structures and land that serve them in cases where the source of income depends principally on the structure rather than the land) can be freely transferred. When the structures or improvements on land are transferred to a buyer, the rights in the land (DUAT) also transfer to the buyer. Rural tenements (defined as a demarcated portion of land and structures where the source of income depends principally on the land) require state authorization for transfer of the DUAT.

Source: [53]

6 Stakeholder Analysis

6.1 Institutions and their responsibilities

The following table shows the main public institutions that play, or should play a role in governing and promoting biomass energy in Mozambique.

Institution	Responsibilities
National directorate of Lands and Forests at the Ministry of Agriculture	• Promote sustainable use of lands and forest and wildlife resources as well as reforestation and wildlife • Ensure the elaboration, implementation, monitoring and evaluation of polices, strategies and legislation
National Directorate of new and renewable energy at the Ministry of Energy	• Elaborate and propose polices for the development of new and renewable energy and monitor its execution • Propose sustainable utilization and disseminate new sources of energy at low costs • Elaborate studies about consumption of biomassa and propose measures for its efficient utilization • Elaborate, in coordination with other entities, proposals for the development and management of natural resources and forest residues for production of energy • Promote the development and utilization of technologies that ensure sustainable production of charcoal ; • Evaluate, certify and monitor technologies of new and renewable energy in order to conform them with the quality standards, safety, health and environmental prevailing in the country; • Propose the regulation of activities of the new and renewable energy sector and support their compliance; • Licensing the facilities of new and renewable energy and maintaining the respective records, • Prepare and submit for approval the technical norms for the efficient use of energy in industrial and public buildings; • Promote the development and use of more efficient technologies and suitable for the burning of fuel wood and industrial waste; • To promote performance of studies on the environmental impact of the utilization of different energy resources and propose measures for their mitigation, and • Give advice on new projects regarding aspects of energy conservation, defense and preservation of the environment
National Directorate of fuels at Ministry of Energy	• Propose policy for distribution, commercialization and utilization of natural gas in the country; • Promote expansion of infra structures of storage, distribution, supply and commercialization of fuels particularly in rural areas • Promote the development and utilization of technologies that ensure optimization and handling of solid, liquid and gases.
National Energy Fund, FUNAE, under the Ministry of Energy	• Provide financial support companies of production and dissemination of production techniques, distribution and conservation of energy in different forms • Acquire, funds to ensure acquisition of equipment for production and distribution of energy particularly the one used for new and renewable energy • Promote development and forest plantations for production of

	biomass assisting financial support for management and conservation in peri-urban or areas with deficit of this fuel • Support financial institutions responsible for performance of studies and inventory energy resources and technologies for its utilization • Support expenditures for performance, publish, of studies and research work with interest to disseminate the techniques and more efficient and accessible technologies to produce, distribute and conserve the energetic and renewable products
Ministry of Finance	• Establish the national budget • Raise funds to implement the budget • Determine taxation levels for the different economic sectors
Ministry of Planning	• Identify national planning priorities • Prepare national plans for intervention
Ministry of Industry and Commerce	• Promote an efficient business environment
UEM/FAEF/DEF	• Research

5.2. Current institutions of biomass energy administration and roles

1. National Directorate Rural Development (DNDR) at the Ministry of State Administration– Community Based Natural Resource Management program (PGCRN) – Systematize experiences on community re natural resource management and inter-institutional coordination
2. National Directorate of Lands and Forests (DNTF) at The Ministry of Agriculture – responsible in management and control of forest resources, concentrate information about forest and wildlife resources
3. National Directorate of Agrarian Extension (DNEA) at The Ministry of Agriculture – responsible for promoting the sustainable agriculture development ensuring the flux of information from and to producers
4. National Directorate of New and Renewable Energy (DNENR) at the Ministry of Energy – responsible for management of the demand and alternative energy sources
5. Energy National Fund, under the Ministry of Energy and Mineral Resources – responsible for supporting financially or support in fundraising for the implementation of efficient energy technologies for utilization and conservation of natural resources and protection of biodiversity.
6. National Directorate of Enrvironment Management (DNGA) at the Ministry for Coordination of Environmental Action - responsible to ensure sustainable utilization of natural resources and biodiversity conservation.
7. Academia (UEM-Faculty of Agronomy and Forest Engineering and Faculty of Engineering) – responsible for Production of scientific and technical knowledge , Training and capacity building in the forestry sector
8. National NGOs (Adel Sofala and ADEM Manica) – responsible for the implementation of projects related to promotion of sustainable resource use as well as efficient energy alternatives and sources.

6.1.1 Ministries and line administrations

The Ministry of Energy has prime responsibility for the energy sector. The all-important forestry resources are under the responsibility of the Ministry of Agriculture (MINAG). The Ministry for the Coordination of Environmental Affairs (MICOA) has an important potential role in documenting and monitoring the effects of both the extraction and end use of energy resources.

Ministry of Agriculture (MINAG)

The Ministry of Agriculture is the major institutional actor for biomass energy. It is MINAG through the DNTF (and their respective provincial and district representatives) that has the responsibility to manage the land and the forest resources. The land is the basic resource for all production process. It is under the responsibility of MINAG to issue the land use rights (DUAT) for land (soil) based activities. It is also under the responsibility of

MINAG to issue licenses for exploitation of forest resources and manage all the state land. Note that the constitution defines land as state owned, therefore the great role of MINAG. It is also the role of MINAG to promote sustainable forest management, engage local communities in the management of forest resources, issue licenses for exploitation of forest resources, among others. Within the Ministry of Agriculture, the following departments play an important role:

DNTF - National Directorate of Forests and Land	Regulate, patrol, evaluate and prepare forest concession contracts
SPFFB - Provincial Service of Forests and Wildlife	Implement the forest regulation, issue logging licenses, forest patrol and law enforcement, collect forest revenue, interact with communities for forest project implementation, handling the (20%) forest revenue share for local communities
SPGC - Provincial Service for Geography and Land Registry	Keep registry of land use, check land occupancy whenever there is a land use request, conduct community consultations regarding land use
FDA - Agricultural Development Fund	Implement the state-community reforestation programs
DARN - Department of Evaluation of Natural Resources	Inventory and assessment of forest resources, land potential evaluation, land and forest resource mapping

Ministry for Coordination of Environmental Action (MICOA)

MICOA is a cross sectorial ministry, with the responsibility to implement the national environmental strategy. In the context of biomass energy in Mozambique, where unsustainable collection of firewood and charcoal making is causing environmental degradation, MICOA plays an important role to alert the users and the involved sectors to direct their sectorial strategies to reduce environmental degradation. MICOA also has the role to regulate and control the environmental impact assessments (EIA) of large scale projects. In the context of biomass energy, if large areas area requested for plantation, these should include an EIA including the effects of the plantation on local biodiversity, the interaction with local species (plant and animal), and assure there will no invasive alien species, among others.

Wood energy is a significant driver to deforestation and climate change, which does not need to be the case. Wood-based fuels are typically harvested from woodlands, shrublands or degraded secondary forests surrounding settlement areas. Mozambique's population will grow from 23 million now to 34 million inhabitants in 2025. Additional land requirements for farming and urban settlements will lead to a further loss of productive forest area of an estimated 4.7 million ha, or more than 17% of the 2011 productive forest area. Urban population growth is expected to rise at a rate of 4.4% exerting additional pressure on the forest cover especially around consumption centres due to the rising demand and the gradual shift from fuelwood to charcoal.

Forest degradation directly affects and diminishes both a forest's storage and absorption capacity. Deforestation not only releases CO2 stored in standing trees, but leads to rapid decomposition of organic matter in the topsoil – adding to the negative effect. According to Mozambique's Initial National Communication to the UNFCCC, land use change and agriculture account for more than 80% of Mozambique's GHG emissions.

Ministry of Energy (ME)

The Ministry of Energy (ME) was created in 2005 and is the major institution to regulate the use of energy. The ME integrates all energy sectors (apart from biomass) and defines the strategy to convert the existing resources from different sectors into energy. Major actions of ME include coordination with MINAG and MICOA in the implementation of the strategy for sustainable biomass production for energy (as indicated in the Energy Strategy), develop and promote technologies for an efficient use of biomass for energy including improved and efficient methods for making charcoal, improved wood and charcoal stoves, among others. The ME is supported by a capacity building project in Energy Planning and Management through EuropeAid/127640/SER/MZ. One of its objectives is to contribute to sustainable use of traditional biomass fuels in main urban areas (Maputo, Matola, Beira, Nampula and Quelimane) through enhancing energy planning and management capabilities of the personnel on central and provincial government level. Via this project valuable

support has also been provided to the BEST team by financing woodfuel consumption studies in Maputo, Beira and Nampula.

National Energy Fund, FUNAE

FUNAE is a public institution funded in 1997 by Decree 24/97 of 22 July, which operates under the auspice of the ME at national level with the aim to fund and provide financial guarantees for projects that contribute for the: (i) Development, production and utilization of energy forms enabling the expansion of low cost energy services in the rural and urban areas; (ii) Promotion of energy resources conservation and rational and sustainable management. FUNAE's vision, mission and values as stated in the strategic plan are as follow [54]: "Become an institution of reference in dissemination and promotion of alternative energy resources and on rural electrification". Apart from financing energy services, FUNAE's mandate includes the provision of technical assistance, the initiation of information campaigns and the implementation of projects to increase energy supplies to low-income urban and rural areas.

FUNAE is undertaking several activities towards diversification of sources of energy, through use of other renewable including small hydro-power and photovoltaic systems, biogas, improved and efficient stoves, and improved charcoalmaking. In 2012 the provinces of Manica and Gaza have been selected for pilot projects to disseminate improved stoves. FUNAE is not supported by any sustainable funding mechanism, such as e.g. a levy on electricity sales. This means that FUNAE is fully dependent on donor funding. While there is a vision for moving towards a programmatic approach to rural electrification, for the time being FUNAE seems to be operating on a project to projects basis searching funding for individual projects. FUNAE receives donor funding through the European Union, NORAD, DANIDA, the World Bank/Global Environmental Facility and other donors.

Ministry of Finance (MF)

The Ministry of Finance is involved at several levels. The first is its role in establishing the national budget and allocating funds for investments in biomass energy. The second is in setting taxation levels as a way to raise funds and to guide actors in their business. The urban charcoal market in Maputo, Beira and Nampula is estimated to exceed an annual turnover of over 250 million USD. Rough estimates show that less than 5% of this market is within the formal sector and subject to licensing and taxation. Furthermore, charcoal supply in Mozambique provides full-time jobs for 214,000 people who support a total of around 1.2 million dependents, or equivalent to more than 5% of the population in Mozambique. Despite its unregulated status the charcoal trade is a clearly a significant area of informal sector employment. There are currently no tools in place to govern this substantial market.

Ministry of Industry and Commerce (MIC)

The Ministry of Industry and Commerce is not much involved, but it should. Business generated in the charcoal market is essentially realized by informal actors and is therefore not covered by the Ministry of Industry and Commerce. A modernization of the entire sector would go a long way in improving many of the prevailing issues. In the public perception, charcoal is discriminated against as "poor men's business" and economically unattractive. This hinders strategic planning as well as mobilization of investment capital. Corruption is systemic and hinders adequate governance and enforcement of simple management rules. This problem further diminishes the legitimacy of the charcoal business, and leaves many producers vulnerable to economic exploitation. Instead of equitable revenue-sharing along the entire value chain, revenue circulates in a loop between traders and consumers, with marginal cash flows to the charcoal burners and virtually none to the communities whose forest areas are being depleted in the process.

Ministry of Planning and Development

The Ministry of Planning and Development is not much involved, but it should. Most of the woodfuel market is currently unregulated, outside of the formal economy and lacking a clear modernization plan. Woodfuels are used by more than 90% of the population and provide more than 75% of the total energy used in the country. The sector requires reforms and modernization to increase efficiency, eliminate corruption, improve product quality, sustainably manage forest resources and promote investment. The woodfuel sector needs to be managed as an integral part of Mozambique's development plan, and this requires regularization of the sector. The woodfuel sector already plays a major role in rural economies and their economic development, and this could increase considerably in case it is modernized. At present, woodfuels are one of the few sources of jobs

and income for many in rural areas. Promoting investment in the sector must include rural populations and offer them ways to benefit from investment, modernization and licensing reform.

6.1.2 Consultative platforms

The **Forest Forum** is a central national multi-stakeholder forum to prioritize, discuss and propose changes to policies relating to land use and forestry. Their key members comprise representatives of the MINAG/DNTF, the private sector, civil society education and research institutions.

The **CBNRM forum** comprising government and non-government organizations has the aim to coordinate CBNRM support through sharing of information, experiences, materials, tools. The CBNRM forum, with financial support of WWF, also led the development of the CBNRM strategy (2009) through participation of regional fora and stakeholders from government, private sector and NGOs.

The **Energy Sector Working Group**

Since July 2007, the World Bank has served as co-chair with the GoM on the —Energy Sector Working Group that was established within the framework of the Paris Declaration. Other members are Norway, ADB, ADF, EU, OFID, BADEA, IsDB, Kuweit Fund. The World Bank is in preparation of the Energy Development and Access Programme (EDAP) that will mainly help establish the necessary operational framework for increasing electricity access to un-electrified areas nationally in a sustainable and programmatic manner, aiming at mainstreaming a sector-wide approach (SWAp) by establishing a comprehensive donor partnership framework for coordinated and sustained financing of investment and capacity strengthening aligned with national priorities and procedures. The Energy Sector Working group meets once or twice a year, and if deemed necessary.

The **Biomass Energy Sector Working Group (GTBm)**

In the fall of 2010, the Ministry of Energy has established the Biomass Energy Working Group (GTBm), chaired by the National Directorate of New and Renewable Energies (DNER); members include the National Directorate of Land and Forests (DNTF), a division of the Ministry of Agriculture, the National Energy Fund (FUNAE), Eduardo Mondlane University (UEM), the Center for promotion of Agriculture (CEPAGRI), another division of the Ministry of Agriculture and Department for Environmental Impact at the Ministry of Environment (DNAIA).

NGOs have taken a significant role in the interface between policy development and policy delivery at the local level. However, these NGO's are reliant on external support and they still have limited resources to provide the necessary spatial coverage that is required to maximize policy implementation and impacts.

ORAM is a nationwide farmers' organization. It has delegations in all provinces that operate with a large degree of autonomy from its headquarters in Maputo City. Since the mid- 1990s, ORAM has been actively involved in the discussions about the 1997 Land Law. It was one of the drivers behind the Law's recognition of community property rights. Since the enactment of the Land Law, ORAM has been very active in supporting communities in securing their collective land ownership rights, in particular in the provinces of Cabo Delgado, Nampula, and Zambézia.

Forum Terra is a platform of provincial NGOs operating in Cabo Delgado, Manica and Nampula. Its importance depends significantly on local leadership. In Nampula, Forum Terra has been engaged in various CBNRM projects, for example, through the training of forest scouts. It is also active in Cabo Delgado, where it has mobilized support from ITC for community land titling.

FEDESMO (Fórum de Energias e Desenvolvimento Sustentável de Moçambique) is a national forum for sustainable energy in Mozambique established in 2009. FEDESMO's secretariat is headed by ADEL-Sofala in Beira, with focal points in other provinces. Members include NGOs, academic institutions and governmental institutions like regional and national ministries of energy, forestry and environment, and the national energy fund FUNAE. In total there are now about 100 members registered. Charcoal production is one of FEDESMO's main concerns and will, together with the Government and the involved communities seek better solutions to avoid deforestation. Within FEDESMO the participating organizations share information between local and national actors to strengthen their own grassroots work and to translate their experiences into the national energy policies.

ADEL-Sofala, the local development agency for Sofala is a NGO which has been involved in the biomass sector for about 5 years. They were selected by the, then, programe for Biomass Energy Conservation (ProBEC) to

introduce and disseminate cooking stove technologies throughout the entire Sofala province. Today they are active in cooking stove production, training and promotion, PV dissemination, Improved Charcoal Production and CDM activities. They have established a string of co-operation agreements with other donor agencies, such as OVE (Denmark, UNDP GEF, etc.).

KULIMA was another partner of ProBEC in Maputo, Gaza and Inhambane. There were active in the production and promotion of the POCA ceramic stove as well as, institutional stoves. Training of artisans and small entrepreneurs was a cornerstone of their activities and they continue to be involved in the sector trough agreements with new donor agencies.

LIVANINGO is an NGO which has struck a partnership with OVE from Denmark to carry on biomass activities in Mozambique. They were active in sensitization and promotion activities for clean cooking technologies, namely, improved cooking stoves. They were also poised to enter the field of CDM and explore the poetential associated with cooking stoves.

6.1.3 Universities

The **Eduardo Mondlane University** (Faculty of Agronomy and Forestry) provides technical support relative to quantitative analysis of deforestation and degradation resulting from land use changes and timber/woodfuel exploitation. In the framework of the REDD exercise they support with funding of JICA the development of reference levels for reducing emissions, as well as establishing a system for measuring, reporting and verifying performance.

6.1.4 Capacity, strengths, weaknesses, threats

The main observation is that the responsibility for managing woodfuel is of no focal concern to any of the cited administrations and/or institutions. It is mostly treated as side aspect of other environmental concerns such as nature protection, climate change and/or timber production and often considered as the major reason for deforestation. The ME focuses on electrification and biofuels marginalizing the woodfuel sector. FUNAE, which is the instrument for realizing energy activities other than related to regular electricity supply, is mostly interested in financing improved stoves projects or other small-scale intervention.

Hence it is not surprising that the coordination between the ministries of energy, agriculture and other relevant institutions barely exists. There is no culture of integrated planning in terms of supply and demand. This lack of integrated planning is evident by the lack of availability of any meaningful information about wood fuel consumption as well as woodfuel supply. For example the promotion of the development and planting of forests for biomass production is subject to both ME through its attached agency FUNAE and MINAG with only limited coordination.

Capacity

- MINAG, SPFFB, SDAE – distributed all over the country the district and locality

Strengths

- Biomass production and consumption policies are harmonized

Weaknesses

- Limited capacity to enforce the law (political interference, limited human capacity)
- Deficient coordination of development actions across sectors
- Lack of clear implementation strategy for biomass production (there is no clear and formal production of biomass for energy neither from natural forests or plantations)

Threats

- If the biomass energy sector remains marginalized and operating outside the regulatory framework, there are no incentives to become more efficient, and eventually the resource base will run out, taking away the major energy source for the bulk of the population.

6.2 Energy projects and programs

6.2.1 Forest and CBNRM Projects

Since the late 1990s many CBNRM projects were promoted to support local communities to secure their rights to land and other resources and providing technical assistance with regard to the sustainable management and exploitation of these resources. However, many of them phased out due to the fact that they did not adequately and effectively deliver the envisioned benefits. Although viable approaches have been applied a major reason lies in the failure of achieving sustainability through enough economic benefits. In April 2011 the 4th Conference on CBNRM took place with the aim to share experiences, results and lessons learned and to revitalize CBNRM as a means for poverty alleviation.

The still existing CBNRM projects do not focus on providing energy but pursue multiple objectives to enable communities to use the land as a starting point for activities that will engender local development e.g. promote improved practices of honey production, vegetables, wildlife conservation and eco-tourism some of them by capitalizing on the carbon markets.

The projects include initiatives such as the **Nhambita Community Carbon Project**, around Gorongosa National Park, part of the voluntary carbon market, implemented by a private company Envirotrade[55]. This project promotes forest plantations in agroforestry systems and compensates participating communities by paying carbon credits as inventive for them not to cut trees and discourage them from entering the charcoal business. The other initiative is the **Mecuburi community forest project**, implemented jointly by the Nampula Provincial Forest Service (SPFFB) and a national NGO, Forum Terra, with the main objective to promote alternative land and forest resource use activities to avoid deforestation, including conversion of forests to agriculture and charcoal making.

Finland is supporting a 5-years forestry program (**APRONAF/SUNAFOP**) that started in 2009. The programme provides both national level and geographically focused support, where provinces of Cabo Delgado, Niassa, Nampula and Zambezia are involved. The duration of the programme is five years and it is concentrated on three dimensions: 1) Institutional support and good governance, 2) Forest utilization, industrial development and improved business environment and 3) Community based natural resource management. In regard to CBNRM it is foreseen to pave the way for a harmonic co-existence between large scale plantation investors and members of local communities by engendering partnerships through promoting out-grower / tree farmer schemes. In addition communities are reactivated in natural resource management initiatives in selected forest reserves.

JICA is providing a capacity building support on management of forest information in the framework of the REDD process.

6.2.2 Large-scale forest plantations

Norwegian forestry group **Green Resources** and Portuguese paper producer **Portucel** have started on eucalyptus plantations, investments each worth more than $2.2 billion covering a total of 250,000 hectares. The **Global Solidarity Forest Fund**, run by churches in Norway and Sweden, holds around 23,000 hectares for pine and eucalyptus in a similar program. There are many studies claiming that the projects have drawn the ire of local communities who sometimes claim they were never consulted, and of activists who fear the consequences of replacing natural forests with commercial plantations of pine and eucalyptus (cf. chapter 4.2.1.2.)

Green Resources intends to plant eucalyptus trees for industrial purposes across large swathes in Nampula. According to Government officials, USD 209 million will be spent on the eucalyptus plantation itself, and another USD 2 billion on a pellet factory in Nacala, and other industrial infrastructure. The project is expected to create 10,000 jobs currently 1200 peoples are hired to prepare the plantation sites. A World Bank study considers these mega investments as growth poles —where out grower schemes could be developed as major sources of employment [56]. Furthermore Green Resources has received a EUR 2.4 million renewable energy grant from the European Development Fund's ACP-EU Energy Facility for a project on Sustainable Wood and Charcoal Production in Rural Mozambique and Tanzania. Green Resources will use the fund to build two methane-free charcoal factories. The project involves establishing 4,000 hectares of fuelwood plantations with 2,000 farmers and two methane-free pyrolysis bio-carbon (charcoal) plants producing 7,500 tonnes of charcoal

per year, one in each country. The objective is to increase access to modern, affordable and sustainable energy services for rural and peri-urban poor by focusing on renewable energy solutions as well as on energy efficiency.

The major constraints faced by investors are reported to be related with access to land and to problems in establishing relationships with local communities. Also the lack of standards regarding environmental mitigation measures (with monoculture), increased transaction costs and slow investment processes are factors of hindrance.

5.2.3.1. Improved stoves project implemented by UEM 2000-2005

Under support provided by the Danish government, the Ministry of Energy together with UEM have attempted to develop a massive nationwide effort to set up artisanal manufactures of cook stoves in key locations where demand was considered to be high. Teams from UEM conducted short-term training in portable clay stoves and kiln production. The initiative gained some momentum and until 2007 there were groups of artisans trying to make a living out of cook stove production. Despite the glitz and publicity which this one-off initiative had, a close examination of this project shows some of the reasons behind its failure.

The project encompassed a very short training of people, some of them without prior know-how of clay works. Furthermore, the project was very much focused on skills transfer and production of stoves, ignoring other parts of the value-chain, namely, the market. This was, ultimately, the reason behind the collapse of the initiative, as producers were pilling stocks of stoves which could not sell. Also, people did not quite understand that the idea behind the project was to set up commercial producers of stoves. As with many other government interventions, some people saw this initiative as a relief or donor-led project, one that would hand out free stoves for the community. Another aspect which was ill-conceived had to do with the lack of continuous support and backstopping of the learning process people were undergoing. The end result is that today there is very little people still actively involved in the business of stove production in those locations were UEM trained people.

Some other experiences with cookstoves in Mozambique, were linked to ProBEC, which always tried to mainstream the stove business into other organizations, such as KULIMA in Maputo, Gaza and Inhambane, ADEL-Sofala in Sofala, ASDELO, ADEM and CarboN Checkers in Manica as well as, World Vision and Heifer International in Nampula.

5.2.3..2. Charcoal potential in Southern Africa Research Project_Mozambique

The project was implemented by Forestry Department at the Faculty of Agriculture and Forestry at Eduardo Mondlane University from 1999 to 2001, funded by the European Union (INCO-DC). The aim of the project was to link ecological, social and environmental aspects of charcoal production and use. It focused specifically on the charcoal production, its implication to forest regeneration and degradation, the actors, the costs, the types of fuel used in towns, and in what quantities were important questions for those concerned with the sustainability of forests resources.

The study has been conducted in Maputo city due to the fact of being the main urban consumer of wood fuels in Mozambique. The detailed study area was Matutuine district due to be the main charcoal supplier to Maputo and Matola city, having biodiversity value, and availability of baseline data (forest inventories, community management area). Major conclusions were the following:

- The degradation and fragmentation of forests and the predominance of thickets and woody grasslands in Maputo province has been seen as consequence of charcoal production, agriculture encroachment and frequent fires occurrence;
- The charcoal production has also increased the radius of influence: in the 80's it was recorded as been produced from areas located within 50-60 km from Maputo, in the 90's firewood and charcoal was coming from the natural forests located within a radius of 60-100 Km from the capital city and actual reports states that charcoal is being brought from railway line from distances as far as 600 km (e.g. Beira, Inhambane and Sofala);
- Charcoal production is characterized by a "clear felling system", where almost all species are used for charcoal production;
- The choice of location of charcoal production areas is determined by the occurrence of accessible roads and desired tree sizes;

- Charcoal makers in areas with abundant forest resources operate on a shifting charcoal production areas model similarly to agriculture shifting cultivation; and
- The efficiency of traditional kilns was found to be in the range of 14 – 20%

5.2.3.3. The Program for Biomass Energy Conservation in SADC (ProBEC)

The program was launched in Mozambique in 1999 through SADC Regional Program and funded by the German Government (GTZ). ProBEC operated in 8 SADC countries amongst them Mozambique. The program focus was provision of basic energy for poor people with emphasis on biomass energy. The program duration was about 10 years and its focus has been on contributing to the sustainable use of Biomass energy through promotion of improved cooking stoves in Manica and Sofala provinces. Through the program evaluation there was seen that the improved cooking stoves was widely adopted by communities due to its comparative advantages in terms of energy efficiency, reduction of fuelwood consumption, reduction of pollution and associated health improvements. The ProBEC (Programme for Biomass Energy and Conservation) was a SADC regional programme implemented by the German Agency for Technical Co-operation (GTZ, now GIZ) in 9 SADC countries**.** This chapter of the BEST report tells, in a nutshell, the history of ProBEC, with specific areas of focus being:

a) History of the ProBEC programme in Mozambique;
b) Technologies promoted;
c) Results and impacts;
d) Lessons learned;
e) Conclusions and recommendations.

ProBEC started its operations in Mozambique in 2000. In the beginning, the focus of ProBEC was to promote co-ordination amongst the different Ministries dealing with biomass, as well as information sharing and capacity building amongst energy officers in the Ministry of Energy. There were 4 distinct phases of ProBEC in Mozambique:

- 2000 to 2005 focus on sectoral co-ordination amongst biomass stakeholders (Energy, Forests and Environment); first pilots of improved cook stoves in Maputo and Manica.
- 2006 to 2008, mass production of fix mud stoves and portable clay stoves in Manica. Initial trials for the Maputo charcoal stove, later named POCA stove.
- 2009 to 2010, mass production of portable clay stoves and expansion of the program into Gaza, Maputo, Inhambane, Sofala and Nampula, on top of Manica.
- 2009 to 2010, Introduction in the marketplace of the prototype of the POCA stove.
- Beginning of work on a regional sustainability criteria for biofuels produced in Africa;
- Beginning of work around the Clean Development Mechanism and submission of the PIN at the DNA (National Designate Authority).

Over the course of the 10 years ProBEC the following technologies were promoted in Mozambique: Portable clay stoves; Fix mud stoves; Bakery ovens; POCA charcoal stove; and Institutional rocket stoves.

Lessons Learned are the following:

- Given the fact that ProBEC started with a very strong presence and visibility of the donor, GTZ, beneficiaries and stakeholders always identified ProBEC as a German product and thus, struggled to take ownership of what, otherwise, was intended to be a truly SADC regional project for the people of the member states.
- Communication of the project goals and strategy for implementing was a problem. This problem left people guessing as to what the goals of the project were. The problem was enhanced by the fact that ProBEC changed radically its strategy, half-way trough project implementation, changing from a pure self-help approach into a commercial one.
- Negotiation with target groups and stakeholders was, also, poorly done. This is perhaps one of the most striking findings we have to highlight and one that GTZ, now GIZ, has been progressively trying to improve. GTZ conceived the project to a very high and detailed level, drawing on a wide range of resources and information. However, the aspect which was neglected was the pre-consultation of

intended beneficiaries on how they saw the process of changing their cooking practices. This explains, to some extent, the resistance which some people showed to change when presented with innovations and radical proposals for their cooking habits.

- ProBEC focused almost entirely on production of good, improved cooking devices. This was done in detriment of marketing and promotion. Therefore, it was not at all unusual to see communities where stocks of stoves in storage were high and little movement was seen in terms of buyers for those stoves.
- Because ProBEC had to work with the Ministry of Energy, a healthy relationship had to be forged with the counterpart. This stems from the fact that any ProBEC activity had to be in line with the national biomass policy and the priorities set forth by government for the biomass sector. In Mozambique, the relationship with the counterpart only became smooth when ProBEC decided to set up a National Co-ordination office and full operational staff on the ground.

Conclusions

-Access to affordable, reliable and sustainable household energy in Mozambique in a medium-term cannot be guaranteed without biomass at the centre of the supply jigsaw. The reasoning here is simple. The country is well endowed with various types of energy resources: Coal, LNG, Hydro, Solar, etc. However, a simple cost analysis of what it takes to develop those types of energy and what it takes to modernize biomass energy shows that biomass is much more affordable, cleaner and sustainable due to its renewable nature. ProBEC was the first attempt, ever, to come up with cheap and affordable solutions for cooking energy. There is still a long way to go in this respect and government must act now.

5.2.3..4. Bio Gas, Briquettes

Experience with use of Biogas and Briquettes in Mozambique is very limited. Up to present, there have been only a handful pilot and experimental projects which tried to implement these technologies.

With regards to biogas, within the auspices of the Ministry of Energy, DNER installed a bio-digester in the district of Magude in 2008. This was aimed at serving as a pilot project which would tap into the huge potential in terms of manure availability presented by the relatively high stocks of livestock that is typical in that part of the country. The experience with this project was short-lived and the biogas plant quickly came to a halt because of the lack of feedstock. The project has, since, been abandoned and the equipment is idling in Magude. FUNAE also tried to venture into this field trough the installation of a bio-digester in Boane district. Again, this location was chosen due to the huge potential presented by the availability of large chunks of feedstock. The success of this initiative is also quite limited, as there has not been a replication of the technology elsewhere in the country.

Regarding briquettes, DNER tried to develop a pilot project for the Maputo periphery, including the boroughs of Luis Cabral and Xipamanine. Here too, the logic was that being Maputo a big demand area, this briquette solution would fit very well into the efforts to provide more affordable biomass solutions to the growing Maputo charcoal consumer base and surroundings. Unfortunately, the planning behind this initiative was not properly done and the end result was that a machine was bought and no feedstock is being sourced for briquette production.

6.3 Lessons learned from past and current energy programs

Even though the legal regime for CBNRM can be seen as advanced, a major outstanding problem relates to its implementation. Sustainable forest management plans and practices are often completely undermined because of poor governance of the forest service: weak skills, poor supervision, corruption and a lack of transparency and accountability offering no incentives. In addition, many potentially viable initiatives were not consistently supported by donor agencies and/or NGOs and government in order to reach sustainability (technical, financial and institutional) levels [57]. As a result there is apparent failure in this approach. This failure is also associated with the productivity and value of the resources devolved to communities, entrepreneurship and business management skills and level of support provided. While community participation led to visible contribution to improvement of the management practices and conservation of biodiversity, there were no equally measurable and substantial economic benefits. If tax returns to communities would be substantially increased CBNRM could certainly be revitalized.

Investment environment and opportunities are better in forest plantations than in native forest management. Mozambique is taking substantial steps in plantation development. Currently forest plantations have a clearly defined strategic role in country's development plans and the investment environment is positive – the national afforestation strategy and the aforementioned projects are a sign of this.

From the past implemented projects regarding biomass energy use and management there were general lessons documented such as:

- Improve the regulation dealing with management and use of forest resources according to its specific needs
- Integrated action planning and management across sectors dealing with biomass energy
- Need for involvement and motivation of local communities (example: Licuti) in the project and activities and promote their ownership, through local empowerment programs
- Understand the local context, for instance consider the role of the local administrative authorities in the local development as they have much more power than outsiders
- Knowledge at community level should be improved in issues related to sustainable resource use, for instance for charcoal productions, where the majority of local communities produces charcoal without following the legal procedures established for charcoal licensing
- Increase the extension of areas under proper management and control is needed to ensure vast forest areas to provide the resources needed
- Systematic and transparent monitoring system of fuel woods value chain and control system regarding species selection, sizes and appropriate cutting cycles is needed for effective control of resource use; independent verification might be useful
- There is a need of shifting from low efficient charcoal production system to modern and clean. As efficient energy use and improved kilns as usually seen as alternative to reduce the impact of charcoal production in the native forests
- Incentives needed to be given to stimulate investment in sustainable management as no price difference is obtained from unsustainable and sustainable production areas
- Improved stoves will be bought and used if their performance is superior; need independent tests to establish performance against set criteria.
- Awareness campaign is useful to disseminate the various interventions to all.

6.4 Stakeholder consultations

The GIZ funded AMES project graciously agreed to discuss these problem statements in the districts as follows: a total of 23 districts including the provincial capitals in the central region (Manica, Sofala, Tete and Zambezia); 18 districts in the north (Nampula, Niassa and Cabo Delgado), and 14 district in the South (Maputo, Gaza and Inhambane). This work started in October 2012 and was completed in November. An overview of the reported issues as well as reported solutions is found in the next 2 tables.

Table 42: : Issues highlighted during the stakeholder consultations

Province	Manica					Sofala					Zambezia					Tete			Total
City/District / Issues/Problems	Chimoio	Gondola	Sussundenga	Bárue	Manica	Beira	Dondo	Buzi	Nhamatanda	Gorongosa	Namacurra	Nicoadala	Mocuba	Lugela	Quelimane	Changara	Moatize	Tete	
Weak law enforcement/ supervision	X		X	X	X	X	X		X	X	X	X	X	X	X		X	X	15

Regulatory framework not applied/publicly known	X	X		X	X	X		X						X	X		X	X	10
Deforestation /Woodfuel shortage	X				X			X	X	X		X	X	X			X	X	10
Lack SFM/forest replacement		X	X	X	X	X			X				X		X		X		9
Frequent fires (hunting, agriculture)		X		X		X	X	X		X	X			X	X				9
Illegal logging	X			X		X		X							X			X	6
Weak management committees					X	X		X		X							X	X	6
Climate change impact is perceptible		X	X		X			X		X					X				6
Inefficient charcoal technology		X				X	X			X					X	X			6
Livelihood/ subsistence product			X	X				X				X						X	5
Inefficient end-use technology (stoves)					X			X	X		X								4
Livelihood/subsist ence product			X	X								X						X	4
Tax/levy evasion	X	X	X																3
Agricultural land acquisition							X					X		X					3
Loss of revenues government/ community					X		X												2
Lack of inter-sectoral collaboration			X	X															2

The issues are ordered according to reported priority: the issues mentioned first have been mentioned the most. It is more than clear that the regulatory framework and the lack of law enforcement are of primary concern to the people in the districts – in all districts. They also feel deforestation, although this may also reflect the fact that the resources in their immediate surroundings are disappearing, and that they do not benefit much from this. As an example, the following quote is obtained from the stakeholder consultation:

Access to trees is easier for third parties who make use of this asset for commercial purposes, than for the actual tree owners, i.e. the population living in the proximity of the resource. Communities are unable of employing sustainable management procedures for trees that are located in their land, as this is not permitted. The current market price for wood fuel includes the cost for collection, conversion, transportation and trade, but not the cost for wood or coal production. Wood fuel resulting from sustainable forest management will have to compete with wood fuel obtained from overexploitation in open access areas. As a result of the low prices for wood fuel peasants tend to convert their woodlands into more profitable land for agricultural activities. Identified impacts include deforestation and degradation. This does not produce any sort of incentive for the communities to invest in sustainable management measures for their forests; the present licensing system for wood exploration does not

encourage this. The 20% rule is not applied in an efficient manner due to lack of forest control measures and law enforcement.

Table 43: Solutions mentioned

Province	Manica					Sofala					Zambezia					Tete			
City/District / Solutions	Chimoio	Gondola	Sussundenga	Bárue	Manica	Beira	Dondo	Buzi	Nhamatanda	Gorongosa	Namacurra	Nicoadala	Mocuba	Lugela	Quelimane	Changara	Moatize	Tete	Total
Support reforestation programmes	X	X	X	X		X		X	X	X	X		X	X	X		X	X	14
Improve regulatory framework	X	X	X	X	X	X		X		X	X	X		X	X				12
Improve control and supervision		X	X	X	X	X		X		X		X		X	X				10
Provision of seedlings/set-up of nurseries	X			X	X			X		X	X		X		X		X		9
Awareness creation (fire, deforestation etc.)		X	X		X	X	X	X			X	X			X				9
Improved stoves dissemination	X	X	X		X	X	X	X							X				8
Improve revenue collection					X	X		X		X									4
Support to management committees		X	X	X		X				X				X	X				7
Enhance SFM through communities	X		X	X		X			X	X					X				7
Woodfuels supply master plan	X			X	X	X			X										5
Intensification of agricultural management				X		X	X												3
Improve honey production			X	X				X											3
Support alternative livelihood systems								X							X	X			3
Improved kiln dissemination						X									X				2
Enhance public private partnerships						X										X			2
Improve sector coordination						X													1

The proposed solutions follow the identified issues of regulatory and law enforcement, which were felt as the highest priority. Nevertheless, it is remarkable that forestry related suggestions are deemed of high importance as well, such as support for reforestation and issuance of seedlings, despite the regulatory issues. Another quote by the stakeholders is the following:

Solution

- *Local communities must become the title-holders of forest resources contained in their land, and must boast additional responsibilities and benefits. Responsibilities should involve sustainable resource management, and benefits should include land owners becoming the main beneficiaries of physical products deriving from such resources;*
- *The increase of return tax, from 20% to 80%, for populations that employ sustainable management procedures, as compensation for the transfer of responsibilities;*
- *Introduction of a separate taxation system that incorporates substantial surcharges in relation to wood fuel from unregulated / unsustainable sources, concurrently defending the rights of communities that deal with forests in a sustainable manner;*
- *Introduction of a transparent law enforcement system for widespread and effective application of a separate taxation system.*
- *Disclosure of legislation and community rights, at community level;*
- *Clear definition of each stakeholder's responsibility in the value chain of natural resource +(e.g. biomass);*
- *Clarification as to the allocation of the 20% for local community benefit;*
- *Introduction of an environmental book-keeping system as a form of promoting natural resources (e.g. biomass) when used by third parties.*

A full-scale report on the stakeholder consultations will be issued by AMES[57].

[57] Processo de elaboração da estratégia nacional de energia de biomassa (best); resultados da auscultação best – região centro; Feedback das auscultações sobre a estratégia de energia de biomassa (best) na região norte – províncias de nampula, niassa e cabo delgado

7 Identified Key Issues

7.1 Institutional constraints at the national, provincial, and local level

Although wood-fuels provide the biggest portion of domestic energy needs the GoM principally centers its energy policy dialogue on electricity access and generation. A case study from South Africa revealed that the potential benefits to be gained from displacing woodfuel by electricity is not realized [58]. Likewise a World Bank initiated evaluation in regard to impacts of rural electrification shows that in average **less than one percent** of rural households connected to the grid in the countries studied use electricity for cooking [59]. This will certainly also hold true for Mozambique. Consequently the GoM would be well advised to give **woody biomass a higher priority on the national energy policy agenda.**

Shaping woodfuel policies presupposes reliable baseline information as a precondition for rational decisions. To date these data are merely non-existent neither on the supply nor on the consumption side. Hence none of the concerned ministries disposes of coherent implementation strategies from national level downwards.

Additional information on the woodfuel value chain in the different provinces is needed as well as **thorough inter-ministerial policy coordination** so as to design a combination of clear rules, transparent enforcement, strong incentives and awareness-creation/capacity development.

To date there are only isolated interventions (e.g. by FUNAE) largely dependent on donor support without attaining a critical mass to achieving tangible impacts. Furthermore, governments at the provincial and district levels are not prepared to ensure adequate law enforcement and provision of services due to the limited numbers and qualifications of personnel, lack of transport, poor communication equipment, and a shortage of funds. Communities are left alone in organizing themselves as the support from NGOs entirely depends on respective foreign funding which seem to progressively decreasing.

On local level there is still a weak progress in assigning and delimiting land to communities [60]. Many communities are still ill equipped to deal with the government. Adequate negotiation power is missing and funds for NGOs to act as facilitators are lacking. Hence local communities are not able to meet the requirements on their own stipulated in the regulation (set up management committees, bank account). The coordination and sharing of responsibilities, as well as costs between facilitators (NGO's) and State agents to support the devolvement process leaves room for improvement.

7.2 Lack of forest governance to exercise law enforcement

Corruption is one of the biggest problems to the development of Mozambique as a whole and to the forest sector in particular. Mozambique ranks 120th out of 182 assessed countries worldwide and 24th out of 48 countries in the Sub-Saharan Africa region in Transparency International's Corruption Perceptions Index for 2011 [61]. During the regional workshops -conducted by the BEST team- the issue of corruption has been evoked several times and identified as a major constraint specifically affecting the natural resource management sector as it is associated with natural resource depletion and environmental degradation, while reducing revenues that could be used for improved forest management. Moreover, poor and irregular salaries (around 80 USD/month), bad working conditions and lack of transport erode the forest service's capacity and invite extortion, fraud and corruption (sidestepping regulations, irregular issuing of permits, obstruction of punishment, etc.). Policy makers in Maputo seem to be well aware of this situation but are not willing/able to induce a change. The result is a bustling underground economy of the charcoal sector obstructing a desired formalization of the woodfuel chain.

As development is an outcome of efficient institutions rather than the other way round, the challenge will be to tackle weak forest governance (including abuse of authority, corruption etc.) as the focus of political reform. Additional support and funds may seem necessary to this end. On the other hand, one should bear in mind that a functioning and efficient tax collection system would already mobilize substantial capital for investment.

7.3 High prices for most alternative fuels, low incomes for most households

As described in Chapter 3.4, non-biomass energy is more expensive than biomass-based energy with the exception of electricity: LPG and kerosene are more convenient than charcoal and firewood, but more expensive as well. Low income households will therefore use biomass energy by preference. Although prices pose a problem for many households given their income levels, the real issues are of a different magnitude:

- low biomass energy prices also imply that users have little incentive to use it efficiently
- the production of any alternatives fuels may not be viable
- low financial returns for the wood producer do not promote better management of existing forestry resources

In other words, because the price of biomass energy is so low, it is very difficult to develop alternatives.

7.4 No biomass-based alternative fuels available

For the reasons aforementioned, it is difficult for alternative biomass-based fuels to be competitive: the production cost of these alternative fuels is higher than the retail price of biomass fuels. Therefore, the production process is not viable unless subsidized, or households decide that they are willing to pay more for a superior fuel (as they do with LPG). Currently there is some commercial production of alternative fuels in Mozambique, but all is export oriented. The price of energy in other countries (particularly Europe) is much higher, which makes the production viable even though transport costs are incurred. In addition, carbon finances play a determining role in these processes as well, although Mozambique hardly benefits from this as most of the benefits will flow to the European partners.

7.4.1 Mozambique Biofuels

Several studies developed over the last decade have shown that Mozambique has ideal conditions for the development of biofuels. A wide range of factors has contributed to Mozambique being categorized as one of the best countries for biofuels development in Africa. Among those factors are:

- Land availability (between 10 and 38 M hectares of arable land are thought to be readily available);
- Water availability;
- Favourable climate and weather conditions;
- Cheap labour;
- The majority of the population living in rural areas and already having agriculture habits, a factor which may prove important for rural development trough biofuels out-grower schemes;
- Huge dependence on fuel imports, hence, the opportunity to off-set the respective costs;

A serious strategy to develop both large and small-scale Biofuels could go a long way in helping Mozambique decrease petroleum products dependence and increase energy security. Energy access and security is often referred as the main goal of energy policy in Mozambique. Although traditional biomass sources such as, wood and charcoal are the most accessed and used energy sources in Mozambique, petroleum products play an increasingly crucial role in the energy matrix of the country.

It estimated that over 11% of Mozambique's fuel is imported and, more importantly, the money spent on these imports constitutes over 15% of the nation's total GDP, which makes the country vulnerable to fluctuating fuel prices. According to one study, Mozambique could produce up to 6.7 EJ of bioenergy a year, contrasting with the 0.18 EJ of energy Mozambique consumes per year.

Therefore, even if the current efforts for developing a biofuels industry are somehow executed in a phased manner, in a medium-term there could be a good chance of output exceeding national consumption with domestically produced biofuels and, thus, contributing to the international biofuels market. Developments in the EU linked to emissions reductions and the need for biofuels use to be increased, present a unique opportunity to countries like Mozambique from an export point of view. This can further enhanced by preferential trade agreements under EU-ACP schemes or the North American AGOA scheme.

7.4.2 The institutional arrangements to boost the supply side

It was not until 2006 that the Mozambican government seriously discovered its potential for biofuels and

started working on the supply side of that value-chain. The Ministry of Energy and the Ministry of Agriculture share responsibility for actual management of biofuels in Mozambique and the Ministry of Environment completes this tri-partite structure. This stems from the fact that the Ministry of Energy addresses demand issues, the Ministry of Agriculture deals will supply and the Ministry of Environment with sustainability. The Ministries of Finance and the Ministry of Planning and Development have, also, a modest say in this complex jigsaw.

As WWF Mozambique states in one of its research papers, the institutional arrangement is of paramount importance given the complexities the biofuels value-chain. Any biofuels initiative means that many resources are likely to be impacted on, positively or otherwise. The following may or may not be subject to changes: land, biodiversity, conservation areas, food, water, environmental impacts of the processes of production of raw materials, processing and transportation, creation of employment and even, socio-economic cohesion due to need for resettlement of communities among others.

Some milestones in the evolution of the biofuels sector in Mozambique are:

- In 2004, Mozambique's President declares that the country should be a biofuels exporting country and that wide scale plantations of Jatropha Curcas should take place in all unused land.
- From 2004 to 2006, Jatropha Curcas seeds were distributed on a wide scale, however, no follow-up with technical assistance was done, no market development and no setting-up of processing facilities for biodiesel occurred.
- In 2005, an inter-ministerial working group, which was tasked with accompanying developments of the biofuels sector, was set up.
- In 2007, a sub-group was set up to develop the sustainability for biofuels production.
- 2008 saw a wide range of activities being carried out in the biofuels sector. These activities encompassed, amongst others, the following:
    - Biofuels assessment by EconEnergy;
    - Agro-ecological zooning: 1 to 1.000.000 scale;
    - Beginning of development of the Mozambican sustainability criteria;
- In 2009, the Mozambican Biofuels Strategy was approved

7.4.3 Blending, commercial production, distribution and export to external market

The ministry of energy has been engaged in the process of defining the blending levels for Mozambican-produced biofuels. This exercise was meant to lead to the introduction of mandatory blending levels in the country from 2012 onwards. The government defined the following timescale for the roll-out of the Mozambican biofuels programme: and the GoM's phased mandatory blending

- Pilot Phase (2009-2015)–increase the level of blending up to 10% ethanol (E10) and 5% of biodiesel (B5);
- Operational Phase(2015-2021)-E10B5 available nationwide with possible increase up toE20 e B20;
- Expansion Phase (from 2021) : development of parallel distribution network for blending aboveE75-E100 e B100;

The implementation of mandatory blending levels for the Mozambican fuel industry assumed enough production would take place in the fields. However, a closer analysis of the different projects earmarked for the country presents a more gloomy picture of this in reality. In fact, there is very little, if any, large-scale production of biofuels taking place in Mozambique today. Apparently, the global financial meltdown, which hit global economies in the last few years, played a role in holding back the interest of some investors in developing biofuels in Mozambique. This has, in turn, created a problem for the Mozambican government, as without feedstock, there is no way how the mandatory blends can be implemented. The end result has been to postpone indefinitely the rolling out of the blending regulations.

When it comes to actual production and distribution of biofuels, the prospects for a quick development of the sector are presently inevitably linked to the sugar mills. The government has decided that in order to avoid a conflict food vs. fuel, the only crops which can be authorized for biofuels production are: Jatropha Curcas and Coconut for biodiesel and Sugar Cane and Sweet Sorghum for bio-ethanol. Mozambique boasts a big sugar industry.

However, up to present, the sugar mills have, either shown no interest in Biofuels or have, simply, explored co-generation solutions solely for their own consumption. Provided a business case can be demonstrated to these sugar estates, ethanol could be produced in the short term. The picture with biodiesel is quite different, as there is no organized industrial groups currently looking at bio-diesel from Coconut or Jatropha Curcas. Nevertheless, we think that biodiesel production can be structured into small-scale community or small-enterprise production.

7.4.4 Barriers which can prevent a take-off of the biofuels industry and hinder any export drive to SADC, EU, USA

As stated above, there is *not enough feedstock* at the moment to enable industrial production of biofuels in the country. Furthermore, the government's decision to restrict crops permissible for biofuels production to Coconut, Jatropha Curcas, Sugarcane and Sweet Sorghum, reduced the array of options of investors.

Competition concerns arising out of the role government gives to Petromoc S.A. and EDM S.A. It was the intention of the GoM when the Biofuels strategy was approved, to transform the state-owned fuel company, Petromoc, into a champion for Biofuels development and distribution in the country. Despite some pilot initiatives that took place from 2009 to this date, Petromoc so far failed to develop any Biofuels project of a sizable nature. As far as distribution is concerned, one has to note that currently EDM has the exclusive rights to distribute power in the country.

- Example of a business environment not conducive to biofuels development is the case of Tongaat Hulletts Xinavane sugar mill. This company has the capacity of producing biofuels and from sugar cane and electricity through co-generation. Under the current regulatory environment, produced ethanol would have to be sold to Petromoc (or to one of the private fuel companies) for blending and distribution through the existing filling stations. However, Petromoc is not yet ready to embark on this task.
- As far as electricity is concerned, the sugar mill would have, necessarily, to sell it to EDM. Given the lack of competition in the transport and distribution of power, EDM can, effectively, dictate the price it wants for buying power produced from co-generation. Xinavane sugar mill is discouraged from selling power to EDM at present because the price offered is not attractive enough.

Lack of clear direction and drivers of a SADC common biofuels market. The above example of non-liberalized energy markets, leads to the issue that calls for an urgent need for a regional strategy for the biofuels sector. The strategy must be a bankable one, as this is the only way in which countries in SADC can pave the way for the development of an industry that could herald socio-economic benefits for the SADC region, from a macro and micro-perspectives.

Sustainability criteria in the EU. In November 2008, Mozambique and seven other countries protested vehemently against what they saw as an "unjustifiably complex EU sustainability criteria" for biofuels production. In fact, a close examination of the EU, Dutch or British sustainability criteria show that unless Mozambique complies with a very stringent set of rules, its biofuels cannot be exported to Europe. Thus, while some of the requirements are quite justifiable, it is noted that, unless technical assistance is provided, many developing nations will not be able to comply with those rules.

Subsidies for biofuels producers in Europe and the USA are controversial issues that surfaced in the last ten years. The issue matters, only, insofar as it impacts on international trade and the ability of developing countries to export biofuels to the EU at competitive prices. Many independent researchers seem to agree that subsidies in the EU make exports from non-EU much more expensive. In the end, this is a political question that developing countries should discuss at the highest level with the EU and the USA.

7.4.5 Conclusion

Biodiesel industry development prospects are currently negative in Mozambique; there is very little know-how available amongst farmers, markets are underdeveloped, private sector does not seem to be interested in stepping into the sector due to political uncertainty (tax, legal, technical specifications, etc.). Any significant future development of the biodiesel sector will, certainly, require government intervention in terms of creating a favorable environment and empowering small and medium enterprises as well as, communities, NGO's and

associations which can play a pivotal role in supporting small-scale community processing of biodiesel for agriculture machinery, factories and district or village power generators.

Good prospects for bio-ethanol production exist, as the basic infrastructure for sugarcane production and processing is already installed in in at least 5 millers nationwide (Maragra, Xinavane, Mafambisse, Marromeu and Buzi). These positive prospects are very much linked to the big sugarcane industry scattered around the country. The millers do seem to realize the potential that presents to them the production of bio-ethanol and power from co-generation. However, the considerations made above with regards to an enabling business environment for biodiesel production (which at the moment doesn't exist) also apply here.

Another aspect that can be misleading is the *real* land availability. Despite the glaring numbers showing between 10 and 38 million hectares of arable land, one notes that the outcome of the zooning exercise showed that only about 7 million hectares were deemed to be available for new projects. This is not a reflection of massive agricultural activities are taking place in around 31 million hectares, but rather a reflection of the fact that much of the land is already under title. Deeds have indeed been awarded to people, who use it for speculative purposes, and no activity is taking place on the land. So, investors might be surprised to realize that their options in terms of land availability are not so great.

Biofuels production in Mozambique should primarily be promoted to supply the internal and regional markets (SADC), and only used for export as a second priority. There is a genuine business case for this, given the geographical situation of the country and the inter-dependence that exists between Mozambique and countries such as Botswana, DRC, Malawi, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. The investment landscape is now riff with foreign companies, mainly from the EU. These companies all want to produce biofuels to export to premium markets.

What is more worrying, is the fact all these companies aim to export the raw commodity and process the final product in Europe. If this happens, it is quite clear that Mozambique loses out in this equation, as the added-value will be made at the place of processing and not here. Therefore, it is crucial that the government uses its powers to convince investors to produce, process and sell at least part of those biofuels in Mozambique or in SADC. This is possible if government decides to embark on a serious mission to create an enabling environment, accompanied by investment in the development of an efficient market and basic infrastructure to support this emerging industry. This is quite similar to what is needed to transform the solid fuel biomass energy sector from a traditional into a modern sector.

In November 2011, Bank of America Merrill Lynch provided significant upfront carbon financing to CleanStar Mozambique to help unlock additional equity and debt for the scale up of their business. CleanStar Mozambique has established a pilot factory in Dondo (Beira) using 60 t/d excess cassava to produce 3 t/d ethanol[58]. The cassava is supplied through an outgrower supply scheme. Eventually it intends to produce ethanol at a level of 20,000 m3/yr, mainly for sale in Maputo. It has arranged for a local stove production facility to be set up as well. The pilot plant was inaugurated in May 2012 by the Minister of Agriculture, and initial interest from consumers is high. The cost-structure of the fuel is not disclosed, so it is impossible to determine whether or not the plant can be viable. However, users seem to be satisfied with the use of this new fuel.

7.5 Inefficient Charcoal Value Chain

Details of the charcoal supply chain are presented in Chapter 3.7. The value chain is inefficient due to the informal nature of the business, the low prices for producers and end-users, and corruption. If the sector were modernized, a more efficient supply chain would be the result, with potentially lower supply costs as a consequence. A modernization of the sector would yield higher returns to wood owners and charcoal producers, eliminate fraud, and increase the sustainability of the resource.

[58] By law it is officially prohibited to produce fuel from food crops, except for coconut, sweet sorghum and sugarcane.

7.6 High degree of unregulated timber extraction

There are around 180 timber concessions in the country of which only 110 have management plans as required by law. Only three companies are FSC certified. The total land area under the concessions is approximately 6.2 million ha [62]. Although MINAG maintains that the current logging level is less than the annual allowable cut, the General Inspection of Finance (IGF) estimates that one-third has to be considered as illegal. China's demand for timber is apparently also the most important driver of illegal logging. Its role in illegal logging in Zambézia province has been extensively documented [34].

The following evidences of illegal practice have been identified by Mackenzie (2006)[34] and presents a critical governance question:

- Systematic under reporting of the volume of logs. Standard log weights and volumes are being used on export data which are far below the actual weights.
- There is a significant difference between timber export statistics returned by the different government agencies.
- There is inconsistency in the type of data presented by the different government agencies, making cross checking difficult.
- Much more timber is actually being loaded in the harbors than being reported to the authorities

However, in can be noted that in terms of round wood equivalent and value charcoal is currently the most important resource extracted from the forests.

8 Elements of a Biomass Energy Strategy

8.1 Getting green – the modernization approach

8.1.1 Rational for modernizing the biomass value chain

As shown in the previous chapter, wood-energy has a great social, economic and environmental importance in Mozambique and significantly contributes to the Mozambican economy. Sustainable production of wood-fuels can serve as an engine for sustainable rural development. Forest resources are locally available and display a high potential for decentralized processing and production. Utilization of wood-fuels allows short transport distances with low environmental risks. Unlike other, more technologically demanding energy sources, wood-based fuels generate employment and local income especially for poor or disadvantaged and generally unskilled segments of Mozambique's society.

Wood-fuels and especially charcoal are versatile and display a high potential for technological innovation in terms of enhanced conversion and combustion. Most of these technologies are already commercially available today, while others are still at a stage of development and demonstration. They offer possibilities for more far-reaching technical innovation (e.g. briquetting, chips, pellets), depending on the availability of investment capital. Strategic interventions geared towards promoting enabling framework conditions thus create business opportunities for a wide range of service providers, and foster local employment and income.

Figure 32: Wood pellets and wood chips as modern biomass solutions

Using charcoal can systematically create incentives for landowners and farmers to manage woodlands better, and to invest into fuelwood plantations. Sustainable production of charcoal thus helps to safeguard forests and woodlands along with their multiple functions, including soil conservation, biodiversity and landscape protection, or carbon sequestration. The production of charcoal is ideally suited for community-based management of forests and woodlands, and thus supports general trends towards deregulation and privatization of the energy and forest sectors.

Additionally, sustainably sourced wood-fuels contribute to carbon-neutral energy supplies, thus taking a key role for implementing low-carbon growth strategies and a "green economy". In addition locally produced wood-fuels help to reduce dependency on finite fossil fuels. Aside from direct efficiency gains through innovation, promotion of wood-based fuels likewise offers indirect benefits, such as foreign-currency savings and reduced economic dependency of the countries involved.

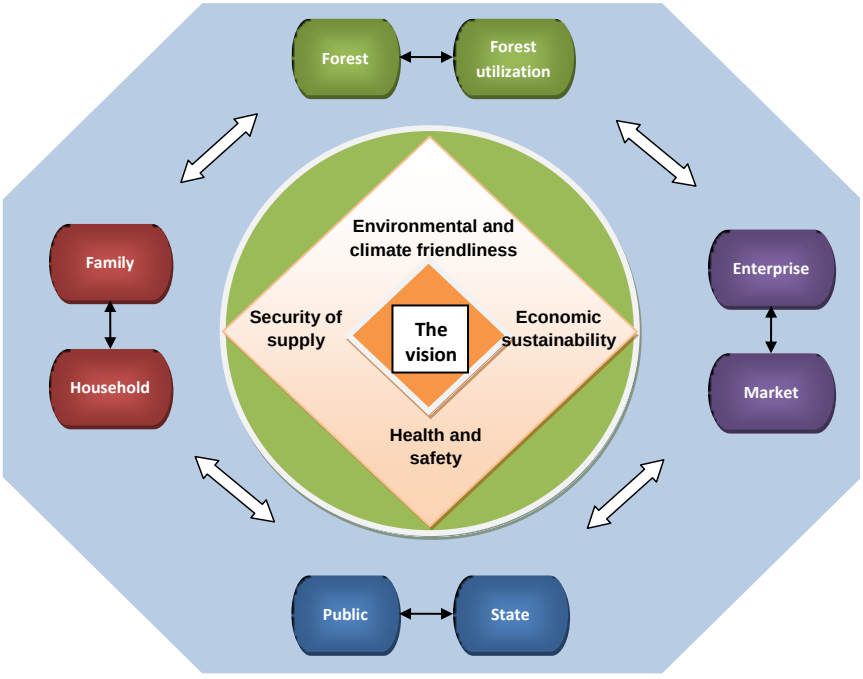
The modernization of wood-fuel value chains and in particular the introduction of efficient combustion technologies contributes in a significant manner to reduce long-term respiratory health problems and deaths linked with indoor pollution.

There is a well-established link between household energy and MDGs with measures for increasing sustainable biomass production and improving cooking technology both cited as being MDG consistent targets. Freeing up time and lessening drudgery can allow more time to engage in income-generating activities while increased employment in the biomass sector can provide poverty relief to numerous households and helping in achieving poverty reduction targets. The availability of affordable cooking fuels and better cooking efficiency can help to reduce hunger while lower time pressure on children to collect fuels has potential to increase possibilities for higher school enrollment and better education. Enabling productive work that is primarily undertaken by women can contribute to greater gender equality by reducing time and effort required for women and young girls to gather solid fuels. Reducing indoor air pollution (IAP) can lead to improving health outcomes for those exposed to IAP, with a particularly important objective to reduce child mortality [63].

8.1.2 The vision statement

All activities within the modernization process should address four basic principles: (1) Economic development and efficiency, (2) environmental and climate friendliness, (3) security of supply, and (4) health and safety requirements. Figure 33 illustrates the vision elements and its interrelationships.

Figure 33: The vision and its interrelationships



These principles apply to the nexus of forest resources' availability, forest use patterns, rights and obligations existing between the different entities, and the exchange of products and services. The challenge during the implementation of a modernized wood energy value chain will be to reorganize these linkages so as to comply with the principles.

The modernization of the charcoal sector requires a consensual vision statement of all relevant government authorities on promoting sustainable charcoal production. To this end a vision statement has been presented

at the BEST Inception workshop in July 2011, amended by stakeholders and reads as follows:

Box 4: Biomass Energy Vision in Mozambique

Biomass energy development will contribute in a number of ways to the economy: (i) improve energy security; (ii) poverty alleviation; (iii) maintain current levels of forestry resources through sustainable and efficient management of natural biomass resources; and (iv) will adhere to the health and safety standards of the country. Wood energy will be used as long as demanded by the population. It is the cheapest and most durable form of energy as long as the supply remains sustainable, i.e., firewood and charcoal comes from managed wood resources. It is therefore necessary that legislative, regulatory, and fiscal measures are put in place to ensure a fully sustainable management of forests, leading to a durable supply of wood (and wood energy). The local population plays a key role in managing and controlling the forest resources, maximizing their inputs and profits. Alternative and efficient forms of energy will be available to the population on a commercial basis while it is understood that - although these are more comfortable - , they will also be more expensive. The vision can only be reached if a holistic approach is used, i.e. regulatory intervention goes hand in hand with demand- and supply side improvements.

An alternative and shortened vision statement is the following: “Access to sustainable, affordable and clean woodfuel energy for all households, institutions and private sector by 2025, based on sustainably managed forest resources and alternative fuels and thus contributing to the growth of regional economy and the improvement of the living standards”. This vision statement is in line with all government policies and strategies listed in chapter 5.

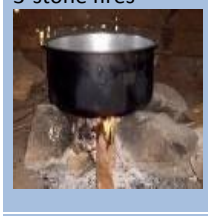
To become effective, the vision statement must be main-streamed into the technical service-culture from central to local level. Policy makers are responsible for communicating the vision regularly, creating pilot projects that illustrate the vision, setting short-term objectives compatible with the vision, as well as encouraging others to craft their own personal perception compatible with the overall vision.

8.1.3 Stepwise into the future

The modernization of the charcoal value chain entails a stepwise process (cf. Table 44), which requires a continuous refinement and/or adaptation of respective framework conditions, organizational and procedural aspects, and technological development.

Table 44: Comparison of different stages of modernizing the wood-fuel production chain

Characteristics	Traditional Phase	Transition Phase	Semi-industrial Phase	Industrial Phase
Supply chain	informal	informal/ formal	formal	formal
Planning of wood-fuel supply	no planning	wood-fuel supply schemes	regional energy master plans	integrated energy planning
Type of management	open access	open access/ sustainable	sustainable/ certified	certified
Type of exploitation	uncontrolled	semi-organized (rural wood-fuel markets)	organized (wood-fuel markets)	out-grower scheme/ energy-contracting
Products	fuelwood/ charcoal	charcoal	charcoal, wood chips	charcoal, wood chips
Conversion technologies for thermal energy	traditional kilns 	improved kilns 	semi-industrial kilns 	industrial kilns 

Characteristics	Traditional Phase	Transition Phase	Semi-industrial Phase	Industrial Phase
Efficiency	8 to 12 %	12 to 18%	18 to 24%	>24%
Emissions (g per kg charcoal produced)	CO2: 450 to 550 CH4: ~ 700 CO: 450 to 650			CO2:~400 CH4: ~50 CO: ~160
Wood-fuel price	X	X+20%	X+40%	X +60%
Combustion technologies	3-stone fires 	improved stoves (first generation) 	improved stoves (second generation) 	stoves of high efficiency 
Efficiency	8 to 12 %	20 to 25%	25 to 35%	>35%
Particulate matter per m3	2800 ppm	1700 ppm	<1000 ppm	< 250 ppm
Type of energy	thermal energy	thermal energy	thermal energy, electric energy	thermal energy, electric energy, chemical energy
Type of conversion	combustion	combustion	combustion gasification	combustion gasification liquefaction

Source: [64]

Whereas political will is pivotal to the modernization of the wood-fuel sector, the shift from traditional fuelwood consumption to a modern, "industrialized" wood based energy supply likewise depends on economic development, specifically: the per capita GDP purchasing power parity. This calls for a step-wise development. As it evolves from a transition phase, the charcoal supply chain is continuously formalized into a (semi-) industrial state characterized by sustainable, affordable, and clean wood-based energy production. Mozambique has the advantage that through the various foreign investments in plantation forestry the industrial phase will be practiced side by side with the traditional phase. This gives leeway for synergies which have to be enforced through governmental directives.

8.2 Greening the biomass energy value chain

The interventions proposed in the following sections aim to contribute to a modernization of the wood-energy sector in Mozambique. Anyhow, the interventions focus on the supply and demand of wood-based biomass, sourced through management of natural forests or plantations, or harvested from ToF.

Nearly all recommendations intend to enhance the development of advanced, decentralized, community-based, integrated rural energy industries that are formal, economically viable, and environmentally friendly. Since the environmental and social impacts of woody biomass production, trade and consumption are extensive and intertwined the issues in the woodfuel sector need to be addressed in a holistic manner, looking beyond a single intervention along the value chain. Isolated interventions will fail to exploit adequately possible synergies that would, if combined, make them sustainable.

The recommendations refer to five basic avenues of intervention: (1) improving framework conditions (2) sustainable wood energy production (3) modernizing exploitation, transformation and commercialization (4) improvement of combustion technologies and (5) access to alternative energy carriers.

Assisting local actors to introduce efficient production options, conversion or combustion technologies calls for two basic modes of support: (1) Knowledge transfer and (2) technology transfer. However, these two issues will only deploy significant impact when the framework conditions are adapted.

It has to be summarized, that nothing presented here, is in any way novel or revolutionary and most "building blocks" draw on experiences in the country or abroad. The recommendations thus deliberately abstains from any attempt to "reinvent the wheel" instead, **the challenge lies in speeding up the development of the biomass energy sector by a holistic approach and in putting it on sound footing**.

8.3 Guiding principles

The following guiding principles form the basis of the Strategy:

a) **Carrots as well as sticks:** Incentives for sound behaviour are considered more workable and effective than regulation based on enforced control. In other words, measures that reward sustainable practice are in general preferred over those that penalise poor practice. Incentives, subsidies and market-driven mechanisms for encouraging sound and sustainable supply chains are likely to be more effective and implementable than the imposition of financial or other penalties, although well-designed taxation systems can be a useful complementary tool if the right institutional mechanisms are in place to ensure enforcement, enabling revenue to be returned to communities at source and providing incentives for more sustainable behaviour.

b) **Decentralisation of responsibilities and benefits**: Most natural resources are controlled, officially or unofficially, by the communities who live close to them, yet most of the benefits currently accrue to outsiders who have no responsibility for maintaining the resource base. Improving the sustainability of biomass production requires community-based management systems that bring tangible benefits to those communities in return for sustainable management of the resources in their surroundings. A shift from open-access towards sustainable forest management by local people with security of tenure should be actively pursued.

c) **Private sector leadership:** The responsibility for managing natural wood resources is officially in public hands, although it has effectively been in private hands for a long time. This is causing friction between government and private actors which is not conducive to sound management of the resource base. The charcoal trade is a good example, since it is unclear whether charcoal production and sale is legal or illegal, meaning that producers, transporters and retailers are harassed - and respond accordingly. Given that the woodfuels sector is made up of numerous commercial supply chains and consumption centres that operate fully in the private sector, the private sector should be assigned the leading role in measures to improve the sustainability of supply and efficiency of end-use. The government has a role to play in providing the necessary legal and regulatory environment, with NGOs providing information and technical assistance.

d) **Realistic expectations:** The government has been expecting that electricity will be the panacea for Mozambique's energy problems. However, the real cost of electricity supply is much higher than the current tariff so cooking with electricity will in future be more expensive than cooking with woodfuels. The required electricity generation capacity for significant expansion of supply is also lacking. It is therefore unrealistic to assume that a large switch-over will take place. Wood, meanwhile, is an indigenous resource, conditionally renewable, that can be produced with local skills and is not subject to OPEC or SADC policies that are beyond Mozambique's control.

e) **More economically sustainable energy pricing:** Wood prices would be higher than they are now if they included full replacement and management costs. Electricity prices are also too low and, with every unit sold, EDM loses money. This does not favor proper management of the electricity infrastructure. Mechanisms are required to ensure that energy prices more closely reflect their true economic cost. In the woodfuels sector this would open the door for private sector investment in a business which is currently unattractive due to the under-pricing of competing products.

8.4 Description of building blocks of the biomass strategy

8.4.1 Improving framework conditions

8.4.1.1 Shape provincial "biomass road maps" and woodfuels supply master plans

Given that charcoal production is, by definition, a local/regional business, it is advisable **to translate the recommendations of this BEST into provincial "biomass roadmaps"**. Any centralized planning – from the

national level downwards – would remain too abstract, too time-consuming, and less efficient besides. The **provincial roadmaps** comprise the design of operational action-plans with clearly assigned roles and mandates, impact-oriented results and corresponding provisions for monitoring and evaluation, and resource allocation. Building a roadmap above all is a consultation & learning process. It benefits greatly from institutionalised stakeholder participation in terms of more cost-effective and less conflict-prone implementation, and more sustainable impact. To this end, additional data on the woodfuel value chain will have to be collected so as to provide target oriented entry-points and to ensure a holistic approach. These roadmaps should comprise clear guidelines in regard to modernization and be **complemented by so called woodfuels supply master plans (WSMPs)** for priority areas where demand is already in excess of sustainable supply, or will be in the near future. This applies primarily to provinces with urban catchment areas such as Maputo, Beira, Nampula and Quelimane.

The WSMP design for urban catchment areas will require setting of agreed priority guidelines for the organization, regulation (location, quotas, and specifications) and monitoring of commercial firewood and charcoal production.

The WSMP development process should include:

- an update of the tree cover inventory;
- identification and classification of commercial harvesting zones as “green”, “orange” and “red”, to indicate the sustainability of supply;
- assessment of accessible woodfuel resources by zone;
- projections of demand from cities and rural areas for woodfuels, timber and other wood products;
- analysis of charcoal flows, including imports from Mozambique and Zambia;
- development of conditions and technical specifications for sustainable charcoal production (simplified rules for forest / customary land /plantation/woodlot management and exploitation such as simplified cutting permits, plus identification of required investments);
- definition of clear rules for sharing of responsibilities and coordination between FD staff and communities with regard to forest / customary land and plantation co-management and exploitation; and
- synthesis of all information into the design of the WSMP; implementation will be by catchment area at district and village level.

The expected results will be:

- a reliable, accurate and updated forest resource inventory and demand assessment for wood products in current and potential urban supply areas;
- simple methodologies and tools for each step of WSMP design, including tools for developing plans for community forest area management;
- training of national and local staff and community members to apply these methodologies and tools; and
- increased engagement of FD personnel with villages managing wood resources, woodlot owners and charcoalers, in the organisation of charcoal production and supply channels.

Furthermore, land-use planning at the regional and community level will be particularly important for the implementation of the forest management and reforestation activities. It is the most appropriate level to ensure complementarity between different sectoral programs (forestry, agriculture, infrastructure, mining etc.) and to determine optimal land-use and serve as plans for investments and development within each region or a community.

8.4.1.2 Fiscal & Regulatory measures

A modern, competitive and efficient biomass value chain can only be developed through effective collaboration of stakeholders and an enabling policy environment that reinforces success factors and removes adverse incentives. It should be kept in mind that in farmers view, trees are just like any other agricultural crop: if profitability decreases, the trees will be replaced in favor of some other crops which are supposedly perceived as more economic by the farmer. Intrinsic values often highlighted by intellectuals on international conferences such as biodiversity, carbon sequestration, recreation, aesthetics, clean air etc. will not feed the families in rural areas.

Excessive bureaucracy and overstretched administrative requirements increase transaction costs and carry the risk of forcing the charcoal business into illegality. In this context, the introduction of a **simplified forestry**

taxation system raised on resource owner (community) level could be a step forward. This would be similar to any other good commercialized (e.g. the gas cylinder at the service station).

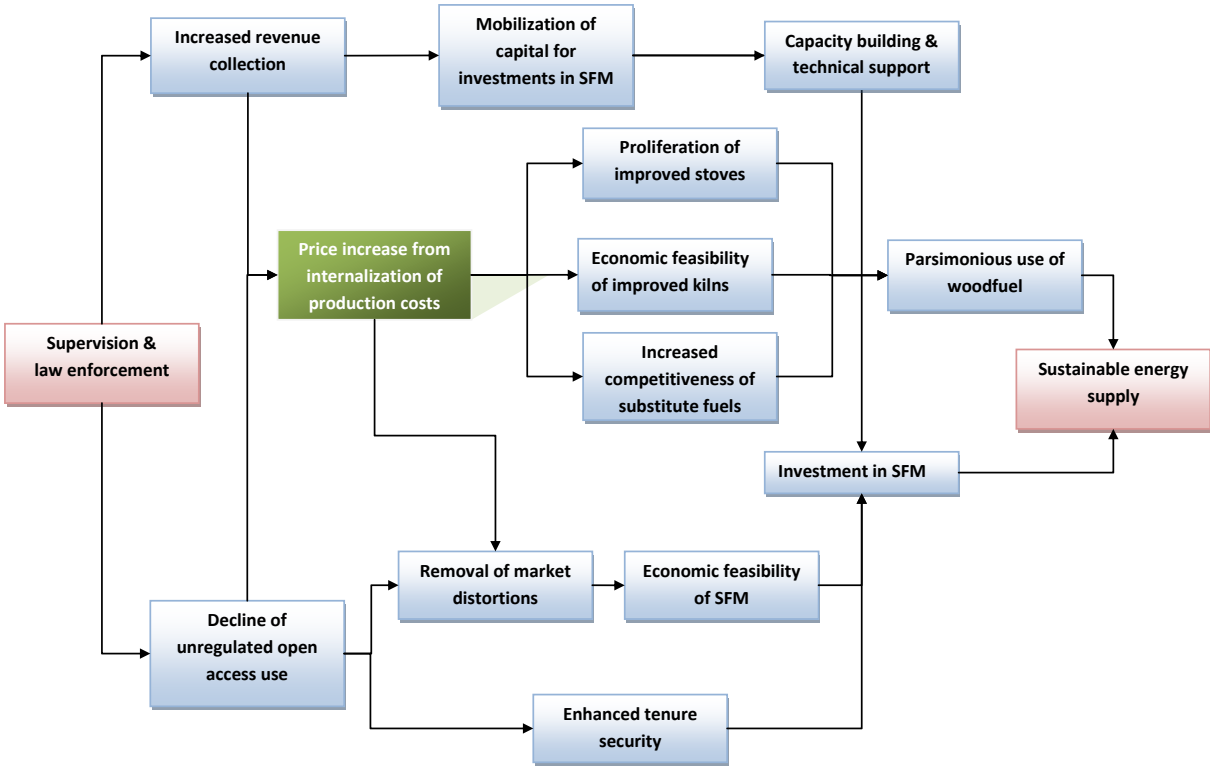
As part of the rationalization of the woody biomass sector, the GoM has to change the existing tax structure on wood fuels. Tax for wood fuel will have to be levied at source meaning on community level and paid by transporters, replacing all existing cutting permits and wood fuel taxes.

This **tax structure is critical to BEST success** as it influences and interacts with all other components of a sustainable woodfuel supply strategy.

If it is properly implemented, it will be an effective management tool to provide incentives to most stakeholders to use scarce resources more efficiently. The user fee is primarily to facilitate natural resource management, reflecting cost of control and management of the resources.

Supervision and law enforcement are major driving forces that influence and interact with all other components of a sustainable woodfuel supply strategy (cf. Figure 34). Improving supervision and law enforcement should lead to a series of reactions: (i) increased revenue collection and (ii) decline of unregulated open access use, which then lead to (iii) a price increase for woodfuel, as merchants are forced to add forest replacement taxes to the consumer price. In return, the price increase should provide incentives for counter-action: (a) investments in sustainable forest management as well as forest plantations; (b) adoption of improved kilns; (c) proliferation of improved stoves; and (d) increased competitiveness of substitute fuels.

Figure 34: Impact chain of supervision and law enforcement measures in sustainable forest management



Source: [65]

This requires the introduction of a differentiated taxation scheme, and presupposes efficient tax collection primarily on the transport of woodfuel. Only wood-based fuels sourced from open access areas should be taxed. In contrast, communities and/or farmers who engage in sustainable management on their own land would have to remain exempted or at least considerably free from taxation (or similar disincentives). Furthermore, sustainably managed woodfuels need to be certified by proof of origin (coupon system on the basis of sustainable exploitation quota). Policy formulation and design of regulatory instruments remain ineffective unless backed up by strong institutions capable of law enforcement. Community based approach depend on transparent fulfillment of management contracts, protection of tenure rights, and road checks of woodfuel transport on the main entry roads to urban areas. Enforcement capacity also depends on

professional skills, equipment, and institutional integrity. Unless staff are internally monitored and paid competitive salaries, the systems described are susceptible to corruption and abuse.

In addition to a more responsible and efficient resource use, "true" producer prices for wood-based fuels would yield the following additional benefits: (i) highlighting the status of tree resources as a renewable, climate friendly resource; (ii) revenue generation that creates space for strategic investment (e.g., to modernize/formalize the woodfuel sector); (iii) rural employment; and (iv) foreign exchange savings .

Differential taxation serves to (i) channel back 90 percent of tax revenues to communities and local management structures (LMS), and (ii) discourage unregulated exploitation of open-access areas by means of a surcharge (double tax rate). Illegal logging and tax evasion carries a fourfold surcharge plus additional fines, and strict control/law enforcement (at city-limit checkpoints) ensured operation of the system.

Table 45: Proposed distribution of tax proceeds per sack of charcoal (in Mt)

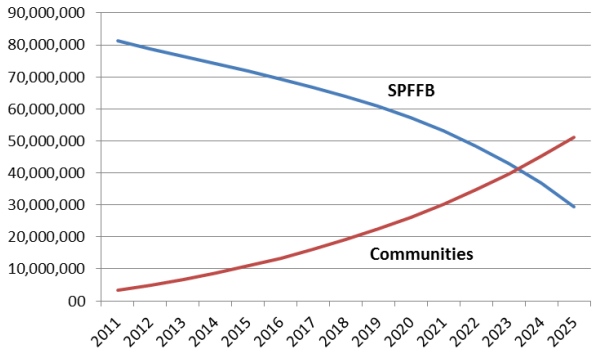
Beneficiaries	Sustainably managed	Open access	Illegal exploitation
SPFFB	2	40	80
LMS	10		
Community	8		
Total	**20**	**40**	**80**

Assuming that the GoM would agree to introduce professional law enforcement measures and the proposed distribution of tax proceeds (cf. Table 45) on a pilot basis e.g. in the Nampula province, the BEST team simulated the tax returns for the SPFFB and the communities for the period 2011 to 2025 by making following assumptions:

	Unit	2011	2025
Productive forest cover	'000 ha	2,369	1,617
Urban population	'000	1,369	2,543
Urban charcoal demand	'000 sacks	2,623	4,874
Source of wood supply			
• **Sustainably managed**		10%	83%
• **Open access**		70%	16%
• **Illegal exploitation**		20%	1%

Assuming that through law enforcement in average 70% of the charcoal flux can be controlled the tax revenues in the first year would amount to 81 million Mt. Assuming that the initial costs for infrastructure, training, anti-corruption measures etc. are born by technical assistance the amount of taxes perceived would by far cover the running costs for the law enforcement units leaving room for substantial investments in supporting communities to undertake sustainable forest management. However, as sustainable forest management is gaining more ground, tax revenues will show a contrary development (cf. Figure 35). Communities will continuously benefit for their services in sustainable forest management at the expense of tax revenues for the SPFFB.

Figure 35: Simulation of tax returns (in Mt) as result of increased law enforcement and sustainable forest management (Nampula example)



However, this trend announces a turning point from exploitative to sustainable forest management.

8.4.1.3 Enhance capacity building for supervision and law enforcement

Whilst the policy and regulatory frameworks for CBNRM has been substantially improved, the issue of law enforcement tends to by conspicuously neglected by the GoM. Likewise, donor supported projects mostly sideline this issue in favor of either policy support, or the promotion of community based strategies and/or the dissemination of improved stove technologies.

Despite growing scarcity, woodfuel generally remains underpriced, relative to its "true" economic value. Market prices reflect opportunity costs and expected profits of freight haulers and retailers involved in the wood-fuel business, with no regard for replacement costs or the legitimate claims of people living within or adjacent to forests and woodlands. The experiences in Mozambique clearly demonstrate that underpricing leads to wasteful and inefficient production and consumption, and creates a formidable disincentive for forest management and tree growing. Additionally, isolated projects aiming to disseminate improved stove further reinforce the widespread perception among consumers that woodfuel was indeed a cheap energy resource – and thus inadvertently engender wasteful use. As shown in the previous chapter supervision and law enforcement are major driving forces which influence and interact with all other components of a sustainable woodfuel supply strategy. This includes enhanced transparency and accountability as preconditions of legal security, as well as raising the overall credibility of forest service involved in woodfuel sector governance. Capacity development therefore needs to reach out to the institutional framework, including police and legal services, with targeted support in the following respects:

- Awareness building, so as to sensitize law enforcement agencies for the risks and potential damage associated with unregulated exploitation of forests and woodlands,
- Anti-corruption training
- Training and extension in regard to land rights, forest laws, detection of violations etc.,
- Clarification and subsequent establishment of proof of origin systems for sustainably sourced wood-based fuels, as well as differentiated taxation schemes to levy surcharges on wood-fuel produced from unregulated open-access areas,
- Improvement/simplification of penal procedures, so as to speed up prosecution and punishment of violators,
- Clarification of roles and mandates in the exercise of legal authority (rights of arrest, search and seizure, collection of fines etc.), so as to enhance transparency and accountability of law enforcement,
- Monitoring and supervision of the community forest management plans and related advisory services.

8.4.2 Increasing the supply of sustainable woodfuels

8.4.2.1 Introduction

The underlying idea behind an increase in the sustainable supply of woodfuels is professionalisation of the entire supply chain, from local communities managing their natural resources and private farmers growing trees, via charcoalers who cut trees and make charcoal, to transporters who bring woodfuels to the market. This is a process that has started by itself but needs to be nurtured and accelerated through better regulation.

Formalization and professionalization of the supply chain will result in greater incentives for growing wood, for making charcoal and for transporting woodfuels. This will be achieved through efficiency improvements from source to customer, with more professional actors working under a more rational system of economic incentives. Examples of such professionalization of the charcoal supply chain can, amongst other countries, be found in Senegal and Chad, albeit the latter operating for a limited time only due to significant political interference.

- Senegal modernized its charcoal supply chain through the Sustainable and Participatory Energy Management Project, from community-managed forests through modern supply channels and more efficient end-user equipment [65].
- In Chad, the Household Energy Project showed that modernization of the supply chain could provide incentives at all levels: at community level, transportation level and end-user level [66]. The Ministry of Finance was also satisfied because of considerably increased tax revenues. The activity ultimately failed because of its own success: the organizational structure put in place was too strong to be influenced by political processes, making it worrisome for the country's leaders who set out to destroy it. For around four years, however, professionalization of the supply chain demonstrated its merits.

Woodfuels – and especially charcoal - can be seen simply as commodities, produced on private land, customary land or community- or state-managed plantations or forests. The managers of this resource can maximize the returns on their investments to produce the commodity for profit, just as farmers do when growing tobacco.

Managing existing stands or planting new trees can provide environmental and other benefits, such as reducing wind and water erosion, lowering evapotranspiration rates, recycling nutrients, controlling the flow of water into streams, sustaining biodiversity and increasing carbon sequestration. Some of these are of national benefit and others of global value. The various tree planting and management initiatives should therefore have both national and international backing. The Clinton-Hunter Foundation is already operationalizing the globalization concept, planting trees for carbon sequestration using financial incentives from UK sources.

The following four sub-components have been identified to increase the sustainable supply of woodfuels, through a more professional functioning of the supply chain:

a) Devolving rights of forest management to local communities
b) Creation of wood lot plantations - from crop to energy farmer
c) Trees outside Forests –Agroforestry

8.4.2.2 Devolving rights of forest management to local communities

Open access to natural resources carries the risk of unsustainable overexploitation (the "tragedy of the commons"). By contrast, sustainable forest management presupposes clear and secure long-term forest tenure ("property rights") as reflected in all CBNRM approaches cited. Once a community is registered as sustainably managing their forests, outsiders are barred from uncontrolled exploitation. Up-scaling of CBNRM approaches is therefore urgently needed to reduce the size of open access areas and to achieve a critical mass of sustainably managed forest areas.

The concept of CBNRM transfers the management responsibilities for woodfuel production to local authorities. They conclude a contract with the forest service clearly defining rights and obligations and effectively restricting free access by outside loggers and traders. Village communities are bound to organize a management committee as their representative body, and to apply sustainable management techniques. In return, interested villagers create user groups and are entitled to harvest and sell the forest products for their own benefit. A service contract between the user groups and the forest management committee specifies harvesting area, standards and the quota. From the turnover of the woodfuel sale the forest user groups are bound to pay taxes to the community. One part of the taxes is used to promote investments in social infrastructure (schools, water points, basic health centers etc.) the other has to be transferred to the forest service.

Simple forest management plans are central to the success of CBNRM approaches (cf. Box 5). Through the implementation of the plan, the CBNRM aims to achieve sustainable resource use by balancing the level of extraction with natural re-growth. The plan is also central to the distribution of exploitation rights among community members and the creation of a community fund on the basis of a licensing system.

Box 5: Elements of simple woodfuel management plans

- **Tenure status and location of the forest, boundaries, area, forest type**
- **Block division with details of each block, resource assessment (inventory) including non-wood forest products, maps**
- **Objectives of forest management**
- **Forest management activities: selection of protected areas and areas for regeneration, type of rehabilitation measures (plantation, direct seeding and/or natural regeneration, erosion control) fire protection, surveillance.**
- **Forest exploitation activities: protected species, minimum DBH (Diameter at Breast Height) for cutting per species, cutting cycle, block division for harvest, annual allowable cut (both in areas and volume)**
- **Time schedule for the implementation of forest management**
- **Mutual obligations, penalties and approval.**

With the advent of CBNRM in Mozambique, capacity development of local NGOs has necessarily attracted considerable donor support – even though more emphasis could have been displayed as mentioned in Mozambique CBNRM country profile [41].

For scaling up NGOs have to be capacitated to rapidly build trust with local population and mobilize recipient groups. To this end capacity building of these key partners will have to focus on institutional as well as programmatic capacities. While institutional capacity development should focus on strengthening the capacities for e.g. strategic planning, target setting, financial management, HRD and procurement, programmatic capacity building means to enable key-personnel to conceptualize, and apply development concepts, approaches, methods and tools, including planning, implementation, monitoring and evaluation.

It has to be noted, that investments in CBNRM are only successful if simultaneously an effective control and differential taxation system is put in place to protect and favor communities investing in sustainable forest management.

8.4.2.3 Wood lot plantations - from crop to energy farmer

Planted forests, established through afforestation or reforestation, have a particularly important role to play in providing a renewable and environmentally friendly energy resource if managed responsibly. They can play a very positive role in: (i) providing ecosystem services, such as preventing erosion, protecting soil and water, and storing carbon etc.; (ii) reducing pressure on natural forests; (iii) restoring marginal or degraded land; (iv) providing rural employment and development.

Mozambique has an estimated 7 million ha of land suitable for large-scale plantations. Of this area, 3 million ha have been identified as a national plantation target. Mozambique focusses on large-scale plantations by attracting investments of mostly foreign companies. These large scale plantations are destined for producing wood energy (e.g. pellets) for the export market as it is the case for the "Green Resources Company" in the Nampula region. However, it should be noted, that potential conflicts with the local population are bound to rise in the future. Therefore, it would also be advisable to strengthen local communities to invest in woodlot plantations. The case of Madagascar may be cited as a promising example where tenure rights in respect of marginal public lands have been granted to individuals of local communities for the purpose of creating energy plantations [67]. This GIZ supported project (cf. Box 4) enjoys great popularity and is of tremendous success in regard to poverty alleviation and to enhance regional economy.

Box 6: Example: Individual reforestation scheme - Madagascar

The village-based approach places local people at the center of planning and implementation of plantation management for sustainable charcoal production. It is based on voluntary participation of communities eager to rehabilitate degraded lands by means of voluntary reforestation. As a first step, an afforestation area is identified by the community and legally registered as a "Réserves Foncières pour le Reboisement". A village-based participatory approval process allocates individual woodlots to interested households, along with defined use rights and obligations. Each plot is demarcated, mapped, and documented with the community's approval. Technical assistance is provided by specially trained NGOs. Aside from institutional and technical support, the only substantial external input is mechanized soil preparation. Tractors must be used to break up compact layers in degraded soil, to increase percolation of rainwater and ensure higher survival rates of seedlings. Nursery operation, planting, and maintenance are the plantation owners' responsibilities. An overall GIS-based monitoring system provides data for every plantation plot, including productivity figures, income generated, etc. More than 6000 ha have been planted, providing an annual increase in income of more than 20% for more than 2000 rural households. The monitoring system further revealed that 34% of the poorest and landless people became involved, and 22% of women enrolled as woodlot holders. In addition, the uncontrolled exploitation of natural forests in the vicinity of the villages substantially decreased, as did the incidence of fires. Key elements of the individual reforestation scheme in Madagascar include:

- Limiting afforestation to marginal land (with zero opportunity costs)
- Voluntary decision of community members to participate
- Allocation of responsibilities to all community actors
- Individual ownership of plots and products (secured land/tenure rights)
- Capacity building, creation of rural energy markets
- Monitoring of plantation growth and quality.

Source: [68]

Well acquainted to the Madagascar approach the BEST team undertook an investment calculation by assuming the prevailing cost and price structures and ecological conditions in Mozambique. It was presumed that for the northern provinces a moderate MAI of 10 m^3/ha can be expected and the reforestation costs arising amount to approximately 500 USD per hectare. This leads to an internal rate of return of about 25%. The impact to poverty alleviation is remarkable providing every household with an additional income of 20 to 30% for the

next 28 years (coppicing regime of 7 years with 4 year rotation). Households owing about 5 hectares could make a living from it and thus shifting from crop production to energy production as it is not only the case in Madagascar but also in Rwanda [65]. Decisive are adequate framework conditions and local service providers (e.g. non-governmental organisations and small private businesses) that are able to give professional advice and ongoing support to the relevant target groups.

8.4.2.4 Trees outside Forests –Agroforestry

Trees outside forests (TOFs) include all trees found on non-forest and non-wooded lands, such as agricultural lands, in urban and settlement areas, along roads, in home gardens, in hedgerows, scattered in the landscape and on pasture and rangelands. Most knowledge on TOFs comes from experience in agroforestry[59]. Agroforestry helps farmers create more integrated, diverse, productive, profitable, healthy and sustainable land-use systems. Although TOFs fulfill a multipurpose function, and are part of an integrated land-use system, woodfuel can be a principal product. Farm tree management should be the responsibility of farmers themselves and they should be able to manage the trees in the way they think appropriate, but management advice could be provided through training and at school level for the next generation of farmers. If farmers are capable of cultivating cereals then they should be equally capable of farming trees. If they feel restricted in harvesting what belongs to them, they will certainly not plant more trees.

Improving the woody biomass resource base on or near farms and assisting with agricultural productivity will also increase the supply of residues and dung. It is a win-win situation with several economic and environmental benefits.

Box 7: ToF to rehabilitate fallow land

Production of wood-based fuels can also be promoted as part of systems to rehabilitate fallow land by means of nitrogen-fixing trees. Experience shows that wood can be harvested already after 3-4 years, depending on the circumstances prevailing at a given site. Enough wood can be obtained from one hectare of improved fallow to supply the fuelwood needs of a typical rural household with 6–7 members for 6–8 month.

Source: [69]

Any major expansion of on-farm tree planting should take account of existing systems. Tree planting options include mini-woodlots around or near the homestead on variable rotation from two to ten years or more; single- or double-row hedging around fields and homesteads on a four-year rotation, and pollarding mature trees (10 to 15 years or more) along boundaries and in fields for fodder, poles and fuel. Promotion of tree planting requires providing seedlings to meet the tree planting objectives. However, many trees can be seeded directly. Also, some trees, shrubs and bushes can be propagated from cuttings and cloning, and some can come from digging up wildlings and replanting them on the farm or homestead. In addition, seed multiplication is vital to ensure that certified and superior seeds of the right species are available to farmers. More seeds may be required, particularly of agro-forestry species and fruit trees, if more intensive efforts are to be made to encourage a greater number of trees on farm. Demonstrations should be established countrywide. Through meetings with farmers, such initiatives could be discussed and the modus operandi agreed upon. Farmers may also propose other initiatives. Farmers will have to agree if and where such demonstrations can be sited. It is preferable to have them on farmers' fields.

8.4.3 Modernizing exploitation and transformation of wood-fuels

8.4.3.1 Professionalizing the charcoal value chain

Especially on the level of wood and charcoal producers, the establishment of "business development clusters" should be promoted. Charcoal Producers Association in Sudan, for example, are recognized by the government and can expel members who fail to pay taxes or engage in corruption. In this context, capacity development comprises the strengthening of skills required for product and enterprise development, drafting of business plans, linking charcoal burners to financial markets and to market information. Pertinent market information

[59] Agroforestry is the practice of growing trees and agricultural products on the same piece of ground, and at the same time.

includes not only the prices of fuel wood, charcoal, and transport, but also prices of other wood products as well.

Charcoal burners should be assisted with organizing themselves to have a voice, e.g. by way of an informal national committee; e.g. on a national and at Provincial level the creation of federations of charcoal producers should be promoted. **Via these federations it will be possible to:**

- Formalize the membership and levy membership fees,
- Provide compulsory training in safety and fire prevention for charcoal workers,
- Lobby its members for compliance with labor legislation and environmental recommendations,
- Set up standardized contracts of employment in accordance with the Labor Act and distribute such contracts to producers,
- Arise awareness that charcoal producers should provide each laborer with protective clothing,
- Organize exchange study visits among its members to learn from the best practices,
- Organize training for members as regards the financial and administrative management of a charcoal business.

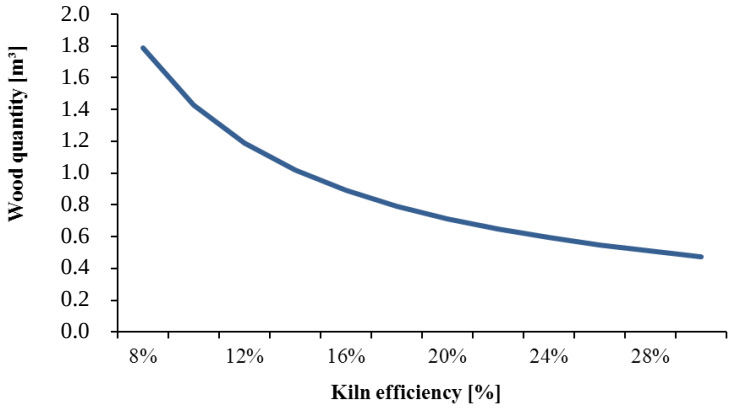
The creation of cooperatives or associations will enforce the negotiation power of charcoal burners vis-à-vis the traders. Finally, due to increasing income, this will open the possibility of direct marketing by purchasing a truck and having contracts with large consumers such as tea factories, bakeries, and brick makers.

8.4.3.2 Improvement of carbonization technologies

Besides organizational improvements and the formalization of charcoal production and marketing, **improved charcoaling technologies are probably the key driving force for the modernization of the charcoal value chain**.

Figure 36 shows the relationship between carbonization efficiency and the amount of wood needed to produce 100 kg of charcoal. The impact of increased efficiency on productivity is non-linear: an efficiency increase of 15 % to 28 % corresponds to a productivity increase of 86 %.

Figure 36: Amount of wood needed to produce 100 kg of charcoal



Source: [70]

In addition, the optimization of carbonization technologies ensures a higher quality of the charcoal produced, but also reduces production times and physical efforts of charcoal burners. Finally, modern carbonization technologies contribute to increased local incomes.

Furthermore, if the entire charcoal chain is reformed in a comprehensive manner, adoption of improved and widely accepted **kiln technologies should be part of revised regulatory frameworks in form of standards for kiln technology to be applied**.

A core challenge when enhancing the kiln technology is that it requires an adaptation of the socio-organizational structure of charcoal production. At present, traditional and improved kilns are constructed on the forest site. When improved kilns with chimney are used, producers need a small chimney that can be easily transported by bicycle or on foot.

Different types of improved kilns have been tested and disseminated throughout Africa, and a wealth of experience and lessons learnt is available for practitioners to draw on. Improved models include non-permanent e.g. Casamance kilns, rectangular kilns using one or two chimneys and stationary brick kilns, as well as transportable metal kilns for more flexible and decentralized charcoal production. Selection of the best suited technologies must, in all cases, reflect ecological as well as socioeconomic site conditions, including availability of investment capital, transport infrastructure, and market access. In average it will be possible to obtain kiln efficiencies of 25 %.

The establishment of semi-industrial or industrial kiln technology depends upon larger-scale private investors. In these cases the wood-sourcing should preferably come through outgrower schemes or other benefit-sharing arrangements allowing the local population to continue earning a steady income through the charcoal sector. In a first attempt it is advisable to test at selected pilot sites the so called Improved Charcoal Production System (ICPS) or “Adam-retort” [71]. This type of kiln has already been demonstrated in Burundi, Kenya, Madagascar, Rwanda, and Senegal. Main features of the ICPS are [72]:

- High economy and better efficiency of approximately 35 % to 45 % (calculated from dry weight),
- Recycling and clean combustion of the pyrolysis gas during the 2nd phase of operation (retort-system) results in a low-emission of carbon monoxides during the charcoal production,
- The effective carbonization of the biomass takes only 10 hours,
- A retort system reduces the emission of harmful volatiles into the atmosphere to about up to 75 % (compared to a traditional kiln),
- Compared to traditional kilns, high investment costs,
- About 3 m³ of biomass (corresponding to approx. 600kg to 900kg wood, coconut shells, compacted saw-dust briquettes, etc., dry weight (moisture not counted), or around 1-1,5 tonnes of wet wood) can be converted to up to 350 kg of charcoal per batch,
- Per week about 3 batches of biomass can be carbonized which is corresponding to about 1 tonne of charcoal per week and unit,
- Only waste wood or residual biomass needs to be burnt (50kg) in a separate fire box to dry and heat the wood and initiate the carbonization process during the 1st phase, after that the process is exothermic and maintains itself without additional energy inputs.

Promoting improved kiln technology requires providing financial resources to potential investors. Due to the increased costs of improved kiln technology, **seed funding in form of “one-time” input subsidies** may be a policy option. If they are applied, however, they should not be a permanent element of any support system. Also, **micro-credit schemes** could provide cooperatives and enterprises or individual producers with the finances needed.

The progressive use of cleaner and more efficient technologies in charcoal production could also have huge health benefits. Air emissions from industrial charcoal production technologies, using batch kilns and continuous operated multiple hearth retorts, are considerably lower. These technologies allow the collection of the gaseous and liquid smoke arising from charcoal production, which can be used as energy source or to increase the efficiency of charcoal production. Unfortunately, these technologies, however, have high initial investment costs.

8.4.3.3 Development of concepts for the grading and packaging of charcoal

A particular problem for the charcoal industry lies in the fact that currently charcoal quality standards in Mozambique are not established through legislative acts and standards. This results in no quality control and consequently, relatively large variation in the quality of charcoal placed on the national market. Furthermore, traders are juggling with the weight of sacks (between 40 to 100kg) to evade tax payments and retailers sell in different container leaving room to cheat the customer.

As long as charcoal is sold by volume modernization implies uniform packaging, so as to comply with tax regulations and providing customers with constant energy content for a certain amount of money paid at the level of retail markets.

In addition, quality grading of charcoal should be sought, as people being economically better off are often willing to pay better prices for premium charcoal.

8.4.3.4 Charcoal briquetting

About 10% of the charcoal stock is being transformed into charcoal dust by the time it reaches the point of sale. Especially at wholesale and retail points charcoal dust accumulates. At the moment, this dust is discarded. Given the high amount of charcoal consumed in Mozambique the potential quantity of charcoal dust only in urban trading sites ranges probably between 200,000 t and 300,000 t. Hence, there is scope for more micro-scale producers to make use of this resource as this dust can be transformed into briquettes by using a binder and compacting[60]. As fuel, charcoal briquettes have higher heating value than wood or plain charcoal. They are almost smokeless when burning and give off intense and steady heat. Briquetting of charcoal dust could be realized directly at production site or - even better - at wood-energy markets in rural and urban areas. Furthermore, there is also room for expansion as there additional feedstock such as coconut, sugar cane, and sawdust available which could be also carbonized and briquetted.

8.4.4 Transport and commercialization of wood-fuels

8.4.4.1 Organization of commercial networks

For the modernization of the charcoal value chain, an end-to-end formalization of commercial circuits is essential. **The creation of a network of rural and urban charcoal markets offers excellent opportunities for the organization of the charcoal sector and assists charcoal burners to obtain better prices**. These charcoal depots have to be managed like micro, small or medium enterprises (MSME) and are subject to standard financial rules.

Centralized rural charcoal depots could be set up in all Districts that produce charcoal and serve as reloading and wholesaling points, formalizing the interactions between transporters, traders and retailers. Systematically, all charcoal producers could bring their charcoal to these centralized depots instead of waiting along the roadside for transporters to sell their products. The spatial distribution of the rural markets depends on the distribution of production sites/forests.

This system was first introduced in the late 1990ies in Niger, Mali and Chad under the title “rural firewood market system”, albeit with different, country-specific approaches (cf. Box 8). Today, Niger and Mali may be regarded as the most advanced examples. Notwithstanding persistent weaknesses in the fiscal, administrative and technical frameworks and lingering corruption, the system is widely regarded as a significant contribution to responsible resource management and pro-poor empowerment, decentralization and good governance.

Box 8: The rural wood-fuel market approach

The rural wood-fuel market approach is a strategy to ensure a sustainable wood-fuel supply in major urban areas. The strategy is based on the establishment of wood-fuel supply master plans that direct and plan forest exploitation by the forest service, in both spatial and quantitative terms, toward priority intervention zones. The strategy’s centerpiece is the devolution of responsibility for forest resource management to rural communities and the introduction of a differential tax system levying substantial additional surcharges on wood-fuel from unregulated or unsustainable sources. The objective is to provide incentives for wood-fuel dealers to go to rural markets and to discourage them from obtaining their supplies from uncontrolled areas. The enforcement of this arrangement requires a strong and efficient control system, which has turned out to be the weakest element of the scheme in locations where it has been tried. This control system relies generally on checking coupons at transport control posts set up on the main entry routes to the urban areas.

Source: [73]

The rural charcoal depots should be organized within a network of several rural depots supplying a network of urban charcoal depots. Urban charcoal depots have to be set up in all district and/or provincial capitals.

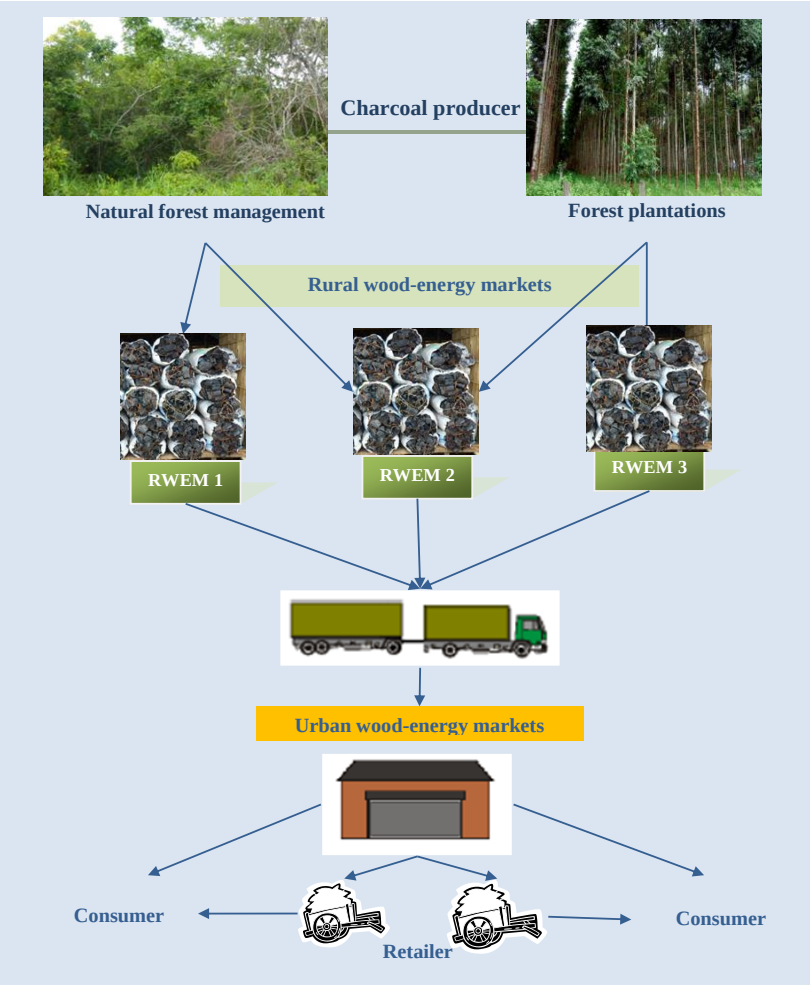
[60] Chardust (www.chardust.com) was the first company in Africa to identify and commercially exploit this resource, and has been in business since 1999 - so the business model is clearly proven. The current production level is around 10 t per day.

Urban depots offer the possibility to centralize the charcoal flows from different Districts or Sectors. Figure 37 gives an idea of the commercial network formed by rural and urban wood-energy markets.

Rural and urban charcoal depots also offer the opportunity for producers to diversify their product lines to target different consumer groups. In the short run, the **charcoal depots could involve into rural and urban wood-energy markets (RWEM and UWEM) offering a variety of "green" energy products from charcoal over fuelwood to ICS**. As already mentioned, a large quantity of small pieces of charcoal accumulates at the wholesale and retail points. Since large volumes of charcoal will be handled at the RWEM/UWEM, the charcoal dust could be transformed on site into briquettes and sold along with charcoal.

In addition, **the development of wood-energy markets will greatly facilitate the control of charcoal flows in Mozambique and help enforce modern licensing and fiscal arrangements**. In this context it will be absolutely necessary to introduce a traceability system to control the source of wood supply (cf. section 8.4.4.2).

Figure 37: Commercial network of rural and urban wood-energy markets



Source: *[70]*

8.4.4.2 Charcoal flow monitoring and control (traceability)

The establishment of a modern, efficient and transparent system for monitoring and controlling charcoal flows is proposed to help enforce the SPFFB, provide reliable and up to date information on charcoal production and supply, and ensure efficient collection of charcoal taxes to increase revenues. The expected results are also regulatory reforms where required, a better understanding of charcoal supply chains and price build-ups, and greater motivation of government personnel responsible for forest management at provincial and district levels.

Modernisation and strengthening of monitoring and control requires:

- improvement of the transport permit system for forest products (new procedure for issuing permits coupled with tax collection, computerised registration and control of transport permits);
- setting up of the control system (construction of checkpoints at city "gates", recruitment and training of control officers); and
- establishment of computerised monitoring of charcoal flows and trade, and related tax revenues, to provide the information required to verify compliance with existing regulations, and redirect the operators if necessary.

Fraud can be combated if the process is transparent: how much charcoal leaves the production zones and how much charcoal is encountered in town. The uniform taxation system may weed out illegal taxes as long as transporters know the rules and report abuse. In other countries, transporters have seen this as an opportunity to avoid paying illegal taxes and most of them have complied with the requirements, after fully understanding the system.

8.4.4.3 Development of a market information system

Information is a critical resource in the operation and management of value chains. Lyrically spoken, it is the tie that connects all links of the value chain and provides for better operation in a competitive environment. Timely availability of relevant information is vital for effective performance of managerial functions such as planning, organizing, leading, and control. But as there are many "small" charcoal producers and less than perfect information for stakeholders in the wood-energy sector, the market is volatile to manipulation and uninformed actions. The participation of charcoal producers in market and transport management is poor. In consequence, most of the time they are being forced to sell their products to middlemen at dumped prices.

This deprivation on part of the charcoal producers may greatly be reduced if they would have been empowered with information on prices and product flows. Timely and unbiased market information will help charcoal or wood-energy producers to bargain with the middlemen for a fair price. In addition to charcoal burners, this information is also important to the wholesalers, retailers, consumers, researchers and policy makers.

In this context, the development of a market information system (MIS) or even a pre-stage of a supply chain management system (SCM) for the wood-energy sector will enable more efficient management of the supply chain by integrating the links of the chain. This includes suppliers, manufacturer, wholesalers, retailers and final customers.

In a first step the focus should be on the development of a MIS centered on flows, quantities and prices of wood-energy and particularly of charcoal. Most existing MIS systems, e.g. for agricultural products, are based on a computer network. However, in general data collection and data access remains a hurdle due to lack of computer maintenance and ICT infrastructure in Mozambique. Compared to a restricted number of PCs in Mozambique, there are now more that 7.2 million mobile-phones in operation. Between 2005 and 2010 the number of mobile-phone users in Mozambique jumped by around 1000 %[74]. Mobiles are increasingly used in rural villages. Mobile phones therefore present an alternative for both data collection and dissemination.

The future wood-energy MIS (WE-MIS) should consider the generally low literacy levels of actors within the charcoal chain, as well as the limitations of the mobile screens and text capacities. A MIS, developed for agricultural products in Bangladesh for example, uses simplified codes for the agricultural produce and market operation. The future WE-MIS could e.g. collect up-to-date market information via cell phone or computer. Market investigators or the manager of rural and urban wood-energy markets collect up-to-date wood-energy prices and quantities and send price information using text messaging over cell phones into a database managed on a SMS server. The server would then be accessible to clients requesting price information for wood-energy products via text messaging. These text messages would both request and receive price information.

The system provides full awareness of all parties of prevailing market prices. The proposed WE-MIS through mobiles will have the following advantages:

- The bargaining position of farmers with traders can be improved.
- Information reduces transaction costs by reducing risks. Farmers or charcoal producers with timely and reliable information and the ability to interpret it can decide which market they should send their produce to maximize returns or, indeed, whether to send their produce to market at all.

- By contributing to more efficient marketing, particularly improved spatial distribution, market information should be beneficial for consumers as well as charcoal producers and traders.
- Such a system would not only be of use to woodlot owners, charcoal producers, wholesaler and retailer, but also to the Government and help to bring the charcoal/wood-energy sector to a more equitable level.
- The WE-MIS will booster rural development due to better functioning markets and more empowered charcoal/wood-energy producers.

8.4.5 Increasing the Efficiency of Energy Use

The justification for energy efficiency is obviously clearer when energy prices are high, but it always makes sense from an economic point of view to use energy efficiently. Particularly low-cost, high-efficiency equipment would appeal to low-income households, who can reduce the burden on their budgets.

The promotion of more efficiency appliances as part of a demand-side management program is proposed for along the following axes:

1. High-efficiency appliances and energy efficiency labeling, for solid fuel as well as electricity and liquid or gaseous fuels
2. Measures targeting commercial and industrial consumers
3. Measures targeting rural customers
4. Measures targeting institutional customers
5. Other complementary actions such as research and capacity building

8.4.5.1 High-efficiency appliances and energy efficiency labeling

Improved charcoal stoves are the main priority in this program. Wood for making charcoal is already the largest commercial use of biomass in the country (excluding timber, which is mainly exported). Any reduction in the use of charcoal will be leveraged through improving charcoal conversion techniques. Modernizing the charcoaling technique will bring further substantial reductions in the use of wood.

Current adoption rates of improved cookstoves are low and could be improved significantly. Moreover, it is not known to what extent existing improved stoves are actually fuel-efficient and reduce fuel consumption in real working conditions over more traditionally used models. Testing standards and labeling should be developed to ensure the enforcement of minimum standards of emissions, safety and efficiency. These standards need to be applied to all imported and locally manufactured stoves, and particularly those that will be supported financially under the dissemination program: charcoal, ethanol, woodfuel and any newly introduced stoves such as those using pellets. Independent testing capacity should be created in the country by setting up a laboratory for the testing of emissions (PM and CO) and fuel efficiency.

The focus of such high efficiency appliances programme would not be a particular model of stove – as is the case now with most stove projects that promote only their stove model - but on all equipment able to carry out the desired task and meeting the earlier defined energy efficiency and emission standards. Manufacturers need to be convinced to produce more energy-efficient models for which, as result of associated promotional activities, market growth can be expected. What is proposed is not another improved stoves programme, but a mechanism to promote the use of higher efficiency equipment similar to that used in the USA and Europe for consumer appliances and cars.

Initial setting of standards for cooking stoves could be expanded to cover electric appliances such as lamps, refrigerators, air conditioners and electric rings and ovens. The efficient equipment could be recognised by a visible energy efficiency label. By setting fuel efficiency standards and promoting the use of labelled equipment that meets or exceeds such standards, consumers could be made aware and possibly convinced to switch to better equipment.

The awareness campaign is needed to inform end-users about the standards, the label and the benefits from switching to using more efficient equipment. The focus should be on the label, which shows that a particular piece of equipment indeed meets transparent minimum standards and can thus be expected to be energy efficient and save the user money.

It will be necessary to assist manufacturers of stoves to understand the need for such a standard and the requirements to produce or import equipment that conforms to these new norms. Although no large changes

are needed, the mechanism put in place will also allow the promotion of much more efficient equipment not yet available in Mozambique. This would be the next generation of improved stoves, such as a gasifier stove or a stove with an in-built fan (e.g. those promoted by Phillips or Bosch-Siemens). Once consumers grasp the idea behind the labeling concept, it is possible that they will understand that much higher efficiencies will be worth the extra investment.

Finally, the standards will need to be enforced or manufacturers will not collaborate. They should be involved from the planning stage so they can provide their inputs in the program. Enforcement should be announced and introduced gradually so that manufacturers have time to prepare themselves.

8.4.5.2 Measures targeting rural customers

Efforts should also be made to scale up the promotion of improved rural woodstoves, but only after independent verification of the results of existing dissemination programs. The stoves promoted should be able to reduce the energy consumption even when used daily in real life.

Rural biomass use is large, but the impact of its consumption on the natural resource base is unclear as rural households are likely to use large amounts of dead wood, trees outside forests and agri-residues. It is also improbable that rural people will invest in a cooking stove when they have hitherto used an open fire, given that they usually source their fuel at low or no financial cost and therefore lack the economic incentive to invest in a fuel-saving device.

Nevertheless, for health reasons it may be worth considering a program to disseminate better rural stoves, subject to the findings of the proposed independent verification of past experiences in this sector. The government may even decide that rural health issues are worth addressing and set aside a provision to support this. FUNAE has always promoted improved stoves, but not yet at a level that it would make a difference nation-wide.

8.4.5.3 Commercial and Institutional Consumers

Institutions and industries use less wood energy overall than all rural households, but due to the concentrated nature of their commercial consumption it may often be more damaging to the environment. Where indigenous trees are being sourced, these commercial supply operations have obvious potential to impact negatively upon the environment. Thus, one reason for pursuing high efficiency solutions for non-household user of biomass energy is the most likely environmental destruction.

Another reason is that these businesses and institutions normally have the financial means to invest somewhat larger amounts of money in such high energy efficiency solutions – even if these are not sold at rock bottom prices. Thus, promoting such equipment for commercial and institutional customers will allow manufacturers and suppliers to create the infrastructure for production and supply of this equipment. Household solutions can then be added at low-costs, which would make equipment available at low prices.

There are opportunities to look both at new efficiency measures and at ways to scale up the adoption of existing fuel-saving technologies (e.g. through credit or subsidy). Large-scale rural wood-consuming institutions and industries can be made aware of the benefits of investing in energy-saving equipment or in a sustainable supply of wood energy.

In the institutional catering sector, fuel efficiency is low and there are opportunities for improvement based on technologies already available in Mozambique (e.g. the ProBEC-promoted institutional rocket stoves, in both brick and metal versions). In addition, biogas installations for agri-businesses, schools and other institutions should be considered. The benefits of these combustion devices go beyond fuel-saving to include better-tasting and more nutritious food, and safer and healthier kitchen environments.

The main bottleneck to wider adoption of these technologies is credit, as the payback period is lengthy and potential institutional or commercial customers generally lack lump-sums of finance for acquisition of capital assets. Repayment schemes could be worked out within their means. The development of workable regulations and conditions for the use of sustainably-sourced woodfuels, targeting mainly commercial and industrial users, will be an important part of the intervention for these users. This would have implications for domestic users, as the uptake on a significant scale among institutional and commercial users will make equipment available at lower costs, to the benefit of households as well.

8.4.5.4 Complementary Actions

A research component will further develop energy-efficient alternatives that are cost-effective and marketable to future users. In particular, the feasibility of more efficient, commercially viable cookstoves could be investigated (e.g. based on the all-metal Lusaka stove or the rocket stove), or "second generation clean cookstoves", as being promoted by the Global Alliance for Clean Cookstoves[61]. The government and its partners (especially ProBEC) have promoted the use of improved biomass cooking stoves, brick charcoal kilns and more efficient tobacco curing/drying technologies for a long time now, and need to reflect on scaling up the effort. Continued research should continue be expanded (e.g. to include simple modifications to earth kilns such as metal covers or chimneys). Many of these industries are in the informal sector and do not have money to undertake research and market promotion for themselves. Government could assist through technical institutes, NGOs and private technical input in looking at ways to promote improved technologies, undertake product testing and field trials, assist manufactures with advice and loans, monitor production quality and undertake research in improving energy efficiency.

For households and institutions alike, complementary actions could be promoted to further reduce the consumption of woodfuels, based on different kitchen practices or equipment. A combination of awareness of these different practices, coupled sometimes with small investments, may lead to considerable fuel savings. An awareness campaign and possibly assisting a firm to start promoting such alternatives will be required. Among the possible ideas to be promoted are:

- the use of pressure cookers, which can speed up the cooking process and reduce fuel consumption for slow-cooking foods such as beans;
- the use of a hay box for cooking beans or boiling rice, which has been piloted by ProBEC and found to have niche application (e.g. for home-based care groups): after bringing the food to a boil, the pan with food is placed in a hay box, a well-insulated box that can be closed off, after which the temperature will remain high for a long time so that the food cooks without using additional energy;
- soaking beans overnight before cooking, which may reduce energy needs by over 30%; and
- the use of a lid (perhaps improvised) on the pan or pot when boiling water, which can similarly save about 30%.

8.4.6 Promotion of innovative financing mechanisms

Whichever ways and means of knowledge and technology transfer are chosen to support the modernization of the charcoal value chain in Mozambique, practical implementation and up-scaling of best practices foremost depends on the availability of funding, and adequate management capacities on all levels. This includes targeted support to market development, investment, and commercialization / formalization of businesses, linked with wood-fuel production chains.

Mozambique's capabilities to mobilize domestic budget-support for the development of a vibrant biomass energy sector are limited and donor support in most cases cannot maintain development processes past the initiation and demonstration stage. Therefore, **innovative funding mechanisms could help to sustain the lasting transition** from an unregulated, non-efficient charcoal value chain towards a modern charcoal sector.

Various global as well as regional initiatives to combat climate change and promote carbon-neutral energy consumption offer considerable potential for the generation of funding for sustainable wood-energy solutions.

The **Clean Development Mechanism** (CDM) under the UNFCCC Kyoto Protocol provides for the establishment of forest plantations with a view to promoting carbon-sequestration and safeguarding sustainable supplies of forest products (CDM-A/R).

In general, afforestation and reforestation measures under the CDM are procedurally challenging, time-consuming and costly, and do not easily lend themselves to small-scale application and flexible integration into integrated rural development approaches. However, the forest carbon sector has matured in the last years. Significantly larger numbers of new **afforestation/reforestation (A/R)** projects have been developed and

[61] www.cleancookstoves.org/

implemented during the last two years[75]. CDM-A/R, being exclusively focused on plantation establishment on hitherto unforested lands, also excludes existing forests (e.g. natural or secondary) from its purview.

According to the register of CDM projects, approximately 600 projects at various stages (from registered to issued) are directly or indirectly related to wood-fuels. They are mainly in the following six areas: (1) co-firing generation of electricity, (2) power generation with biomass, (3) switch from fossil fuels to biomass, (4) switch from fossil fuels to wood-based pellets, (5) ethanol production and (6) direct combustion of woody biomass. The great majority of these projects are in Asia or Latin America [76].

Small-scale renewable-energy and energy-efficiency projects are helping to meet the needs of rural people in developing countries, alleviate poverty and foster sustainable development. However, the low emission reductions per installation are making it difficult for such projects to derive value from participating in the CDM. Negotiators of the Marrakech recognized this problem and adopted simplified procedures for qualifying small-scale projects. These procedures reduce the burden on the project developer and facilitate a faster implementation of the project.

Box 9: Small-scale CDM projects

Renewable energy projects with a maximum capacity of 15 MW
Energy efficiency projects that reduce energy consumption by less than 60 GWh per year
Other projects that emit less than 60 ktonne CO2 annually
Small-scale afforestation and reforestation projects removing up to 16Ktonnes of CO2 per year

Source: [77]

Even with the simplified rules, however, the current design of the CDM still means high transaction costs for individual small-scale projects. Empirical evidence suggests, that economies of scale are the most important factor determining the share of total cost made up by transaction costs because fixed costs form a significant part of transaction costs. Further evidences from CDM projects show that transaction costs can account for a significant share of the total cost of CDM projects. Smaller projects are at a disadvantage because fixed costs become a major factor [78]. Costs can be reduced by bundling similar small projects into a single project that is still eligible for the simplified procedures [76].

Nevertheless, by simplifying and clarifying the CDM's program of activities (PoA), it is becoming easier to develop small-scale wood-energy projects such as those with improved cookstoves. These stoves have so far sought carbon finance opportunities in the voluntary carbon market [63].

Agreed at the 2007 Bali Summit (UNFCCC COP 13), a new instrument is emerging for the post-Kyoto period (past 2012), which expressly promotes protection and sustainable management of existing forests. Designed to combat GHG emissions from deforestation and forest degradation, **REDD will provide a more flexible framework for compensating carbon-sequestration services of existing forests**. It likewise promises significant synergies with other forest-related processes and initiatives, like biodiversity conservation. Funds generated under the REDD mechanism would likely provide useful means for promoting sustainable biomass production in already existing forests.

Voluntary carbon marketing (VCM) operates outside the Kyoto/compliance context. Numerous initiatives, global as well as regional, are emerging in this context. Even though basic verification and registration requirements are similar to requirements stipulated under CDM-A/R, **VCM is widely regarded as a more flexible instrument, one that is also more accessible to decentralized as well as small-scale implementation**.

While forestry projects have long been on the back-burner of climate change mitigation strategies, they can now take advantage of new opportunities. Although financial obstacles indeed remain, **the voluntary markets have shown in many instances a preference for forestry credits**. The VCM enables the development of innovative forestry projects that are exemplary in terms of environmental and social development co-benefits, and the quality of voluntary emission reductions can now be readily guaranteed by numerous accepted standards [79].

The **Voluntary Carbon Standard (VCS)** is a programme within the voluntary carbon market to provide a global standard for voluntary offset projects. It was founded by the Climate Group, the International Emissions Trading Association and the World Business Council for Sustainable Development. VCS offsets must be real,

additional, measurable, permanent, independently verified and unique. All the carbon offsets generated under the programme – "voluntary carbon units" (VCUs) – are registered within the VCS Registry System. The sectoral scope of the VCS is almost identical to that of the CDM. It contains 15 sectors, including energy industries (e.g. renewable and non-renewable sources) within which all wood-based energy projects fall [76].

Some projects have the merit to propose effective alternatives in difficult institutional contexts and may serve as role models for the rest of the market. For example, REDD projects are already supported by "pilot" mechanisms such as Biocarbon Fund, CFPF, the UNEP program CASCADe (UNEP, FFEM), and UN-REDD. A possible opening up of the carbon market to post-Kyoto credits enabling REDD and other forestry sectors not currently supported would drastically change the carbon forest market landscape, stimulating investment and professionalizing this still nascent market [79].

Box 10- Afforestation and Reforestation Carbon Standards

Verified Carbon Standard (VCS)
http://www.v-c-s.org/
Carbon offset standard that is focused almost exclusively on GHG reductions and that does not require projects to have additional environmental or social benefits. VCS is broadly supported by the carbon offset industry (project developers, large offset buyers, verifiers, projects consultants) and has become the most important standard in the voluntary carbon market. It is compatible with CDM AR methodologies and tools – i.e., all CDM-approved methodologies and tools can be directly used for VCS projects - and has gained much experience from CDM, while also allowing for the development of own methodologies. It issues Verified Carbon Units (VCUs).

Clean Development Mechanism (CDM)
http://cdm.unfccc.int/
Carbon offset standard, generating certified temporary (tCER) or long term (lCER) emission reductions coming from AR projects, acceptable for compliance by governments under the Kyoto Protocol.

CarbonFix Standard
http://www.carbonfix.info/
Forest carbon offset standard which enables projects to generate certificates *ex-post* as well as *ex-ante* form and which can be used as a standalone standard or in combination with other certification schemes (e.g., existing Forest Stewardship Council and CCB certification will automatically fulfill some CarbonFix requirements). Modalities and procedures are very simple in comparison to those of the VCS and CDM. AR projects that are not viable under the VCS or CDM standards because of their high transaction costs may be viable under this standard. (However, market acceptance of CarbonFix CO2 certificates is lower than for VCS credits.)

Plan Vivo
http://www.planvivo.org/
A system for designing and operating payments for ecosystem service projects and schemes, targeted at small-scale farmers and forest-dependent communities. Under Plan Vivo, farmers and communities create sustainable land management, or "living plans" (*plan vivos*), that combine existing land uses with additional activities to create carbon benefits. The Plan Vivo Standard is relatively simple, and projects use their own "Technical Specifications," which are designed using elements of other methodologies, such as those of the CDM, or original approaches. It mainly issues *ex-ante* carbon credits, although *ex-post* credits can also be generated. Small projects that are not viable under VCS or CDM standards (because of high transaction costs) may be viable under this standard, although projects may grow over time to reach a substantial scale. (However, market acceptance of Plan Vivo Certificates is lower than for VCS credits.)

The Climate, Community & Biodiversity (CCB) Standards
http://www.climate-standards.org
This standard is different from the above standards in that it does not lead to the issuance of carbon credits. Rather, it is used to evaluate land-based climate change mitigation projects by identifying high-quality projects that adopt best practices to generate significant benefits for local communities and biodiversity while delivering credible and robust carbon offsets. It is usually combined with carbon standards such as VCS, CDM, or CarbonFix to demonstrate added value from communities and biodiversity benefits.

Along a modernized charcoal value chain, there are several potentialities for reducing GHG emissions:

Wood production: Sustainable wood-fuel production, improved sylvicultural treatments or AF/RF activities, will increase the carbon sinks. Efficient biomass harvesting helps to reduce wood residues and wastes.

Improved carbonization technologies: The levels of CO2 emissions from traditional charcoal production in several African countries range from 450 g to 550 g per kg of charcoal produced, while the emission of CH4 about 700 g, CO 450 g to 650 g and NMHC 10 g to 700 g per kg of charcoal produced [48]. In summary, total emissions range between 1.6 kg to 2.7 kg CO2 equivalents per kg charcoal produced. These figures are even low, compared to estimates given by other authors, ranging from 7.2 kg to 9.0 kg CO2 equivalents per kilogram charcoal produced [80, 81].

The potential for reducing GHG emissions by promoting the application of improved kiln technology is tremendous and cost effective, not only due to higher carbonization efficiencies, but also due to the application of GHG reducing technologies generation. A coupled effect of enhanced transforming efficiency and better GHG management reduces GHGs significantly. For example, current industrial type kilns have only less than 10 % of methane emissions compared to traditional kilns. In addition, the carbon sink potential of forests is preserved by avoiding tree cutting and less amount of wood is required to yield the same amount of charcoal.

Improved transport effectiveness: Road transport is responsible for the highest share of emissions globally. Within road transport, automobiles and light trucks produce well over 60% of emissions, but in low- and middle-income developing countries, freight trucks consume more fuel and emit more CO2 than the aforementioned light-duty vehicles. Emissions from transport are estimated at 1.1 kg CO2 equivalents per kilometer.

Increased combustion technologies: Improved charcoal cookstoves are also vital for reducing GHG emissions. They improve the efficiency of the fuel; reduce GHG emissions by 20 % to 30 % through an enhanced combustion process.

This means that several **options** and potential combinations exist, in principle, to generate carbon credits from the BEST Action Plan, including through the scaling-up existing elements of the project.

However, there are some notable **restrictions** in realizing carbon revenues from the theoretical overall emission reduction potential of the various activities:

- Existing activities which have been funded through non-carbon market sources, and where it cannot be demonstrated that their implementation was based on expected carbon market revenues, are not eligible as carbon projects. This is because of the key requirement of *additionality* of all major carbon standards, namely the need to demonstrate that GHG benefits are additional to what would have happened in the absence of carbon credit revenues. Otherwise, these would not be environmentally credible *offsets* of emissions created elsewhere.
- The increased efficiency in charcoal production through improved kilns themselves is currently not eligible for generating carbon credits. Methodologies are limited to quantifying the benefits through reducing CH4 emissions during combustion and pyrolysis. This is likely because of the difficulty to demonstrate that a higher output of charcoal per unit of wood actually leads to a lower consumption of wood from natural forests (causing degradation). Presumably, such benefits could be fully or partly negated through increased charcoal use locally or in export markets (e.g. because of lower prices and price elasticity in consumption) – at least it would be difficult to reliably quantify benefits.

8.4.7 Complementary activities

8.4.7.1 Capacity building

It goes without saying that a modern biomass energy sector requires capable and knowledgeable actors. This is valid for the supply chain actors who produce and bring the products to market (tree owners, wood cutters, charcoaler, transporters, etc), as well as for the actors in a regulatory role (forestry agents, forestry police, license controllers, tax collectors etc.), all need to behave in-line with expectations of a modern biomass energy sector. Capacity building will thus be necessary at several levels, mostly in the field, but also at the planning level in the concerned central and regional ministry organizations.

8.4.7.2 Research

Research on the following issues would be useful: (i) adoption and applicability of certain proven biomass energy solutions in Mozambique, such as clean stoves, improved kilns, production of solid biomass fuels

(briquettes, pellets), liquid biomass fuels; and (ii) further testing, operationalizing and enhancing activities to increase the supply of biomass energy in practical ways.

8.4.7.3 Publicity & Awareness raising

The ideas put forward in this strategy are not new and all elements have been successfully implemented in one country or another. However, the ideas are not well known in Mozambique, even though the stakeholder consultations carried out by AMES showed general support. A well placed publicity and awareness campaign is necessary to prepare the ground for the proposed holistic approach to modernize the biomass energy sector.

8.4.8 Implementation Arrangements (public, private, civil stakeholders)

Under ideal conditions, the roles are clearly defined and well separated:

- Central Government agencies are responsible for developing a conducive regulatory framework, agreeing on the biomass energy development plan for the sector including setting the right targets, establishing a new woodfuel taxation mechanism, and providing adequate budget for implementation by decentralized government agencies and relevant civic organizations
- Decentralized and Regional Government agencies are responsible for oversight and overall implementation of the biomass energy strategy in their respective regions
- Local communities become owner of the land and as such have the right to develop, exploit, manage the trees on their land; they are responsible for maintaining the trees on their lands and also for contracting out work to charcoalers, or produce themselves all of the charcoal coming from their land respecting the carrying capacity of the land in terms of max m3 of wood to be harvested per year.
- Private individuals, associations of individuals, as professional charcoalers, will produce charcoal fully inside the legal boundaries, respecting all tree management & conservation rules, and pay for wood and permits if and when required.
- Private transporters will transport charcoal, with a license, and without paying bribes
- An independent (private) entity will cross-check and validate the statistics collected by public officials on the trade and licenses for the biomass energy sector.
- Forestry agents will become advisors to wood owners (villages) on how to best manage the land and sustainably harvest trees.

Responsibilities for managing the biomass energy sector revert to a large variety of stakeholders, including several different ministries, the private sector, and local communities. Each of the ministries involved has other responsibilities of perceived higher importance than biomass. As an example, timber is deemed more important than woodfuels, or petroleum fuels and electricity are more important than charcoal. Although understandable and logical, it does not do justice to the importance of the biomass energy sector.

Under the best of circumstances, a dedicated organization should be created to assume the responsibilities of managing the biomass energy sector in-house, rather than keep these distributed among the various parent organizations. What worked successfully in other countries is a Biomass Energy Agency, or a Household Energy Agency[62], with the responsibilities for developing conducive policies, strategies, and regulatory framework, assisting ministries to realize and enact these, and to raise funds for the implementation thereof, and finally, oversee implementation by the various stakeholders. Such an agency would thus be responsible for managing the biomass energy sector on behalf of the government. It would report to the government through its Steering Committee, which should consist of high level government and private sector managers.

[62] Mali: Malian agency for the Development of Household Energy and Rural Electrification (AMADER); similar organizations exist e..g. in Cameroon, Chad, Burkina Faso, Madagascar, Senegal, and Tanzania.

8.5 Potential Benefits and costs of the proposed intervention

All incremental public and private economic costs as a result of the implementation of the biomass energy strategy will be identified and estimated. Included are (i) investments by the Government, such as for capacity building for villages, setting up an independent monitoring system of biomass energy trade, awareness campaign, prepare legislative changes, establish tree plantations, develop electricity generation and distribution network, etc.; (ii) investments by individuals, associations and companies, such as to purchase and replace improved stoves and LPG bottles, to use improved charcoal kilns, to produce briquettes, to distribute LPG, etc.; (iii) recurrent public costs, such as M&E, operational costs of providing training & capacity building, operational costs of plantations, awareness raising; and (iv) recurrent private costs, such as incremental energy costs, operational costs of operating modern energy businesses.

Economic benefits can be distinguished into direct and indirect benefits. Direct benefits include increased revenues from the taxation mechanism, reduced fraud, reduced fuel bill, and income generation from; indirect benefits include health benefits from cleaner stoves, environmental benefits from reduced deforestation and lower CO2 emissions.

8.6 Presentation of proposed intervention Scenarios

The following section presents the results of the analysis to determine the pros and cons of the different development scenarios. The scenarios selected include (i) business as usual, without Government intervention reflecting the current status quo while energy markets continue to grow at their own pace; (ii) modern biomass will become the main source of energy in the country while modest inter-fuel substitution takes place; (iii) LPG will become the major urban source of energy; or (iv) electricity becomes the main source of urban energy.

8.6.1 Scenario 0 - Business as usual

In the B.A.U case there is no intervention, no regulatory changes, no awareness campaigns, no campaigns to use improved stoves, etc. Current trends continue, resulting in a slight annual increase of electricity and LPG use for cooking, and a resulting increasing rate of deforestation. These increases are largely driven by population growth. There are no investment costs associated with this scenario. The absence of reform to forest management practice results in continuing corruption, deforestation and degradation of natural resources.

8.6.2 Scenario 1 - Modern biomass, plus modest substitution

This scenario transforms biomass from the traditional source of energy into a modern source of energy, for use in urban and rural areas. This scenario includes a combination of supply and demand-side intervention, coupled to regulatory and fiscal changes. Large economic benefits accrue due to the additional labour creation, particularly in rural areas. This scenario promotes modern biomass-based fuels, such as sustainably produced charcoal, briquettes and pellets, but also biofuels such as ethanol and bio oil. The use of LPG and electricity for cooking will be promoted as well, particularly in Maputo, but no special support is provided.

Planned policy measures encompass:

- Modifications to the forest law to allow real ownership to local communities including reaping all benefits from the sustainable management and exploitation of forests
- Reform of the charcoal and forest exploitation licensing system
- Improved wood and charcoal stove distribution via a temporary subsidy on energy efficient stoves benefitting 50% of Mozambican households. This subsidy should be sufficient to significantly reduce the up-front costs on stoves, this being a particular impediment to rural households.
- A 80% subsidy on a limited number of pellet stoves: 450 000 stoves over 3 years. This higher subsidy reflects the higher resistance to buying a new product.
- A 50% subsidy on a limited number of bioethanol stoves: 450 000 stoves over 3 years. Whilst existing stoves are sold in Mozambique at a slightly lower subsidy than this, the up-take is still too slow and not at the levels required to significantly impact demand.

- The initial training of 1000 charcoal makers to use higher efficiency charcoal production measures, improving charcoal yields
- Establishing 200,000 hectares of wood plantations solely for energy uses such as wood chips, briquettes and pellets.

The supply-side intervention will result in a sustainable supply of woodfuels; the level of this supply should meet the full of demand when incorporating all measures to reduce this demand. The demand-side intervention will make the use of woodfuels more efficient, so that less fuel is needed for the same task. Also, the use of other non-biomass fuels (LPG, electricity) will further reduce the demand for woodfuels, as will modern biomass fuels such as pellets and ethanol that do not require wood from forests for its production. Finally, as a result of the upfront regulatory and fiscal changes, more profits will accrue to wood owners who contribute to the sustainable supply of woodfuels; in turn, they will then have stronger incentives to produce more wood. Although woodfuels will become slightly more expensive, this will be more than compensated using more energy efficient stoves particularly since the emphasis will be on 2nd generation improved wood and charcoal stoves.

The investments to realize this scenario are approximately US$ 252 million; although this seems high, it is not and costs are low both from the personal and the public perspective. The benefits are high, since cooking cost will remain manageable, and global environmental benefits and health benefits increase will increase. Most importantly, this scenario will create a large level of employment in rural areas. Compared to the value of energy used for cooking in the country, or even the value of charcoal alone, the investments required to modernize the entire biomass energy sector are not large at all. Indeed, the NPV of the benefits over a 25 year period are about 12 times the NPV of the costs of the project.

8.6.3 Scenario 2 – LPG for urban areas

To reduce the use of charcoal for cooking a large effort is undertaken to promote the use of LPG. The cost of cooking with LPG is currently slightly higher than with charcoal, but scale economies will bring down these costs substantially. Since LPG is a convenient, low emission fuel, it is expected that households readily adopt this as a solution. However, it comes at a high cost; not only is LPG imported, all households will need to purchase an LPG stove and one or more LPG bottles to store their gas. The value added in terms of labour is quite small. The intervention would focus on urban areas.

Interventions by the government to promote the LPG market would encompass:

- A temporary 50% subsidy on LPG stoves and the first bottle of gas to all who demand it. This subsidy level is intended to bring the up-front costs of investing in an LPG stove and first bottle, down to the same level as an improved charcoal stove. An up-take of this subsidy offer by the vast majority of urban households is likely, as well as possibly up to 20% of rural households.
- A government intervention to initially reduce gas prices by 40%. This is required to bring cost of cooking with gas below those with charcoal. Whilst seeming generous, such a clear advantage of gas over charcoal is required to overcome natural resistance to change and to justify the up-front costs of the gas stove and bottle. This price reduction could be achieved through one or more of:
    - Import duty exemptions for LPG
    - VAT exemptions for LPG
    - Local production and sale of LPG from Mozambican gas fields, enforced by government mandate and price regulation
    - Government regulation of the LPG price, particularly in remote areas.
    - Subsidies other than VAT and import duty exoneration on LPG should be avoided.
- Investment in gas distribution 7 bottling infrastructure, particularly smaller urban centers and selected rural transport nodes.

In addition, some forest management measures will also be introduced, including a reform of the charcoal and forest licensing system. This is to ensure the supply of charcoal for households who select to use this instead of LPG.

The estimated investments to realize this scenario are considerable: US$ 1.0 billion between 2013 and 2025; costs are high both from the personal and the public perspective. Whilst the population will experience a reduction in cooking costs due to government promotional measures, this will be solely due to unsustainable government support to entice them to continue to switch to other fuels. The impact on forests is positive due

to the rapid deployability of LPG stoves and the move completely away from wood-based fuels. However, the economic benefits for this scenario are lower than the costs.

8.6.4 Scenario 3 – Electricity for urban areas

A comparable alternative to promoting LPG is a similar campaign but now with focus on electricity instead. This will require increasing grid access in urban and peri-urban areas. The cost of cooking with electricity is currently some 10% lower than with charcoal, but not many households use it for cooking. Taste preference for charcoal is often cited.

However, from an economic point of view, the scenario comes at high costs. Since the current production capacity is limited, Mozambique would need to reduce its exports of electricity. It would need to create more generation capacity, at high costs, and ultimately for low loads and consumptive use. The value added in terms of incremental productivity and labor is quite small. In addition, this route involves a higher degree of complexity in the development of new generation capacity and the corresponding legal-regulatory framework. The intervention would again focus on urban areas and we have assumed that over 90% of the urban population and 20% of the rural population would cook primarily with electric stoves.

Government interventions planned under this scenario include:

- The encouragement of electricity consumption through tax exemptions and/or a public subsidy on transmission and distribution, totaling 30% of the electricity retail price. This would make electricity cost 58% of the cost of the equivalent amount of charcoal. This is required to help overcome natural resistance to change and a general preference for the taste of charcoal-cooked food. Since the up-front costs of electric stoves/hot plates are less significant than gas, this cost incentive does not need to be quite as strong as for LPG (which we proposed would require a 40% subsidy).
- Measures to increase national generation capacity through one or all of:
    - The encouragement of private sector investment in generation capacity through power off-take agreements at a price around 20% above the commercially viable cost of production (current electricity retail price less the cost contribution of operating EDM). We estimate the this amount would be required to maintain off-take prices well above 10 USc/kWh after allowing for a 20% cost by sales of the transmission and distribution grid.
    - Government investment in generation infrastructure using government finance on preferential terms (lower interest or non-repayable) to enable generation at 20% below commercially viable generation costs. In other words, generation costs would need to fall below 8-9USc/kWh to allow for sale at cost after accounting for a 20% overhead for transmission and distribution.
- A temporary subsidy on electric cookstoves sufficient for 30% of the Mozambican population. This is to help reduce the up-front costs slightly and make the transition to electric stoves more affordable (about 20% cheaper than a charcoal stove.

In addition, some forest management measures will also be introduced, including a reform of the charcoal and forest licensing system. This is to ensure the supply of charcoal for households who select to use this instead of LPG.

The investments to realize this scenario are considerable: US$ 1.1 billion; costs and complexity are particularly high from the public perspective. The benefits are higher than for the LPG scenario, as cooking costs and global environmental costs will decrease, and health benefits will increase. However, electricity can also be used for other purposes, such as productive use but this has not been incorporated in the analysis.

8.6.5 Comparison of Scenario costs

The scenarios described above have been entered into a mathematical model to calculate overall investment cost, impact on energy usage, running costs, impacts on energy expenditures, changes in deforestation, changes in Carbon Dioxide emissions, and a number of other indicators.

The key outputs of these models are presented below in the following Table and Figure. Whilst showing only broad macro-economic trends, the strengths and weaknesses of each scenario and the corresponding

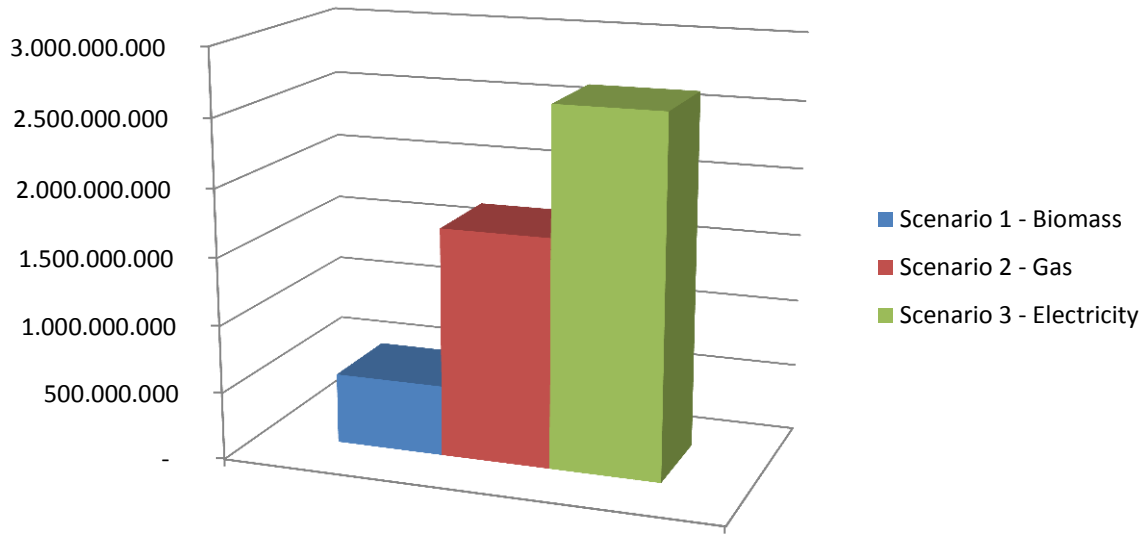
investment strategies become very clear. The information presented provides a sufficiently solid basis for political and strategic decisions on national energy, bioenergy and wood resource management policy.

Table 46: Comparison of costs and benefits of the scenarios, million US$$

	program costs	NPV costs 25 yr	NPV benefits 25 yr	Ratio benefit/costs	CO2 reduction 25 yr, ('000t)
Biomass scenario	252	337	4,051	12.0	6,976
LPG scenario	1,004	1,046	87	0.1	178
Electricity scenario	1,116	1,452	113	0.1	2,157

Beginning with the comparative investment costs, the proposed program to roll out modern biomass energy solutions is much less costly than promoting LPG or electricity. In addition, the amount of subsidy required to realize these scenarios are also much lower for modern biomass energy as well.

Figure 38 - Government subsidies required for the considered Scenarios



The stark difference in costs has a number of reasons, such as:

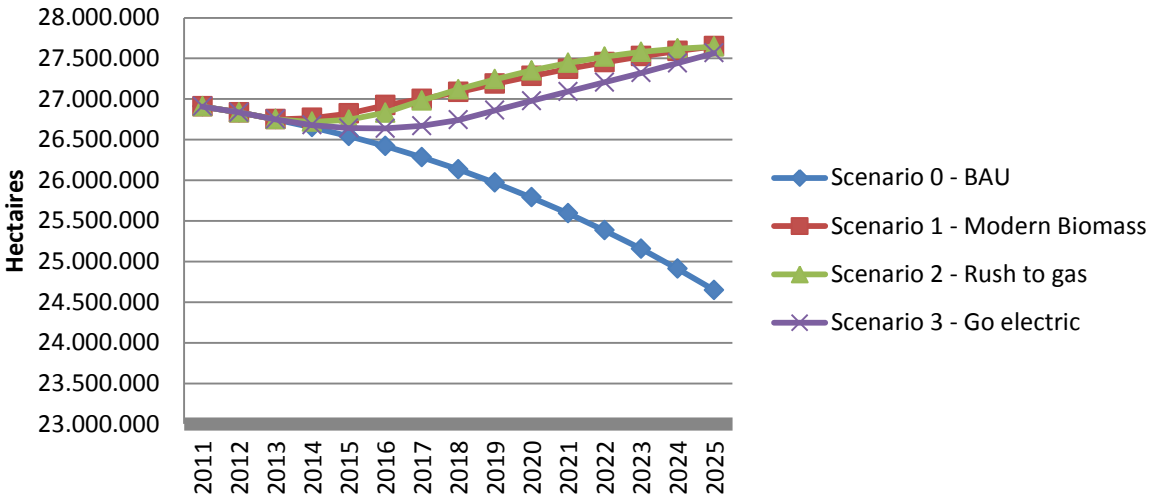
- The biomass scenario focuses on appliance efficiency improvements, better resource management and a more intelligent regulatory and taxation regime. Policies to promote gas and electricity on the other hand, require expensive stove subsidies to encourage people to change their cooking habits, as well as investment in expanding new energy infrastructure.
- Biomass energy technologies are generally less capital intensive and more decentralized. As a result, the government can make much smaller up-front investments and rely on small private-sector actors to engage in the dissemination of improved stoves and investment in other small-scale bioenergy schemes to produce modern fuels such as briquettes, pellets and bioethanol.

The high costs of the electricity scenario compared to the gas scenario, is primarily due to the greater infrastructure required for distribution. Gas can be distributed primarily through bottles imported or filled from Mozambican gas, using existing road infrastructure. Electricity on the other hand, requires the construction of new transmission and distribution facilities as well as the construction of new power plants.

8.6.6 Impact on deforestation

The problems of increasingly rapid deforestation are already well-known in Mozambique and so all scenarios include a sustainable forest management strategy. The modern biomass strategy has the most significant positive impact on forest cover thanks largely to energy plantation forests and active reforestation. The gas scenario is the next most favorable thanks to the comparatively rapid deployability of gas stoves and fuel.

Figure 39 - Changes in productive forest cover under different scenarios

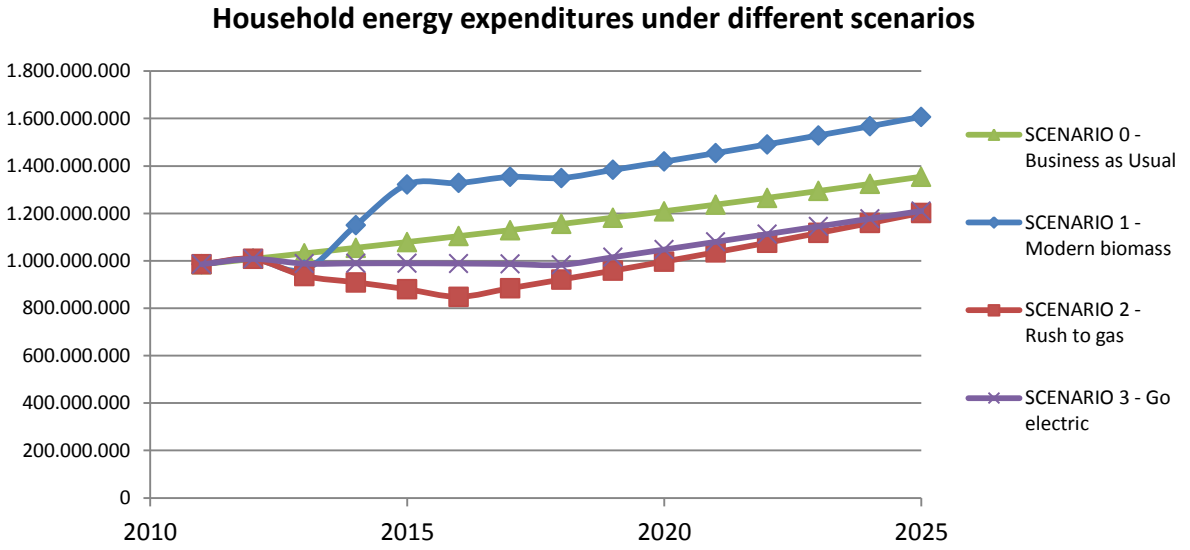


In all cases it is noticeable that all strategies require 2-3 years to show measurable results. The absence of measurable results could provide challenges in the political selling of a strategy. For this reason an well developed results and impact monitoring system is proposed to not only allow for troubleshooting and optimization, but also to supply the data to "sell" the selected strategy on a political level.

8.6.7 Household energy expenditure

As living standards rise and the Mozambican economy grows, household energy expenditure can be expected to increase steadily. A deliberate government intervention to influence energy consumption habits will affect that expenditure by either subsidizing households' energy, or by increasing costs. The Scenarios promoting of gas and electricity usage focus on subsidizing the switch in fuels and so result in slightly lower household energy costs (at the expense of government funds). The Modern biomass strategy on the other hand causes a slight increase in household energy costs due to better enforcement of taxes, protection of forests and encouragement of efficiency measures.

Figure 40 - Household energy expenditures under different scenarios



8.6.8 Influence on the national energy mix

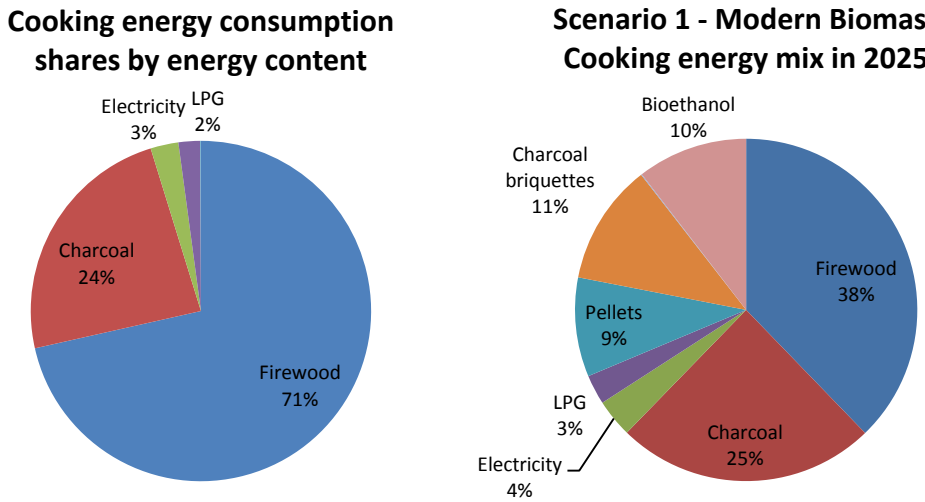
Ensuring a low cost, secure and stable energy supply means balancing a focus on costs, with a diversified energy mix. Our three scenarios influence the energy mix in wildly different ways.

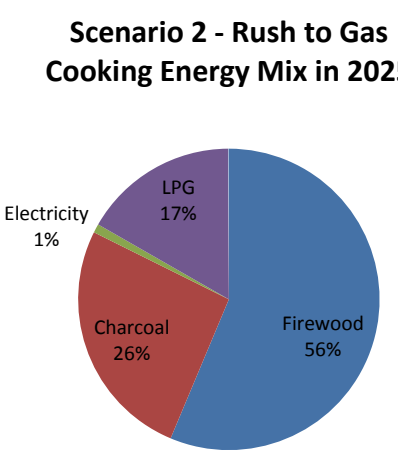
Due to the predominance of firewood in rural areas and the focus of modern energy sources in urban areas, firewood remains a dominant fuel in all strategies. By focusing on a number of cheap alternatives to woodfuel, the Modern Biomass strategy is likely to be more successful in switching people away from traditional wood fuels to more modern wood based fuels such as briquettes, pellets and bioethanol.

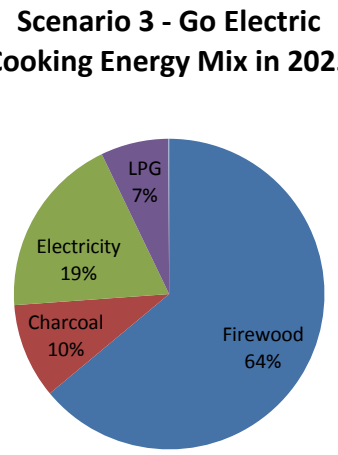
Whilst the gas and electric strategies both introduce truly modern urban cooking habits based upon a gas and electricity infrastructure, both of these strategies fail to introduce much diversity into the energy mix. This leaves and gas- or electricity-focused strategy vulnerable to price shocks, disruptions to supply and rising prices.

The biomass strategy encourages the diversification of energy consumption into a wide rainbow of different sources and technologies. Many of these technologies are widely considered as being rising technologies and as such worth investing in for the future. Mozambique would do well to develop its own expertise in modern biomass technologies as an energy exporter in a fast-growing and energy-hungry region.

Figure 41 - National cooking energy mix by energy content under different scenarios



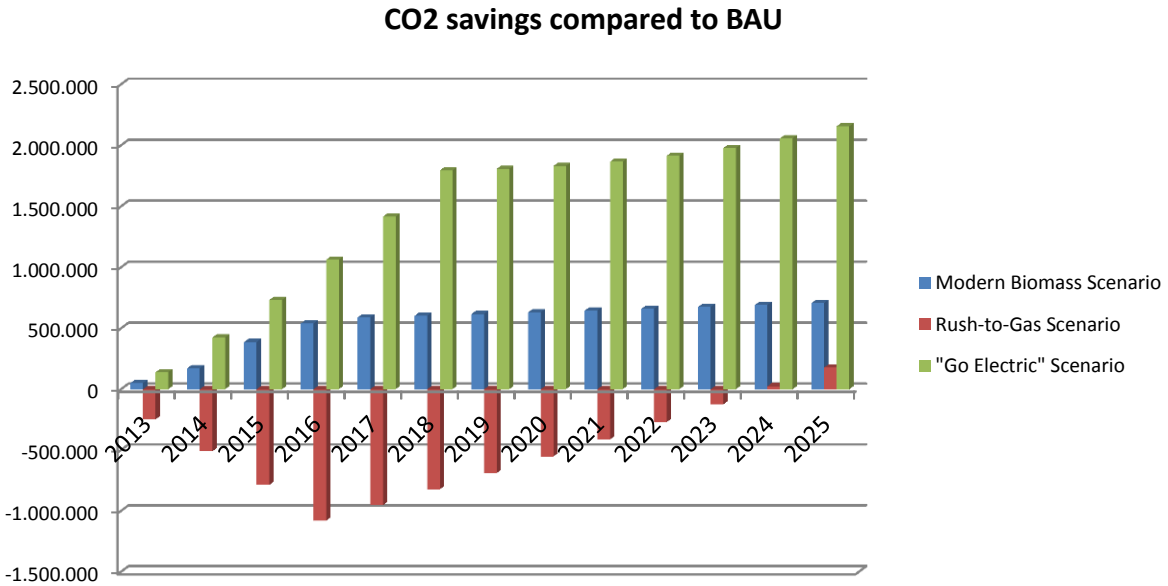




8.6.9 Carbon emissions

Monitoring and trading carbon emissions reductions can provide valuable additional income streams to projects, companies and the Government of Mozambique.

Figure 42 - Tons CO2 saved under different scenarios



Thanks to the relatively low Carbon intensity of Mozambique's electricity supply, the electric scenario offers the highest Carbon savings, followed by the modern biomass scenario.

Any capitalization of these savings through the Clean Development Mechanism or Green Certificates would be dependent on certification procedures. Proving "additionality" in particular may be tricky if measures are part of a national strategy, as such national strategies are often taken to be business-as-usual by certifying bodies such as the FCCC.

8.6.10 Conclusions relating to the Scenarios

On balance, the biomass scenario offers the Government and people of Mozambique the best balance in terms of costs, economic benefits, diversification of supply and protection of national resources. A determining element in this is the benefits for the rural population in terms of income generation. This scenario is the focus of more detailed analysis and planning.

9 Proposed Biomass Energy Strategy for Mozambique

9.1 Objectives

The objectives of the biomass energy strategy have already been mentioned as:

1. Economic development and efficiency: That BEST strategy energy sector should contribute to Mozambique's economic growth both directly by supporting a major economic sector, and indirectly by supporting non-energy economic activities which depend on biomass fuels and electricity.
2. Environmental protection and climate friendliness: Protecting Mozambique's forests and natural areas is of huge importance to the national economy for tourism, ecology, local climate and land productivity. In addition, Mozambique stands to benefit from global greenhouse gas mitigation and trading schemes such as CDM.
3. Security of supply: Mozambique needs to be able to ensure reliable access to energy resources at stable prices to protect economic growth and living standards.
4. Health and safety requirements must be improved and maintained to reduce accidents, respiratory ailments and other health related impacts of cooking fuel use.

Whilst touching on all aspects of energy use, this strategy focuses on the cooking fuel sector, and considers all fuels used or potentially usable for cooking: Charcoal, firewood, pellets, briquettes, ethanol, LPG and electricity.

9.2 Targets & Performance Indicators

The proposed biomass strategy proposed the following targets and performance indicators:

9.2.1 Economic targets

Target	Performance indicator	Date by which achieved
Increased employment in the energy sector	12 000 new permanent jobs created in the wood and energy sector	2020
Mozambique is a net biomass fuel exporter	An annual growth of forest cover exceeding 140 000 ha and 200 000 ha of energy wood/crop plantations allow for the export of biomass fuels as well as national self-sufficiency in cooking fuels	2017
National cooking fuel market value grows	National cooking fuel market value grows 60% to 1.6bn USD	2025

9.2.2 Environmental targets

Target	Performance indicator	Date by which achieved
Deforestation is halted and reversed	Degradation of Mozambican forest stock is halted and reversed, leading to year-on-year growth of productive natural forests	2015
Forest cover is increased	Productive natural forests accounted for an monitored by the Government of Mozambique exceed 28.5 bn ha	2025
CO2 emissions reduced	Emissions from the use of charcoal are reduced through a lower consumption of charcoal; the reduction is expected to be at least 14 million t per year	2017

9.2.3 Political and fiscal targets

Target	Performance indicator	Date by which achieved
Undeclared charcoal is reduced significantly	Undeclared charcoal imported to urban areas is less than 10% of charcoal sales	2017
The revised taxation system on the sale of charcoal will generate considerable revenue for investments in the biomass energy sector	Some 10% of the value of charcoal used in urban areas can be collected and remains in the charcoal productions zones; it entirely pays for the control & verification mechanism	2017
The cooking fuel mix is diversified	Electricity, LPG, wood pellets, charcoal briquettes and bioethanol are each used as a primary cooking fuel by at more than 10% of Mozambican households	2015

9.2.4 Social and health targets

Target	Performance indicator	Date by which achieved
Incidence of respiratory ailments reduced	Respiratory ailments as reported by hospitals fall by 50%	2025

9.3 Action plan

9.3.1 Range of actions proposed

The action plan proposed aims to put in place a wholistic and inter-dependent package of measures which reinforce each other and maximize impact. These are based on the measures described in greater detail in chapter 8: “Elements of a Biomass Energy Strategy”. More detailed work will be required to develop the strategy in much more detail. What is presented here is the main thrust and indicative costs of the proposed program.

A general overview of these measures is shown below to avoid repetition. It is proposed that:

Institutional & Regulatory

- The institutional reform of forest management and licensing system to devolve responsibility to the local level, promote a sense of forest ownership and create a sustainable forest resource management framework on national and local levels.
- Put in place monitoring and enforcement schemes to ensure compliance and fulfillment of benchmarks. The revised taxation system is will also generate funds to pay in part for the investments of the program.
- These measures are required, without them it would not be possible to realize the supply side intervention or the demand side intervention.

Supply Side Intervention

- Develop 200 000 ha of energy plantations using government investment over the 5 years between 2013 and 2017 at a rate of 40 000 ha each year. These plantations should ideally be handed over to private operators for efficient operation under government-defined rules and priorities, such as the sale of all wood produced in Mozambique for energy uses. The wood from these plantations should be mostly used for modern biomass fuel production, particularly wood pellets.

Demand Side Intervention

- Dissemination of improved energy-efficient wood and charcoal cookstoves under a government subsidy program. The subsidy program should be sufficient to provide stoves to 50% of the population at a 50% subsidy. The subsidy should only be awarded to stoves which meet minimum fuel efficiency criteria (see chapter 8 for details). The program should focus primarily if not exclusively on rural areas. The stoves need to satisfy criteria for efficiency, PM emissions, and CO emissions, to be verified in an independent stove emissions laboratory.
- Support purchases of wood pellet cookstoves with a 80% subsidy. The subsidy fund should be sufficient for 450 000 stove purchases in the 3 years 2013-2015.
- Support purchases of ethanol stoves with a 50% subsidy. The subsidy fund should be sufficient for 450 000 stove purchases in the 3 years 2013-2015.
- Train 1000 charcoal makers in improved kiln making and use to increase charcoal production efficiency.

9.3.2 Cost Estimates

The cost estimates shown on the following page is an approximate budget for the activities described above. The costs are a mixture of subsidies, forgone tax income (e.g. due to tax exemptions) and project implementation costs. In cases where government programs already exist (such as in forest management) these amounts should be considered to represent additional costs above these existing programs.

The majority of the activities are planned over an initial period of 5 years to start the intervention and realize the infrastructure and general environment to obtain the benefits over a longer period. Certain activities will however require the creation of permanent long-term government budget allocations. Notably, this includes the national forest management scheme.

Whilst the proposed action plan should be considered as an inseparable package of mutually reinforcing measures, it is likely that budgeted amounts need to be managed by different government departments, for example:

- Fiscal measures such as tax incentives should be managed by the Ministry of Finance or Ministry of Industry and Commerce.
- Subsidy schemes are likely to be implemented by the Ministry of Energy and Ministry of Industry and Commerce in collaboration with the Ministry of Finance and/or Ministry of Industry and Commerce
- Forestation and forest management schemes should be implemented by the Ministry of Environment Cooperation and the Ministry of Agriculture
- Inter-ministerial coordination tasks and land use planning are likely to be managed by the Ministry of Planning and Development

In addition it is highly recommended that the government seeks to subcontract all activities that are not part of its core activities and skills to the private sector or NGOs, for example:

- Awareness about the understanding of the new approach
- Distribution channels of products such as stoves and other equipment
- Training activities and workshops
- Monitoring of project implementation
- Administration of subsidy programs
- Technical and engineering support activities

Table 47: Proposed action plan budget in USD

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2,025
Plantations scheme : 200 000 ha of plantations													
Plantations per years	40,000	40,000	40,000	40,000	40,000								
Cost per ha planted (US$)	250	250	250	250	250								
Costs	**10,000,000**	**10,000,000**	**10,000,000**	**10,000,000**	**10,000,000**								
Improved Cookstove Dissemination : 50% of population @ 50% subsidy													
No of households urban	343,842	1,146,140	2,521,508	3,438,420	3,667,648	3,667,648	3,667,648	3,667,648	3,667,648	3,667,648	3,667,648	3,667,648	3,667,648
Subsidy per cookstove (US$)	25	18	13	13	13								
Costs	**8,596,051**	**14,040,216**	**17,192,102**	**11,461,401**	**2,865,350**								
Pellet stove distribution (80% subsidised)													
Number of stoves		150,000	150,000	150,000	150,000								
Subsidy per pellet stove (US$)		15	15	15	15								
Costs	**0**	**6,000,000**	**6,000,000**	**6,000,000**	**6,000,000**								
Ethanol stove distribution (50% subsidised)													
Number of stoves		150,000	150,000	150,000	150,000								
Subsidy per ethanol stove		25	25	25	25								
Costs	**0**	**3,750,000**	**3,750,000**	**3,750,000**	**3,750,000**								
Natural forest management													
Prod forest area	26,749,295	26,765,274	26,820,213	26,922,513	27,000,053	27,085,160	27,187,058	27,282,326	27,370,677	27,451,820	27,525,452	27,591,262	27,648,931
Per ha. costs of management (US$)	5	5	5	5	5	5	5	5	5	5	5	5	5
% where management is applied	0	0	0	0	0	0	0	0	0	0	0	1	1
Costs	1,337,465	1,940,482	2,819,475	4,103,832	5,967,695	8,680,434	12,633,982	18,383,467	26,742,350	38,891,363	56,543,734	82,184,440	119,416,512
Improved Kiln Dissemination : 1000 CC makers trained per year													
Annual No of CC maker trained	1,000	1,000	1,000	1,000	1,000								
Cost per charcoaler trained (US$)	150	150	150	150	150								
Costs	150,000	150,000	150,000	150,000	150,000								
Costs of program													
develop taxation scheme	500,000												
implement taxation scheme	2,000,000	4,000,000	4,000,000	4,000,000	4,000,000								
verification costs	810,351	1,961,164	4,708,771	6,190,526	6,210,336	6,353,174	6,499,297	6,648,781	6,801,703	6,958,142	7,118,179	7,281,897	7,449,381
publicity & awareness	1,000,000	2,000,000	2,000,000	2,000,000	2,000,000								
training for wood owners	5,000,000	10,000,000	10,000,000	10,000,000	10,000,000								
Costs	9,310,351	17,961,164	20,708,771	22,190,526	22,210,336	6,353,174	6,499,297	6,648,781	6,801,703	6,958,142	7,118,179	7,281,897	7,449,381
GRAND TOTAL COSTS	**29,393,867**	**53,841,862**	**60,620,347**	**57,655,760**	**50,943,382**	**15,033,607**	**19,133,278**	**25,032,247**	**33,544,052**	**45,849,505**	**63,661,913**	**89,466,337**	**126,865,893**

9.4 Benefits

9.4.1 Economic Benefits from a sustainable supply of woodfuel

Multiple economic benefits from developing a modern and sustainable bioenergy sector include:

- Keeping cooking costs low for the bulk of the population by using a locally produced renewable source of energy and avoiding the use of imported fuels or reducing exports.
- Jobs created directly due to government programs supporting the modernization of the biomass energy sector: forest & plantation managers, briquetting plants, pellet factories, stove wholesale/retail, stove production.
- Halting degradation and deforestation of the national resource base due to the use of biomass energy.
- Increase in financing available for further investments in modernizing the biomass energy sector through an improved fiscal mechanism.
- Reduction of fraud from the commerce of wood products
- Increase of incomes from the high value processed products produced and sold in and outside Mozambique, such as pellets, briquettes and ethanol.
- The indirect creation of jobs and income in sectors supplying and supporting the energy sector such as industrial equipment suppliers, trainers, cooking appliance retailers, vehicle leasing companies, etc.
- The securing of the sustainability of an economically vital sector for the long term by ensuring wood productivity and forest resource protection.
- Health benefits from the use of more modern stoves and fuels or energy sources
- Local and global environmental benefits from the reduction of forest degradation and destruction, and from using more combustion efficient equipment.

Naturally, it is extremely difficult to quantify all of these areas precisely. Nonetheless, with some simple assumptions, we can at least estimate those areas directly affected by the intervention proposed.

With relation to job creation, it is assumed:

- 1 forest manager per 10 000 ha for natural forests or plantations
- Employment in the charcoal sector remains roughly in-line with our current estimations for the Mozambique ratio of 136 000 full-time jobs supplying 122 260 000 sacks of charcoal per year, or 0.001112 jobs per sack of charcoal per year.
- 3 full-time job created for every 460 improved wood and charcoal cookstoves sold per year.
- 3 full-time stove wholesalers and retailers for every 1500 pellet stoves or ethanol stoves sold per year
- 3 full-time jobs in the ethanol or pellet production value chain for every 1500 stoves bought by consumers

This leads to the following directly created new jobs under the proposed intervention:

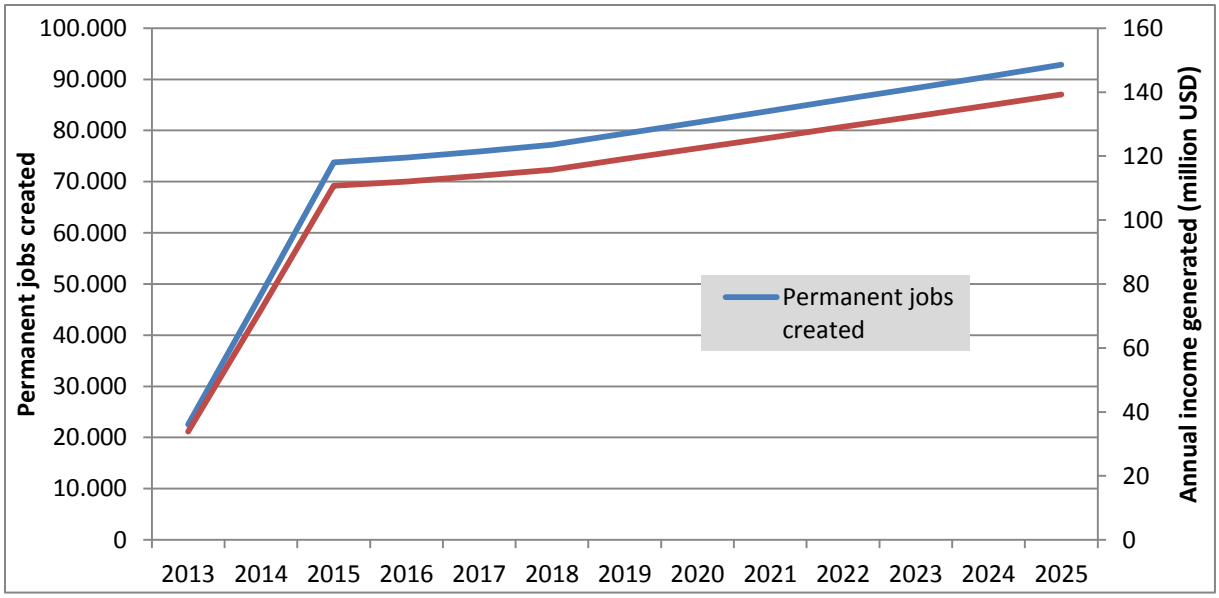


Figure 43 : Permanent jobs created directly by proposed intervention

In addition to the above direct jobs, a number of indirect jobs are to be expected in supporting industries such as industrial equipment suppliers, transport companies, vehicle suppliers and NGOs. Further, the income generated above will further stimulate the economy through the multiplier effect (money earned being re-spent on other products). At a savings rate of 20% of income[63], this would lead to additional GDP due to the multiplier effect of 174m USD by 2025 (in 2011 dollars).

9.4.2 Environmental benefits

Environmental benefits are multiple:

- At a *global scale*, a modernization of the biomass sector will result in reduced CO2 emissions from (i) the energy efficiency improvements in end-user equipment; and (ii) reduced deforestation and degradation. Less charcoal will be produced with more efficient methods, leading to less N2O, CH4, CO2 emissions, and improved stoves using less fuel and better combustion characteristics will also emit less CO and particulates, including black carbon. The total emission reduction between 2013 and 2025 is about 65 million t of CO2. It is higher due to the result of improved carbonization, this is difficult to quantify.
- At the *local or regional scale*, the strategy will result in reversed deforestation and at least maintaining the existing forestry resource base at its current level, or even increasing it. Not only is the resource base preserved for the future, it can be used and economic benefits can be derived at the same time when good management practices are applied.
- At the *household level* indoor air pollution will be less, from the use of stoves with better combustion characteristics.

9.4.3 Health Benefits

The aforementioned reduction of indoor air pollution will ultimately result in better health and sanitary conditions for households. The air in the house will be less polluted with PM particles, which will positively affect the health conditions of particularly women, children, and the grand-parents, who are indoors the most. The kitchen will become less dirty as well, which may lead to further sanitary improvements of the households. These issues are very difficult to quantify without long-term impact surveys.

[63] Minerals Cluster Policy Study in Africa, UNECA, 2004

9.4.4 Summary Benefits

The Table below shows the NPV of the benefits in terms of employment, health improvements, fuel savings, and CO2 emission reduction for the three intervention scenarios. The largest benefit by far is employment generation as occurs in the modern biomass scenario. In fact, this is what the modernization of the biomass energy sector is all about: enabling the rural population to take part in the sustainable supply of wood fuels, which is a major commercial commodity that is currently produced outside of their involvement. This can only be realized if they assume real responsibilities and in return are allowed to reap real fruits of their work. Health benefits are approximately similar for the three scenarios, and that can be understood as it is an implicit goal to improve health issues from cooking. Because LPG is a non-renewable fuel, CO2 emissions are slightly higher than for the BAU scenario.

Table 48: Benefits of the 3 scenarios by component (million US$)

Benefits	million US$ over 25 year period		
	biomass	LPG	electricity
NPV fuel savings	(45.3)	50.2	31.8
NPV employment	4,009	43.8	29.7
NPV health	43.3	43.8	33.6
NPV CO2	43.7	(50.8)	17.9
Total	4,096	37	81

Aforementioned costs and benefits are indicative only and can be used to analyze the various options available to the Government to further develop the household energy sector. More detailed costs should be determined when a decision is taken which development path to follow. Although the main aspects of the analysis will not change much, depending on the specific contributions from private players, the public contribution to the overall costs can still vary a lot. A more detailed analysis will be required irrespective of the development path that will be selected.

9.5 Conclusions

Although biomass energy is important for the economy of the country for a variety of reasons, it would be beneficial if this were more appreciated by the authorities. Laws are in place but not effectively applied, the sector is not well regulated, and there are no effective mechanisms to manage and preserve the resource base, avoid waste, and transform it efficiently into a modern energy sector. In addition, the sector is not effectively taxed, although it is a major source of revenue. Some of the biomass energy products, particularly charcoal, are full-fledged commercial products with a large value. Improvements in the fiscal, legislative, and regulatory framework could transform the biomass energy sector into a modern sector, generating substantial and long-term income and labor opportunities particularly in rural areas, and allowing the population to benefit from Mozambique's rich resources as long as required.

Technically it is entirely possible to create a sustainable supply of biomass energy, sufficient to cover the needs of the population at least into the medium term future. However, this is only possible if the suggested improvements in the fiscal, legislative, and regulatory framework are effectively realized. However, without such improvements it will be difficult to realize sustainable changes. The people of Mozambique would be the most important beneficiaries if and when the suggested changes are implemented, as they would continue to have access to reasonably priced, renewable, and locally produced energy sources while they can maintain their forestry patrimony for future generations.

The proposed biomass energy strategy shows the directions in which the Government should think when it starts to put in place an action plan for the modernization of the biomass energy sector. Exactly how, when, and where should be subject to considerable discussions among the main public stakeholders in central and regional administrations. It is suggested that the Ministry of Energy takes the lead in this, as was suggested during the December 7 restitution workshop.

10Annexes

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10.2 Projection statistics

10.2.1 Population

Province	Gaza	Inhambane	Maputo	Cabo Delgado	Nampula	Niassa	Sofala	Tete	Zambezia	Manica	Total
Population Total											
2011	1,320,970	1,402,245	2,638,745	1,764,194	4,529,803	1,415,157	1,857,611	2,137,700	4,327,163	1,672,038	23,065,626
2012	1,343,814	1,424,312	2,717,572	1,791,453	4,638,656	1,473,477	1,903,304	2,228,910	4,435,095	1,733,518	23,690,111
2013	1,367,053	1,446,791	2,798,755	1,819,532	4,751,008	1,534,208	1,950,202	2,324,012	4,546,800	1,797,289	24,335,649
2014	1,390,695	1,469,692	2,882,364	1,848,463	4,866,997	1,597,451	1,998,338	2,423,173	4,662,451	1,863,436	25,003,059
2015	1,414,747	1,493,024	2,968,471	1,878,281	4,986,765	1,663,310	2,047,748	2,526,565	4,782,233	1,932,048	25,693,191
2016	1,439,215	1,516,796	3,057,151	1,909,022	5,110,462	1,731,893	2,098,466	2,634,370	4,906,340	2,003,219	26,406,933
2017	1,464,107	1,541,019	3,148,481	1,940,723	5,238,244	1,803,313	2,150,529	2,746,774	5,034,976	2,077,045	27,145,212
2018	1,489,430	1,565,702	3,242,541	1,973,423	5,370,272	1,877,689	2,203,973	2,863,976	5,168,357	2,153,627	27,908,991
2019	1,515,192	1,590,856	3,339,411	2,007,162	5,506,717	1,955,143	2,258,838	2,986,180	5,306,711	2,233,067	28,699,277
2020	1,541,400	1,616,492	3,439,176	2,041,984	5,647,754	2,035,802	2,315,163	3,113,598	5,450,275	2,315,475	29,517,119
2021	1,568,062	1,642,619	3,541,923	2,077,931	5,793,569	2,119,801	2,372,989	3,246,454	5,599,303	2,400,961	30,363,612
2022	1,595,187	1,669,250	3,647,740	2,115,050	5,944,354	2,207,277	2,432,357	3,384,980	5,754,060	2,489,642	31,239,897
2023	1,622,781	1,696,396	3,756,720	2,153,389	6,100,309	2,298,375	2,493,310	3,529,418	5,914,827	2,581,639	32,147,164
2024	1,650,853	1,724,068	3,868,956	2,192,998	6,261,643	2,393,246	2,555,893	3,680,020	6,081,900	2,677,077	33,086,655
2025	1,679,412	1,752,278	3,984,547	2,233,929	6,428,577	2,492,047	2,620,151	3,837,049	6,255,590	2,776,086	34,059,666
Urban population											
2011	338,967	322,192	2,190,220	395,398	1,369,053	327,807	690,414	290,089	823,951	409,629	7,157,720
2012	345,233	331,287	2,255,132	412,564	1,431,004	342,740	701,453	302,844	871,341	421,674	7,415,272
2013	351,615	340,639	2,321,968	430,475	1,495,758	358,353	712,669	316,160	921,456	434,074	7,683,167
2014	358,114	350,254	2,390,785	449,164	1,563,443	374,678	724,064	330,061	974,454	446,838	7,961,855
2015	364,734	360,141	2,461,641	468,664	1,634,190	391,746	735,641	344,574	1,030,501	459,977	8,251,810
2016	371,476	370,307	2,534,598	489,011	1,708,139	409,592	747,403	359,724	1,089,770	473,503	8,553,524
2017	378,343	380,760	2,609,717	510,241	1,785,434	428,250	759,353	375,541	1,152,449	487,427	8,867,516
2018	385,337	391,509	2,687,061	532,393	1,866,227	447,759	771,495	392,053	1,218,732	501,760	9,194,326
2019	392,460	402,560	2,766,699	555,507	1,950,675	468,156	783,830	409,292	1,288,828	516,514	9,534,522
2020	399,715	413,924	2,848,696	579,624	2,038,945	489,483	796,363	427,288	1,362,956	531,702	9,888,696
2021	407,104	425,608	2,933,124	604,788	2,131,209	511,781	809,096	446,076	1,441,347	547,337	10,257,469
2022	414,629	437,622	3,020,054	631,044	2,227,649	535,094	822,033	465,689	1,524,247	563,432	10,641,493
2023	422,294	449,976	3,109,560	658,441	2,328,452	559,470	835,176	486,165	1,611,914	580,000	11,041,448
2024	430,100	462,678	3,201,719	687,027	2,433,817	584,957	848,530	507,541	1,704,624	597,055	11,458,047
2025	438,050	475,738	3,296,609	716,854	2,543,949	611,604	862,097	529,858	1,802,667	614,612	11,892,038
Rural population											
2011	982,003	1,080,053	448,525	1,368,796	3,160,750	1,087,350	1,167,197	1,847,611	3,503,212	1,262,409	15,907,906
2012	998,581	1,093,025	462,440	1,378,889	3,207,652	1,130,737	1,201,851	1,926,066	3,563,754	1,311,844	16,274,839
2013	1,015,438	1,106,152	476,787	1,389,057	3,255,250	1,175,855	1,237,533	2,007,852	3,625,343	1,363,215	16,652,482
2014	1,032,581	1,119,438	491,578	1,399,299	3,303,554	1,222,773	1,274,275	2,093,112	3,687,996	1,416,598	17,041,203
2015	1,050,012	1,132,882	506,829	1,409,617	3,352,575	1,271,564	1,312,107	2,181,991	3,751,732	1,472,071	17,441,381
2016	1,067,738	1,146,489	522,553	1,420,011	3,402,323	1,322,301	1,351,063	2,274,645	3,816,569	1,529,716	17,853,409
2017	1,085,763	1,160,258	538,765	1,430,482	3,452,810	1,375,063	1,391,175	2,371,233	3,882,527	1,589,619	18,277,696
2018	1,104,093	1,174,194	555,479	1,441,030	3,504,046	1,429,930	1,432,479	2,471,923	3,949,625	1,651,867	18,714,665
2019	1,122,732	1,188,296	572,712	1,451,656	3,556,042	1,486,986	1,475,008	2,576,888	4,017,882	1,716,553	19,164,755
2020	1,141,685	1,202,568	590,480	1,462,360	3,608,809	1,546,319	1,518,801	2,686,310	4,087,319	1,783,772	19,628,424
2021	1,160,959	1,217,011	608,799	1,473,143	3,662,360	1,608,020	1,563,893	2,800,379	4,157,956	1,853,623	20,106,143
2022	1,180,558	1,231,628	627,686	1,484,005	3,716,705	1,672,182	1,610,324	2,919,291	4,229,814	1,926,210	20,598,404
2023	1,200,487	1,246,420	647,160	1,494,948	3,771,857	1,738,905	1,658,134	3,043,253	4,302,913	2,001,639	21,105,716
2024	1,220,753	1,261,390	667,237	1,505,971	3,827,827	1,808,290	1,707,363	3,172,478	4,377,276	2,080,022	21,628,608
2025	1,241,362	1,276,540	687,937	1,517,076	3,884,627	1,880,443	1,758,054	3,307,191	4,452,924	2,161,474	22,167,629
Population density (Persons/km2)											
2011	18	20	112	23	58	12	27	21	42	27	30
2012	18	21	115	23	59	12	28	22	43	28	30
2013	18	21	118	23	61	13	29	23	44	29	31
2014	18	21	122	24	62	13	30	24	45	30	32
2015	19	22	126	24	64	14	30	25	46	31	33
2016	19	22	129	25	65	14	31	26	48	32	34
2017	19	22	133	25	67	15	32	27	49	33	35
2018	20	23	137	25	69	15	33	28	50	35	36
2019	20	23	141	26	70	16	33	30	51	36	37
2020	20	24	146	26	72	17	34	31	53	37	38
2021	21	24	150	27	74	17	35	32	54	39	39
2022	21	24	154	27	76	18	36	34	56	40	40
2023	22	25	159	28	78	19	37	35	57	41	41
2024	22	25	164	28	80	20	38	37	59	43	42
2025	22	25	169	29	82	20	39	38	61	45	44

10.2.2 Forest cover

Province	Gaza	Inhambane	Maputo	Cabo Delgado	Nampula	Niassa	Sofala	Tete	Zambezia	Manica	Total
Forest cover dev. ('000 ha)											
2011	2,422	1,437	683	3,175	2,317	6,050	1,419	3,340	4,112	1,951	24,485
2012	2,411	1,430	650	3,159	2,270	6,007	1,405	3,295	4,049	1,923	24,189
2013	2,400	1,423	618	3,142	2,222	5,963	1,391	3,250	3,985	1,894	23,888
2014	2,389	1,416	586	3,125	2,173	5,918	1,376	3,203	3,919	1,865	23,582
2015	2,378	1,409	555	3,107	2,125	5,871	1,362	3,154	3,852	1,834	23,270
2016	2,366	1,402	525	3,089	2,076	5,823	1,347	3,105	3,784	1,804	22,954
2017	2,355	1,395	496	3,071	2,026	5,772	1,331	3,054	3,715	1,772	22,633
2018	2,343	1,387	468	3,052	1,976	5,721	1,316	3,002	3,645	1,740	22,306
2019	2,331	1,380	440	3,032	1,926	5,667	1,300	2,948	3,573	1,708	21,974
2020	2,319	1,372	414	3,012	1,875	5,612	1,284	2,893	3,500	1,675	21,638
2021	2,307	1,365	388	2,992	1,824	5,556	1,268	2,837	3,426	1,641	21,296
2022	2,295	1,357	363	2,971	1,772	5,497	1,252	2,780	3,351	1,607	20,950
2023	2,282	1,349	339	2,949	1,721	5,437	1,235	2,722	3,274	1,572	20,598
2024	2,270	1,341	316	2,927	1,669	5,375	1,218	2,662	3,197	1,537	20,242
2025	2,257	1,333	294	2,904	1,617	5,311	1,201	2,601	3,118	1,501	19,881

10.2.3 Annual available cut from natural forest cover

Province	Gaza	Inhambane	Maputo	Cabo Delgado	Nampula	Niassa	Sofala	Tete	Zambezia	Manica	Total
Annual Available Cut (in '000 m3)											
2011	780	778	351	3,030	2,295	6,260	1,300	1,837	6,884	1,835	25,350
2012	777	774	334	3,015	2,248	6,216	1,288	1,812	6,779	1,808	25,050
2013	773	770	317	2,998	2,201	6,170	1,274	1,787	6,671	1,781	24,744
2014	770	766	301	2,982	2,153	6,123	1,261	1,761	6,561	1,753	24,432
2015	766	763	285	2,965	2,105	6,075	1,248	1,735	6,449	1,725	24,115
2016	763	759	270	2,948	2,056	6,024	1,234	1,708	6,335	1,696	23,792
2017	759	755	255	2,930	2,007	5,973	1,220	1,680	6,219	1,667	23,463
2018	755	751	240	2,912	1,957	5,919	1,206	1,651	6,101	1,637	23,129
2019	751	747	226	2,893	1,907	5,864	1,191	1,621	5,981	1,606	22,789
2020	747	743	212	2,874	1,857	5,807	1,177	1,591	5,859	1,575	22,443
2021	743	738	199	2,855	1,807	5,748	1,162	1,561	5,735	1,543	22,092
2022	740	734	186	2,835	1,756	5,688	1,147	1,529	5,609	1,511	21,735
2023	736	730	174	2,814	1,705	5,626	1,132	1,497	5,481	1,478	21,372
2024	731	726	162	2,793	1,653	5,561	1,116	1,464	5,351	1,445	21,004
2025	727	721	151	2,771	1,602	5,495	1,101	1,431	5,219	1,412	20,631

10.2.4 Energy balance

Item	toe	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PRODUCTION (Net)	**toe**	**7,492,621**	**7,810,985**	**8,020,920**	**7,998,483**	**9,420,961**	**10,635,202**	**11,230,071**	**11,570,610**	**11,783,540**	**11,944,985**	**12,452,534**	**12,788,021**
BIOMASS	toe	6,658,169	6,787,905	6,925,814	7,058,446	7,199,615	7,343,607	7,490,479	7,640,289	7,632,679	7,817,361	8,006,512	8,200,240
ELECTRICITY	toe	833,522	1,021,831	1,092,677	937,507	1,006,853	1,142,284	1,265,396	1,381,250	1,299,746	1,496,793	1,432,296	1,417,224
NATURAL GAS	toe	930	1,249	2,428	2,531	1,214,494	2,115,977	2,414,045	2,475,632	2,772,294	2,550,975	2,967,110	3,125,679
PETROLEUM PRODUCTS	toe	0	0	0	0	0	33,334	60,151	73,440	78,821	79,855	46,616	44,878
IMPORTS	**toe**	**657,275**	**920,815**	**798,341**	**1,167,050**	**1,307,548**	**1,207,112**	**1,294,785**	**1,352,032**	**1,306,239**	**1,350,360**	**1,488,439**	**1,622,670**
ELECTRICITY	toe	111,553	334,770	335,286	522,852	680,423	694,355	727,624	736,686	705,672	717,073	733,721	675,681
PETROLEUM PRODUCTS	toe	545,723	586,045	463,055	644,198	627,125	512,757	567,161	615,346	600,568	633,286	754,718	946,989
EXPORTS	**toe**	**669,757**	**813,689**	**870,181**	**697,825**	**1,965,080**	**2,987,489**	**3,379,424**	**3,534,713**	**3,712,402**	**3,608,631**	**3,922,776**	**4,054,131**
ELECTRICITY	toe	669,757	813,689	870,181	697,825	777,919	899,153	979,770	1,061,614	964,035	1,092,003	1,038,265	1,027,894
NATURAL GAS	toe	0	0	0	0	1,187,160	2,055,001	2,339,502	2,399,659	2,669,546	2,436,773	2,837,896	2,981,359
PETROLEUM PRODUCTS	toe	0	0	0	0	0	33,334	60,151	73,440	78,821	79,855	46,616	44,878
CONSUMO (TFC)	**toe**	**7,295,738**	**7,644,821**	**7,833,725**	**8,207,837**	**8,456,032**	**8,629,054**	**8,841,030**	**9,077,894**	**9,079,036**	**9,451,516**	**9,754,063**	**9,999,582**
BIOMASS	toe	6,658,169	6,787,905	6,925,814	7,058,446	7,199,615	7,343,607	7,490,479	7,640,289	7,632,679	7,817,361	8,006,512	8,200,240
ELECTRICITY	toe	175,542	416,315	421,752	628,888	735,712	754,047	817,846	844,338	837,999	899,525	904,073	842,909
NATURAL GAS	toe	181	204	223	138	247	17,231	28,208	31,383	54,622	68,427	70,249	81,244
PETROLEUM PRODUCTS	toe	461,846	440,397	485,935	520,365	520,457	514,170	504,497	561,884	553,736	666,203	773,229	875,189
biomass		89%	87%	86%	88%	76%	69%	67%	66%	65%	65%	64%	64%
net energy supply (Moz), TOE		7,480,140	7,918,111	7,949,080	8,467,708	8,763,429	8,854,826	9,145,432	9,387,929	9,377,378	9,686,713	10,018,197	10,356,559
biomass content (%)		89%	86%	87%	83%	82%	83%	82%	81%	81%	81%	80%	79%

10.3 Inception workshop Maputo

July 7, 2011; 8-12:30

As part of the Inception workshop, feedback was requested from the participants. They were asked on separate occasions to share their ideas about: (i) the Vision for biomass energy in Mozambique; and (ii) the priorities to be addressed by the biomass energy strategy. They were asked to write their ideas on a piece of paper, which was categorized and placed in a structure, and discussed in the plenary meeting.

The results are provided in the following two matrices showing the (i) Vision; and (ii) the Priorities for intervention to guide the development of the strategy. Finally, the list of participants is given.

	Vision	
	• What do we want? (i) reduce deforestation; (ii) improve charcoal chain efficiency; (iii) improve access to energy services? • 75% of people must know advantages of sustainable supply of biomass • Reduce biomass consumption by 30% • Reduce biomass consumption by 50% • 50% of population use other sources of energy for cooking than biomass • Awareness raising	
Tools • Promote transparency in entire value chain • Provision of regular consumption & supply data collection • Harmonize strategies biomass energy • Incorporate other sources of energy in the strategy	**Important considerations** • Socio-economic & cultural aspects of biomass use • Environmental aspects • Promote other income generating activities for rural population • Attribute value to biomass assets Involve local community in preserving the access	

Promote Energy efficiency
• Charcoal kilns
• Use of biomass energy
• More efficient technologies for use & produce charcoal
• More efficient technologies for use & produce firewood in rural areas
	Use alternatives
	• Particularly in urban/peri-urban zones
	  ○ Electricity
	  ○ Urgent necessity to promote alternatives
	  ○ LPG
	• Rural areas
	  ○ Biogas, pellets, briquettes, etc
	• Large-scale use of clean coal
		Promote sustainable supply of biomass
		• Give incentives for forestry
		• Protect biomass assets
		• Prevent wild fires
		Better control

	Priorities	
Data & legislation • Answer first: what do we want? • Legalize charcoal trade to monitor better • Create database and respective control •	**Coordination** • Biomass working group needs to coordinate with consultants • Time lines and results, transparent monitoring	**Awareness & education** • Introduce biomass sustainability at all levels of schools • Same with energy component • Information about fuel alternatives that can be used in Mozambique • Information about costs of alternative energy • Promote public awareness about sustainable use of biomass • Sensibilization of local communities
Incentives/control • Fiscal measures to regulate forest exploitation • Give communities the right to control forestry resources • Legislation to protect parks by local communities • Reinforce control of forestry exploitation • Bring value to different trees: (i) timber trees; (ii) energy trees • Better law enforcement • Each family to control a few trees, plus villages to control a whole plot • Fight illegal timber trade • Reduce corruption by providing incentives to local authorities • Create local & regional entities for control	**Incentives/use** • Cost benefit analysis of all options on national & community level • For urban dwellers to refrain using charcoal • New brand of charcoal in markets from sustainable production, identifiable by sack design & color	**Incentives/production** • Transfer responsibility/ownership to local level • Consequences of ownership, transfer to village/household level • Introduce fees for producers of charcoal when they cut trees • Harmonize fiscal aspects of forestry exploitation • Alternative business generation for rural people
Efficiency • Technologies to use biomass more efficiently • Identify the main sources of biomass energy in the country • Gasifier stoves • Ethanol stoves (environment & health benefits) • Rocket stoves • Replace inefficient kilns	**Diversify energy sources** • Promot decentralized energy supply to peri-urban areas with mixed supply matrixPropose sound alternatives • Promote electricity for domestic use • Municipal solid waste recycling & briquettes • Natural gas • Use coal	**Wood/biomass energy supply** • Energy plantations • Carefully use mangroves as energy source • Briquettes • Biogas (small & big) •

• Improved stoves in whole country		

List of participants – Inception Workshop, 7 July 2011 VIP Hotel Maputo			
Name	**Organization**	**Email**	**Telephone**
IsacTsamba	FUNAE	isactsamba@funae.co.mz	826284010
Margarida Mabjaia	DNAIA	margarida.mabjaia@yahoo.com.br	824235080
Juliao Matsimbe	FDA	juliao.matsinhe@yahoo.com.br	844241530
Imaculada dos Santos	FUNAE	imaculadadossantos@funae.co.mz	827858460
Steve Sepp	Eco Consult	steve.sepp@eco-consult.com	
Antonio Malalane	SINERGY CONSULTING	SINERGY>CONSULTING@GIMAIL.COM	823072213
		MALALANE@JUSTICE.COM	844878800
Robert j. Van der Plas	MARGE	RVANDERPLAS@MARGE.EU	
Marcelina Mataveia	DNER	mam@me.gov.mz	824195400
Marta Susana Penicela	DNER	msp@me.gov.mz	827656400
Dadenne Lio-Paul	FDM	gadennelo@afd.br	95027
Jose Nicolau	ME	miguel1556@gimail	844351240
SHAUN CLEARY	British High Comission	shaun.clery@fro.gov.uk	
Eva Kohl	Cooporacao Austria	evo..kche"@nado.gv.at	21317305/4
Dulevan	SIZ		827865293
Castelo Banze	DNTF	castelobanze"hotmail	
Bodebendes	EUEI PDF	mirka bodubac"	
Andrade Egas	UEM	aegas@uem.mz	823077370
Nndaud Dant	ME	dtn@sapo.mz	
Maluluane Gilberto	UEM	gilberto.maluluane@uem.mz	823807870
Sheila Mapilele	FUNAE	sheilamapilele@funae.com	826058928
Julieta	CEPAGRI		
Ana Ribeirop	WWF- MCO		828371390
Ines Chalufo	ME	iec@me.gov.mz	823911850
Xavier Cossa	ME	xrc@me.gov.mz	824581730
Boris Atanassov	GREENLIGHT	atanassov.b@gimail.br	820206274

10.4 Regional Workshops

Concise workshop reports as prepared by the team in Beira, Nampula, and Matola are provided in this annex, including the list of participants. The agenda was roughly the same in all three regions: (i) Introduction by the Biomass Energy Working Group representative or Ministry official, (ii) short presentation of the main recommendations of the Biomass Energy Strategy by the BEST Team, and discussion & feedback session.

10.4.1 Beira

February 29, 2012 10-14 Hrs

The Workshop was opened by the Acting Director of Energy of DRPREME-Sofala, the acting Director of Environment. After an introduction of the participants (annex 2) and a short presentation of the BEST process, two presentations were given by the BEST team (See Annex 3).

The discussion that followed is presented below by the questions that were asked with the responses to the questions.

Discussion

1. What about coordination with other strategies that are already accepted by the Government, such as conservation, reforestation, biofuels, etc; The team answered that these will be integrated in the strategy. (DIPREM-Tete)
2. What is proposed for implementation, and by what mechanism and with what funding will the strategy be implemented?; The team answered that it is the government who decides if and how the strategy will be implemented or not. Examples of BEST Malawi (no action) and BEST Rwanda (at least $40m of an action plan of $120m is under implementation now). (DIPREM-Tete)
3. How pressure areas are identified for the analysis; using actual forestry data and biomass use data for as far as available (Note: recent consumption surveys done in Maputo-Matola, still to be done in Beira, Nampula). (DIPREM-Tete)
4. There is a huge forestry resource base, but no strategy yet, why?; we actually ask the same question and fear that there is a lack of real interest among most politicians for traditional biomass. (FUNAE Beira)
5. Agree to need modernization, this will require imports, will biomass then still remain a cheaper alternative?; need detaxation/exoneration for imports; if end-user comfort is higher, slightly higher costs are acceptable (LPG is now also more expensive than charcoal). (FUNAE Beira)
6. How to ensure massive roll out of Improved Cook Stoves (ICS); will be included in the strategy, which means are at disposal will be determined by the Government .(ADEL Sofala)
7. How were local communities involved in the other BESTS?; absolutely essential to build capacity of local communities for managing local resources; this is a key element of the strategy, and we should determine how to support the local communities so that they are really able to manage the resources.
8. Comment: many biomass projects are not implemented because we don't work with and in the communities. It is key to involve communities to get their support and buy-in, so that they facilitate rather than hinder the implementation of the strategy and it's initiatives (DIPREME Tete)
9. Comment: electricity is not a solution to the wood fuel problem; In Maputo many people have electricity but also use charcoal. Question: How to realize benefits for the villages?; there are ways, such as innovative licensing system, or taxation system whereby the proceeds directly flow to the villages that manage their resources. (ADEL Sofala)
10. There is a risk that the Government doesn't accept the strategy; what can be done in that case by the civil society? ; It will be more difficult to intervene efficiently as there are fundamental problems that need to be corrected.
11. Comment: Timber logs do not provide any benefit to the communities.
12. Comment: Environmental education should be included in the normal curriculum in schools. (university)

13. Don't see how license, tax can benefit the community, as they do not have the capacity to manage this; true, but it is a goal to create this capacity and transfer the user rights to the community that live among the resources. It is very important that the resources are managed by the communities.
14. If funds go to the community, does that mean that charcoal prices increase?; not sure, there are other gains to be made if the value chain were better organized. However, communities earn nothing at the moment, and that is one of the main reasons that there is no proper management of the forests.
15. Empower local communities to engage in business using the resources they have (ADEL Sofala).
16. Proposal to make simplified planning mandatory; it does make a difference if the current "simple license" is given only if a simplified management plan is produced. Moreover, it would help also if the requestor of the license cannot ask for a second license in another area until it is clear that the management plan in the first area is being implemented.
17. Most forestry concessions include the creation of a piece of communal land for the community; make it mandatory that the concessionaire prepares a management plan for the communal lands.
18. A question was asked how the benefits could flow to the community in practice; this was answered on the flip chart, and many questions were asked in between (not written down). The key is that the license is given to the community that lives among the resources, as they along can really look after the resource base. It was mentioned that in Mukumbezi this system is already implemented on a trial basis, and in Dondo there is another trial of a licensing of up to 50 bags of charcoal. In principle, this mechanism will be proposed (this is somewhat more elaborated than was explained during the workshop:
    a. The license is given to the community instead of to the transporter; the license is based on the mean annual increment of the trees on the land of the community; this is the maximum volume of wood they are allowed to sell legally in one year;
    b. The village is the only organization that can decide where to cut wood, who can cut wood, how much wood, etc. intruders can be prosecuted; a simplified management plan is required
    c. The village needs to create the capacity to manage their resources; an elected village committee with a bank account should be created, and training should be given.
    d. An audit will be done on an annual basis to verify the village bank account where the proceeds of the tax are deposited;
    e. If the simplified management plan exist, and the village committee exist and has a bank account, the license will be granted
    f. As an example, say that their village produces 1000 m3 of wood per year, then they can produce 1500 bags of charcoal using a traditional charcoaling method or 2000 bags using an improved method. The transport coupons they will receive will correspond to how much they are estimated to have produced (1500 or 2000).
    g. Each transporter will have a coupon with the number of bags imprinted (not hand written), even bicycle transporters. The transporter will pay the tax and will pay for the product (bag of charcoal).
    h. Legislation will be passed proclaiming that a uniform tax on charcoal will be levied, with 2 or three different levels (a low tariff such as 10 Mt/bag for villages that manage their resources; a double tariff of 20 Mt/bag for all other areas (except conservation areas); and a fine of 50 Mt/bag and confiscation for charcoal from conservation areas.
    i. The bags will need to become more uniform, such as a 50 kg rice bag without the top-up;
    j. In managed zones, the village collects the tax and keeps 80%; 20% flows to the Ministry of Finance to pay for control & monitoring of the tax payment compliance; there will be close monitoring of the system, through NGOs visiting regularly and writing down the number of bags sold and the tax coupons issued.
    k. In non-managed zones, 100% of the tax flows to the Ministry of Finance to pay for control & monitoring of the tax payment compliance;

l. An independent, third party controller is needed, encircling the city to monitor charcoal flows and verify if tax payments have already been made; transporters with a legitimate transport coupon (incl bicycles) have paid their tax in the village and do not pay again; all others pay the (higher) tax at this point.

List of participants

Name	Organization	e-mail
Isac Tsamba	FUNAE	isactsamba@
Antonio Malalane	SYNERGY Consulting	
Ubaldo Ombe Gemusse	Universidada Pedagogica	ugemusse@yahoo.com
Dércio Chiemo	CEDECA	dchienmo@
Domingoes Sinibe	Abiodes-Biomassa	
Silvistre des Scury	DPA/SPFFB	sijomanze@yahoo.com.br
Paulino Mugu…	UNIZAMBEZE	
Anares Nhasnitsambo	FUNAE	
Joaquin Gabriel Majoaere	DPCA	
Giljacinto di Cordacho	DIPREME Zambézia	eagildpremez@gmail.com
Manuel Sithole	DRPENE- Tete	Sithole.manuel@gmail.com
Hamid Taybo	ADEL-Sofala	adelsofala@tdm.co.mz
Elias E …	DPREMES - BEIRA	
Gorge Dominga Arnanga	DPRMES-Sofala	
Nikolzij Moller	ADEL-Sofala	
Herminio Cumbana	DIPREME-Tete	
Henure M. Matene	DIPREM-Manga	
Robolpo Assane	ADEL-Sofala	
Ermelinder Xavier Maquenji	DP Ambiente Sofala	
Sazia Yora Ismael	ADEL-Sofala	

10.4.2 Nampula

29th February 2012,

The Workshop took place at Hotel Milenio, Nampula City. Participated 12 invitees from different institutions such as: Municipalities of Nampula and Nacala, Industrial School, Commercial School, Agrarian Research Institute (IIAM Nampula), Provincial Forest Services and APRONAF, Green Resources, DIPREME, Provincial Directorate of Environment Action. The team members represented UEM, ECO Consult and Ministry of Energy. Unfortunately the participants from Niassa and Cabo Delgado did not participate however invitation were sent. Limited logistics means was the reason given to explain their absence.

Before starting the workshop after arrivals of the participants, there was registry and given the opening speech by the representative of DIPREME, Celestino de Sousa. After welcoming the participants Celestino de Sousa thanked the participants for their positive feedback to the invitation made and he called attention to participants to give their valuable contribution in the elaboration of Biomass Energy Strategy that comes to contribute development of efficient energy options minimizing the high dependence in fuel woods. Following was the auto presentation of the participants and given a brief context of the Biomass Energy Strategy by Marta Susana from the Ministry of Energy, National Directorate of New and Renewable Energy.

Regarding the context of BEST

Marta Susana gave the brief context of the elaboration of the BEST and highlighted that reason that motivated the development of a Strategy that dealt with issues related to use of biomass such as:

- Pressure over forest resources which results in scarcity of energy resources
- High level of dependence in fuelwoods by around 23 million inhabitants, where 86% live in the rural areas

- Around 65 million hectares of forest is estimated to have 22 million tons of biomass energy with an annual potential of 14.8 million
- Inefficient use of energy resources (low efficiency of transformation of charcoal)

Looking to the figures above is clear that if the same path of use of resources, by 2015 there is no capacity of the forest to satisfy the population energy needs. As such the Ministry of Energy understood the need for intervening in terms of regulating the biomass use and management. So the Ministry requested fund to undertake this exercise for the creation of a regulating instrument, the National Biomass Strategy. It also will promote efficient biomass energy use in form of briquettes (sawmill and logging residues), bio gas (through animal excrement, municipality waste). Susana ended her presentation referring that the process if funded by European Commission and implemented by GIZ (German Cooperation), Eco Consult and Marge. Following Susana delivered the word to Steeve who continued with a presentation on the overview of charcoal business. The major information brought for discussion is related to the magnitude of the charcoal business, where price and productivity comparison was made. It was showed that there is inverse relation between price and site productivity as the South Part of Mozambique presents limited productivity (0.58 cubic meters per year) and high fuel woods prices (650 Mtn in average) while the Center and North Parts have high site productivity (approximately 1.5 cubic meters per year) and lower fuel woods prices (70 Mtn in average). If taken the 70% of the urban population that consumes fuelwoods there is approximately 900 000 cubic meters (2.6 million bags of charcoal) needed to supply Nampula Province, and for this amount the state received only 502 000MTn (corresponding the licensing of 43 600 bags of charcoal, 2% of the amount that could be received if the charcoal business was formal, controlled and monitored.

On other hand, if the actual used kilns are of low efficiency, limited of residues for production of alternative efficient energy sources, destruction of the natural resources by fires, illegal logging, agriculture, and more and more land is requested by biofuel projects and if the situation maintain as it is now, is expected a scarcity in resources in the South and some provinces in the Central Region, particularly Nampula province as result of its high population density. These are results given by a model applied to forecast the future resource situation in Mozambique. Following was opened discussion with the plenary.

Muino Taquidir (APRONAF) said that there was no surprise on the information provided regarding to resource situation in Mozambique and its regions. But, the estimation are exaggerated, more explanation was needed to be understood the figure of 900 000 cubic meters needed to supply Nampula province, as it depends on species density. Further he referred that Mozambique use to have in the past forest plantation programs for energy purposes and they did not succeed due to lower charcoal density. So if there is interest on providing alternative energy products, density have to be considered. Susan added stating that there is a need of promoting awareness campaigns to convince people on the benefits of alternative biomass energy sources, because however we have available residues form logging and sawmill as well as animal excrement there is a limited use in Mozambique. For instance, the project of dissemination of improves stoves there was very low level of use or adherence to new technologies as limited information was provided.

Continuing the discussion on charcoal density, Steeve asked to Green Resource representatives what density they will consider to the charcoal there will be produced through their plantations. No clear answer was given , Brune referred that 700 Kg per cubic meter will be accepted. The plantation will be used *Eucalyptus camaldulensis* as good examples exist in Brasil and Latine America. Brune referred that after knowing that there was a failed project plantation for energy purposes, he is curious to know why the projects did not succeed. Further, issues related to decrease in agriculture production and climate change have also to be considered. The representative of the Municipality referred that if the energy projects have failed the Government did not have proper regulation and policies in place otherwise it is not understandable. Why does not work in Mozambique and worked in Malawi for example. Strong regulation is needed to ensure sustainable resource use.

The representative of the Municipality asked the word to argue that there is a huge amount og waste that could be used but this is not recyclable. If the people separate the waste by category we could easily use it. Steeve commented that the Municipality is losing out, for example Matola Municipality uses 80% of the waste energy. In addition, the representative of the Municipality suggested that the charcoal producers to be linked to forest concession owners to use the leftover from logging as well as sawmill. Joint discussion need to be held to evaluate this alternative solution to control and monitor the use of resources for charcoal production. The discussion continued with the representative of the Municipality arguing that potentially the charcoal

producers in the field receive instructions on how to use the forest resources and they do not follow. Is there a penalty for local communities that do not obey the rules, as it could minimize the problem of destructive resource use by local communities and charcoal producers. No penalty was referred to exist, review of the forest regulation needed to be done to accommodate this. These first part of the presentation ended with Susan intervention regarding Green Resources plans and what was the link with DIPREME? No answer was give and the question was past. This was the end of the part I, 5 min break was announced.

Regarding the direction of the interventions

The part II started with the presentation on the different direction of the interventions for the development of the Biomass Strategy. The presentation focused on the richness in terms of energy resources such as coal, hydropower, fuelwoods, LPG among others. There was presented a comparative matrix where was clear that biomass was the most viable investment as low investment resources are needed, it is already used as such do not represented any new option, no need for changing devices but only would be a need to adapt to new technologies of energy use. Other advantages were listed for the use of biomass energy namely: biomass can contribute to rural development (it involves local people in the biomass energy production), can be decentralized (local community or local authorities can be empowered) and can be implemented in rural areas where the local communities are located. Biomass can contribute either for climate change adaptation as well as mitigation. So, there is a need for change, sectors need to collaborate and coordinate their actions, there is a need for modernization of biomass energy sources, technologies as well as modernization of the whole charcoal value chain, trees must be valued to give incentive to the forest owner to invest in the sustainable use of resources and they should benefit from it. One solution advanced was the introduction of tax that can raise up the value of the tree for the producers and composite the efficiency in terms of energy use.

Further an example was provided illustrating a situation of a modern farm that provides energy resources for household use or institutional use such as fuel woods, briquettes, pellets, bio gas, and other. The reason behind the illustration was to reflect on what Mozambique would like to be in terms of energy provider. Steeve highlighted that the exercise has started, the baseline information being collected, and so far there was a distinctive characteristic between regions in Mozambique. So, there is no idea on how the BEST will look like, will it be national or be specific for the regions. Discussion will be held with the other stakeholder in Maputo 2nd March 2012. The presentation ended giving information on principles that should govern BEST namely:

- There should be put in place a system of incentives (tax system) for the communities to invest in conservation of resources,
- The process have to be transparent
- Need for standardization of products and products should be valued for exports
- Proper land use planning is needed to direct investments according to land conditions

Finished the presentation, the participants were asked to give comments and suggestions. Brune from Green Resource highlighted that whatever I being planned to be done, land access should be considered because none investment may suggest if land is no accessible. For instance, access to land in Mozambique is left to negotiation with local communities which is constraining the investment environment. Review on regulation and legislation is needed to accommodate this. No further comments come up. The word was delivered back to the representative of DIPREME to give the final remarks. He concluded acknowledging the importance of wider participation in the process of development of the Biomass Strategy and requested to all participants to continue contributing to this process in order to have a strategy that leads for clean and sustainable energy sources.

List of participants

Name	First Name	Organization	e-mail address
Assane	Mahando	FUNAE	mahandoassane@funae.co.mz
Awase	Aky	UPMC-SPFFB/BPA-NPL	Awase_zoonzero@yahoo.com
Brune	Arno	Green Resources	arnobrune@hotmail.no
Constantino	Antonio	Conselho M. Vila Ribané	@tdm.co.mz
Danas	Isilda	Accie Ambiental	isildadanas@yahoo.com
De Lous	Celestino M.		@yahoo.com.br
Elias	Marta Susana	ME-DNER	susanapenicela@gmail.com

Name	First Name	Organization	e-mail address
Falume	Imede Chafim	DPA	Imede.falume@yahoo.com
Gamal	Arnaldo M.	Inst. Invest. Agr. Moc	
Jemusse	Fernado	CM Maputo	fjemusse@gmail.com
Joao	Moisés Paulino	DPRME	Moisesp2005@yahoo.corn.br
Jorge	Adriano	Inst. Indust. Comes NPL	adrianojorg@yahoo.com.br
Kiosterud	Axel	Green Resources	Axel.Kiosterud@greenresources.no
Mande	Carno Raul	CM Maputo	
Taquidir	Muino	MoA-APRONAF	muinotaq@gmail.com
Tozota	Miguel	Fundo de Energis	mtozota@hotmail.com
Yuvenus	Yolanda	DPA APRONAF	yolanda@gmail.com

10.4.3 Matola

March 2, 2012; 10-14 Hrs

The Workshop was opened by the Director of Energy of DIPREME-Matola. After an introduction of the participants (annex 2) and a short presentation of the BEST process, one presentation was given by the BEST team (See Annex 3). The meeting was closed by the National Dept. Director of ME-DNER.

The discussion that followed is presented below by the questions that were asked and the statements made.

Discussion

1. DPREME Matola, Dir.
    a. Look at gold trading, and how they implied small producers: weekly local trade fairs, were prices were set. Maybe something to consider for charcoal as well.
    b. Mining license given by province, village & province work together; data base of producers with Province; license awarded based on knowledge about licenses already issued before and state of resources
    c. Acknowledged fraud problems
2. Dir. Trade & Industry
    a. Fraud problems are real
    b. The Ministry for Environment organizes workshops to introduce ICS
    c. Is in favor of the proposal; likes to see more cooperatives with charcoal making
    d. Central Govt is aware of the issues; President said before that each community needs to have a communal forest
3. Hd Dept Provincial Level Forest & Wildlife
    a. Corruption is endemic along the value chain; A forest officer earns Mt 2000/month and can keep 50% of the fines he issues, what can you expect? Very difficult not to ask for money from traders! Problem is bureaucratic, as it takes > 1 yr for the money to reach the forest officer
    b. ICS – careful, as rural folks don't destroy the forest; it is the urban people!
    c. Pressure comes from Maputo town; no licenses for timber any longer, but for charcoal. We must impose that charcoal licenses are accompanied by reforestation: 10 trees for each bag of charcoal licensed.
    d. Charcoal comes from the North
    e. Whilst the price of gas is competitive with charcoal, the smaller dosage of charcoal retail purchases makes it easier to afford than the relative expense of a full gas bottle
    f. Strategy not isolated from other strategies
4. Unknown
    a. Coordination with other strategies that are already accepted by the Government, such as conservation, reforestation, biofuels, etc;

   b. Has the team talked to beneficiaries, stakeholders? (Yes, through surveys/Boris with 500 hh in Maputo/Matola and soon with 200 something in Beira and Nampula each, plus with charcoalers; team talked to charcoalers, whole salers, wood growers, etc).
   c. Need for the Govt to come up with a plan
   d. Need for permanent monitoring of the implementation of the strategy, so that Govt can better assist the population
   e. Corruption: conditions are really bad; lack of articulation between organizations, trucks go through several districts but no coordination between authorities
   f. Need to have more alternatives; tourist resorts use charcoal as they can't find gas
5. Dept. Dir DNER
   a. Why people use charcoal: it's available, in small quantities also, convenient, used to it, and have resistance to change
   b. Think in alternatives, better access to gas (incl methane), smaller containers to hh
   c. Look at biogas, for hh & communities with cattle
   d. Licensing: agrees with decentralizing to local level, but not only Min Agric, also Min EM
6. WWF
   a. ICS need a social & cultural side as well; don't just people to change stoves!
   b. Pellets, are they as good as charcoal?
   c. Agrees with the strategy to have approach by region; differences in regions are real
   d. Focus on incentives is good, but don't remove the penalties!
   e. Bush fires are frequent; regulation at local level can help
   f. Solid Waste: look at this as well, although it may not be feasible (composition of waste); land fill methane?
7. About the question on Ethanol: Can we please explain what ethanol is? Should not be produced from Cassava, as production of biofuels from edible crops is against the law.
8. Several other issues came up:
   a. Control and M&E are important but not easy. Answer: if 10% of the market value is used for this, for Maputo/matola some $14m per year are available. With that type of money you can arrange for some things!
   b. Management plans for villages, who pays? Answer: capacity building is needed through a project; if Government finds this a priority, funds will be allocated.
   c. DPREME Imhambane reject the licensing at local level; communities can't even pay for the fee to obtain a license, so how can they manage receiving 20% of the value?

List of participants

Name	Organization	e-mail
Isac Tsamba	FUNAE	isactsamba@funae.co.mz
Antonio Malalane	SYNERGY Consulting	
Carlita Rupia	DPICT	Carlita_mesa@yahoo.com.br
Dino Miguel Milisse	DPREME-Inhambane	dimomilesse@yahoo.com.br
Evgenio Casiniro José	Conselho Municipal de Inhambane	casiniromajenjie@yahoo.com.br
Marta Susana Elias	ME-DNER	susanapenicela@gmail.com
Horacio Mujacarama	DIPREME-Maputo	Eng_mujacarama@yahoo.com.br
Ana Riberio	WWF	aribeairo@wwf.org.mz
Sandre Cinhuzo	DIPREME Maputo	Sander.cinhuzo@yahoo.com.br
Steve Sepp	ECO COnsult	Steve.sepp@eco-consult.com
Famieta Amenirolfanjat	DPIET-Maputo	Fmailjate2006@yahoo.com.br
Marcelina Mataveia	ME-DNER	mam@me.gov.mz
Olivia S. Silva Amossa	DPA-Maputo, SPFFB	olisuzysilva@yahoo.com.br
J. Liama Matsiuhe	DPCAM	liamamatsiuhe@yahoo.com.br

Alcina Olivia Valente	DPCAM	Jesreich_07@hotmail.com
Castro J Elias	DIPREME-Maputo	cstrojelias@gmail.com
Armando Sigauque	CMC Matola	
Maurice Pigaht	MARGE	mpigaht@marge.eu
Robert J. van der Plas	MARGE	rvanderplas@marge.eu

10.5 Final Workshop December 7, 2012 Maputo

REPÚBLICA DE MOÇAMBIQUE

MINISTÉRIO DA ENERGIA

DIRECÇÃO NACIONAL DE ENERGIAS NOVAS E RENOVÁVEIS

Síntese do Seminário Nacional sobre o lançamento do primeiro Draft da Estratégia de Conservação e Uso Sustentável da Energia da Biomassa

Maputo, Dezembro de 2012

1. INTRODUÇÃO

O Ministério da Energia, com o apoio do Mecanismo e Parceria para o Diálogo da EU (EU PDF) está a desenvolver a Estratégia de Conservação e Uso Sustentável da Energia de Biomassa, com vista a estabelecer um quadro estratégico para responder aos actuais desafios na área de biomassa.

Neste contexto, por forma a validar os dados recolhidos com vista a estruturação da proposta da Estratégia, o Ministério da Energia, através da Direcção Nacional de Energias Novas e Renováveis realizou, no dia 07 de Dezembro de 2012, no Centro de Conferências Joaquim Chissano, Cidade de Maputo, o Seminário Nacional sobre o lançamento do DRAFT da Estratégia de Conservação e Uso Sustentável da Energia de Biomassa.

Este encontro contou com a presença de cerca de 50 convidados, com destaque para o Exmo. Senhor Secretário Permanente do Ministério da Energia, Exma Senhora Directora Nacional Adjunta de Energias Novas e Renováveis, Representantes dos Ministérios da Agricultura, da Energia, Indústria e Comércio, Finanças, Planificação e Desenvolvimento, Transportes e Comunicações e do Ministério para a Coordenação da Acção Ambiental, Senhores Directores Províncias da Agricultura de Gaza, Manica e Zambézia, Senhores Directores Provinciais dos Recursos Minerais e Energia de Maputo, Gaza, Inhambane, Sofala, Tete, Zambézia, Nampula e Niassa, Representantes do Sector privado, Sociedade civil, ONG's e Instituições de ensino.

Na sessão de abertura do Seminário, a mesa do presidium estava constituída por Exmo. Senhor Secretário Permanente do Ministério da Energia, Senhora Directora Nacional Adjunta de Energias Novas e Renováveis e pela equipa dos Consultores (Eco-Consult e Marge), responsáveis pela elaboração da Estratégia.

A abertura do encontro foi feita pelo Exmo Senhor Secretário Permanente do Ministério da Energia, tendo desejado boas vidas a todos os participantes e endereçado saudações especiais ao Mecanismo e Parceria para o Diálogo da EU (EU PDF)pelo apoio financeiro concedido.

Referiu ainda quela individualidade que a procura de energia em forma de carvão e lenha estima-se em cerca de 16 milhões de m3 por ano e que a produção deste combustível lenhoso tornou-se uma das principais fontes de renda nas zonas rurais, sendo realizada de forma não estruturada, o que contribui significativamente para a degradação das florestas.

A elaboração da Estratégia de biomassa revela a existência de uma vontade política de integrar a biomassa na matriz energética do País e que esta estratégia estabelecerá a ligação entre a energia de biomassa e outras fontes de energia.

O Senhor Secretário Permanente do Ministério da Energia Terminou apelando aos participantes, a dar os seus mais valiosos contributos, para o melhoramento da presente proposta de Estratégia.

2. TEMAS APRESENTADOS

Durante o Seminário, foram apresentados 3 temas, nomeadamente: (i) Introdução ao Esboçoda Estratégia (ii) Proposta de Estratégia (elementos/estrutura da estratégia), e (iii) os Resultados das Consultas aos Stakeholders.

2.1 Introdução ao DRAFT da Estratégia

Nesta apresentação, deu-se a conhecer o processo seguido para a elaboração da proposta de estratégia de energia de biomassa, seus custos e benefícios, principais questões de energia de biomassa, as soluções avançadas na presente proposta de estratégia e os passos subsequentes.

Alguns aspectos mencionados na apresentação:

- A Biomassa é a principal fonte de energia no País e constitui a grande fonte de geração da renda, principalmente nas zonas rurais.
- Lenha e carvão são as fontes de energias mais baratas para a confecção de alimentos.
- A contribuição da biomassa na balança do consumo de energia reduziu nos últimos 10 anos, quando comparado com gás e electricidade.
- Ultimamente não há muita informação sobre preços de energia de biomassa.

- O preço de carvão aumentou significativamente com o tempo (75%).
- O preço não e o principal factor que influencia da escolha da fonte e/ou alternativa de energia a usar.

2.2 Proposta de Estratégia (elementos/estrutura da estratégia)

Esta apresentação debruçou-se sobre o contexto do uso de biomassa no País, bem como os elementos da estratégia.

Principais aspectos abordados:

- Mais 80% de agregados familiares usam a energia de biomassa na confecção de alimentos.
- Mais de 75% da biomassa consumida provem das florestas.
- Os combustíveis lenhosos são fonte de sustento e um sector da economia nacional.
- 1.2 Milhões de pessoas (5% da população) dependem da produção do carvão vegetal e esta é uma das principais causas do desmatamento.
- A taxa de desmatamento é de 1.4% e não de 0.58%, referido pelo último Inventário Nacional.
- A Estratégia de Biomassa requer mudanças no "Statuos-quo" e uma visão holística de toda a cadeia de valor.
- A melhor estratégia passa necessariamente pela elaboração dos road maps provinciais e introdução de novas medidas fiscais que incentivem aqueles que exploram os recursos florestais de forma sustentável.
- A biomassa deve ser considerada como um dos pilares na área de energia.
- É necessário dar responsabilidade de gestão dos recursos florestais às comunidades locais.
- É preciso incentivar a criação de associações de carvoeiros, padronizar o saco de carvão, pensar em outras fontes alternativas de energia, melhorar a rede de comercialização da biomassa, monitorar o fluxo do carvão vegetal, bem como desenvolver um sistema de informação de mercados.

2.3 Resultados da Auscultação dos Stakeholders.

Nesta apresentação deu-se a conhecer as consultas feitas a diferentes intervenientes, nas regiões norte, centro e sul, principais constatações e as propostas de medidas para a solução dos problemas encontrados em 55 Distritos, sendo 18 no Norte, 23, no Centro e 14, na zona Sul do País.

A anteceder o debate em plenário, os consultores colocaram as questões de reflexão abaixo, para a consideração dos participantes:

- Quem é que deverá ter a liderança em termos da implementação da Estratégia da Biomassa?
- Seria ou não uma boa ideia, a criação de uma **Agência Nacional de Biomassa**, entidade aglutinadora dos diferentes pontos dos pontos de vista sobre a energia de biomassa, com autonomia administrativa e financeira?

Os debates em plenário andaram em torno das questões acima mencionadas e das apresentações feitas pelos consultores e os comentários do plenário e/ou constatações são apresentados abaixo:

Principais Constatações e/ou comentários do plenário:

- A Energia de biomassa é a solução energética para o nosso Pais;
- A energia de biomassa diz respeito a muitas instituições e diversos sectores de trabalho;
- Há diferente percepção sobre a energia de biomassa entre os níveis central e provincial;
- O principal problema, em relação a conservação e uso sustentável da energia de biomassa, difere entre os diferentes sectores (agricultura, ambiente, energia, indústria e comércio, planificação e desenvolvimento, etc.)., isto é, o que constitui o principal problema para o sector agrário é diferente daquilo que constitui o principal problema para outros sectores;
- Em Moçambique, não existe um quadro regulamentar eficaz para orientar os diferentes actores e assegurar a sustentabilidade da base de recursos, apesar do facto de a energia de biomassa fornecer cerca de 80% de toda a energia utilizada no País;

- Há desconexão entre o Ministério da Agricultura e o Ministério da Energia, no que diz respeito ao assunto de biomassa;
- A inclusão da Agência Nacional de Energia de Biomassa, numa Direcção Nacional iria criar problemas institucionais. Por isso, seria melhor que fosse uma instituição independente. Contudo, devia-se apresentar a proposta da sua estrutura orgânica, tendo em conta o envolvimento de diferentes sectores;
- Os estudos feitos devem mostrar a contribuição da estratégia de energia de biomassa, na conservação da biomassa, sua relação com outros instrumentos legais, bem como o processo de partilha de benefícios entre os diferentes intervenientes;
- É necessário que estratégia de biomassa mostre como se pode aproveitar os restos de carvão mineral produzidos na Província de Tete;
- A estratégia de biomassa devia propor como melhorar a aplicação da legislação sectorial;
- Na implementação da estratégia de biomassa, deve-se ter em conta experienciaslocalizadas e descentralizadas, isto é, o contexto sócio-económico de cada região;
- Deve-se olhar para o envolvimento do Ministério da Mulher, pois as mulheres são as que estão mais envolvidas na produção e comercialização do carvão (ter em conta aos questões de género);
- Há consenso de que há problemas na implementação do Diploma Ministerial 93/2005, de 04 de Maio, que define os mecanismos de canalização dos 20% das taxas de exploração dos recursos florestais e faunísticos, às comunidades locais. Contudo há divergências nas medidas a tomar, pois, uns defendem a revisão do Diploma com vista a se aumentar os benefícios das comunidades, remetendo a definição do novo valor a um estudo específico. Por outro lado, outros defendem que ao invés de se aumentar as taxas, devia-se consolidar a implementação do Diploma em vigor e encontrar mecanismos para que o dinheiro possa chegar as comunidades em tempo útil;
- A floresta se for devidamente gerida, ela pode gerir as necessidades de consumo de biomassa no País;
- Há problemas de assimetria de consumo dos combustíveis lenhosos entre as diferentes regiões do País, a estratégia deve mostrar como solucionar esses problemas;
- A legalização de florestas comunitárias e/ou concessões florestais comunitárias iria incentivar a conservação do recurso por parte das comunidades;

- Há necessidade de se estudar mecanismos para o aumento da eficiência na produção de carvão;
- Devia-se licenciar o produtor do carvão e não os compradores/transportadores;
- Todo o carvão devia passar por uma espécie de entreposto, para melhorar o controlo da sua legalidade;
- As taxas cobradas são inferiores ao volume de carvão vegetal explorado. Mesmo se todo o valor da taxa fosse canalizado ás comunidades, não corresponderia ao valor dos recursos explorado/destruído;
- A melhoria de fiscalização dos recursos florestais e da sua exploração requer reforço institucional, medidas anti - corrupção, muito investimento, etc.

Finalmente, a Senhora Directora Nacional Adjunto de Energias Novas e Renováveis, em representação da Direcção do Ministério da Energia, fez o encerramento do encontro, tendo agradecido aos participantes pelas valiosas contribuições dadas para o melhoramento das propostas apresentadas.

Referiu ainda que o grupo de trabalho ira trabalhar no sentido de adaptara presente proposta ao formato próprio das estratégias governamentais Moçambicanas, que será mais uma vez circulada para comentários e, provavelmente, discutida num outro seminário, antes da sua apresentação ao Conselho de Ministros.

Maputo, aos 08 de Dezembro de 2012

December 2012

REPUBLIC OF MOÇAMBIQUE
MINISTRY OF ENERGY

GOVERNMENT OF MOZAMBIQUE

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List of attendees

BEST Final Workshop, Maputo 07th December 2012

Name	Organization	E-mail
Júlio Bernardino Mahumane	ME-Permanent Secretary	N/A
Marcelina Mataveia	ME-DNER Director (Deputy)	mam@me.gov.mz
Sheila Mapilele	FUNAE	sheilamapilele@funae.co.mz
Mariano Jone	DIPREME-Cabo Delgado	N/A
Manuel Sithole	DIPREME-Tete	sithole.manuel@gmail.com
Moisés Paulino	DIPREME-Nampula	moisesp2005@yahoo.com.br
Sertório Azevedo	DIPREME-Niassa	serto2010@yahoo.com.br
Almeida Manhiça	DIPREME-Zambézia	possemeda@yahoo.com.br
Henure Mudoro Matene	DIPREME-Manica	N/A
Cândida Cumbe	Dipreme-Sofala	aurocumbe@yahoo.com.br
Dino Miguel Milisse	Dipreme-Inhambane	dimomilesse@yahoo.com.br
João De Lima	Dipreme-Gaza	lim03jul@gmail.com
Castro J Elias	DIPREME-Maputo	cstrojelias@gmail.com
Eugénio Manhiça	DNTF-Maputo	eugenioamanhiça @yahoo.com
Carlita Rupia	DPICT	carlitamesa@yahoo.com.br
Yolanda Gonçalves	DNTF-Maputo	yogoncalves@yahoo.com.br
Ermelinda Chongo	DNER-Maputo	ermelindachongo@gmail.com
Marta Susana Elias	ME-DNER	susanapenicela@gmail.com

Andrade Egas	UEM	N/A
Ana Riberio	WWF	aribeairo@wwf.org.mz
Francesca Blasone	Italian Co-operation	N/A
Steve Sepp	ECO-Consult	steve.sepp@eco-consult.com
Jan Cloin	FUNAE	N/A
David Nadaud	ME	dtn@sapo.mz
Ernesto Paulino	DPA-Gaza	nacolonha@yahoo.com.br
Dánia Falcão	FFA	N/A
Laurance Hart	AFD	hartl@afd.fr
Tsamba	UEM	N/A
Boris Atanassov	Greenlight	atanassov.b@gmail.com
Nilza Puná	Green Resources	nhp411@gmail.com
Robert J. Van Der Plas	MARGE	rvanderplas@marge.eu
Dirk Van Eijk	GIZ-AMES	dirk.vaneijk@giz.de
Charles Chidamba	GIZ-AMES	charles.chidamba@giz.de
António Malalane	SYNERGY CONSULTING	synergy.consulting1@gmail.com
Mário Batsana	FUNAE	mario.batsana@funae.co.mz
Ina de Visser	EU-PDF	neeltje.de-visser@euei-pdf.org
Erik van Malderen	BTC / FUNAE	erik.vanmalderen@btcctb.org
Anthony Williams	Consultant for UNEP	n/a
Ernesto Tumuquile	DPA-Niassa	N/A
Américo Manuel Conceição	DPA-Tete	N/A
Miguel Coimbra	DPA-Sofala	N/A
Amine Oliveira	DPA-Manica	N/A
Pedro Zucule	DPA-Nampula	N/A
Ramiro Nguiraze	DPA-Cabo Delgado	nguiraze@hotmail.com
Ernesto Paulino	DPA-Inhambane	N/A
Elídio Bande	DPA-Zambézia	N/A
Januário Tsenane	DPA-Gaza	N/A

10.6 Biomass energy matrix

Types of biomass	Occurrence	On-going initiatives	Regulatory provisions	Current practices	Current use	Potential
Firewood	59% of the household cooking energy mix in MOZ, dominant in rural areas	CBNRM experiences acquired, however without signs of up-scaling	Law 10/1999 Law on Forestry and Wildlife Decree 12/2002 Regulations on the Law on Forestry and Wildlife	Informal and unregulated	Cooking purposes with traditional stoves	High, because versatile; transformation to chips, pellets coupled with 2nd & 3rd generation stoves
Charcoal	23% of the household cooking energy mix in MOZ, dominant in urban areas	No substantial dissemination of improved kilns	Law 10/1999 Law on Forestry and Wildlife Decree 12/2002 Regulations on the Law on Forestry and Wildlife	Mostly informal and unregulated, use of traditional kilns	Cooking purposes with traditional stoves, Amount of ICS still negligible	High, through dissemination of improved kilns and stoves
Wood residues	Residues from logging and timber processing (approx. 0.05% of the pot. woodfuel supply)	Considerations of using for co-generation	Law 10/1999 Law on Forestry and Wildlife; Art. 19	Considered as waste	Left to population for cooking purposes or burnt on-site	Low, as linked to sawmilling sites
Crop residues	Contributes approx. 6-8% to the rural household energy supply.	No activities	n/a	Used after harvesting period	Traditional stoves	Low, the value as soil amendments is considered higher than using for energy
Biogaz	Few known biogas projects mostly located in the Gaza and Maputo province	Pilot projects	Part of the MICOA climate change program	Experimental	Provision of electricity and heat	Low, as only few households have enough dung for a household biogas production
Municipal waste	No contribution	Feasibility study Maputo/Matola; possible private interest in financing				Limited exploitable municipal waste sites in MOZ to produce landfill gas

10.7 LPG scenario, costs & benefits

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	€ million, total
Urban households shifting to LPG : all urban households and 20% rural households with a 50% stove and 1st bottle subsidy															
No of households		421,750	440,954	460,818											
Costs (million €)		42.18	44.10	46.08											132.35
Fuel subsidy on LPG sales (subsidy includes foregone VAT/duty as well as direct subsidies):		0%	0%	40%	30%	23%	17%	13%	9%	7%	5%	4%	3%	2%	0%
Costs support for LPG stoves (million €		99.38	154.57	212.25	175.18	121.40	86.84	63.41	46.95	35.10	26.43	19.99	15.18	11.56	1,068.25
Reforestation scheme : None under this scenario															
Natural forest management: Management of existing forest cover															
Prod forest area (million ha)		26.75	26.72	26.74	26.83	26.98	27.12	27.24	27.35	27.44	27.52	27.58	27.62	27.64	
Per ha. costs of management		5	5	5	5	5	5	5	5	5	5	5	5	5	
% where management is applied		1%	1%	2%	3%	4%	6%	9%	13%	20%	28%	41%	60%	86%	
Costs forest management (million US$)		1.34	1.94	2.81	4.09	5.96	8.69	12.66	18.43	26.81	38.99	56.65	82.27	119.40	380.05
Investment in gas distribution infrastructure															
Number of new HH users	8,367	421,750	440,954	460,818	481,362	50,072	51,224	52,402	53,607	54,840	56,101	57,392	58,712	60,062	-
Costs		21.1	22.0	23.0	24.1	2.5	2.6	2.6	2.7	2.7	2.8	2.9	2.9	3.0	115.0
GRAND TOTAL COSTS		163.98	222.65	284.19	203.34	129.87	98.09	78.69	68.06	64.66	68.22	79.52	100.39	133.96	1,695.61
2013-2025 cost (€)		1,695,613,229													
cost 5 yr (€)		1,004,018,984													

Benefits	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025

charcoal saved (t/yr)	(188,987)	(199,203)	(209,788)	(220,756)	47,360	48,450	49,564	50,704	51,870	53,063	54,284	55,532	56,810	-
additional annual quantity of LPG sold (t/yr)	62,487	65,362	68,335	71,411	6,155	6,296	6,441	6,589	6,741	6,896	7,054	7,217	7,383	-
additional nr of stoves sold	413,190	432,197	451,860	472,198	40,697	41,633	42,591	43,570	44,573	45,598	46,646	47,719	48,817	2,171,290
Fuel cost savings (relative to BAU), million US$	3.54	5.43	7.43	9.53	9.14	8.74	8.33	7.92	7.49	7.06	6.61	6.15	5.69	-
Cumulative jobs created														
LPG transport	12	13	14	14	1	1	1	1	1	1	1	1	1	-
LPG retail	4,374	4,575	4,783	4,999	431	441	451	461	472	483	494	505	517	-
LPG filling	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LPG stove retailers	1,033	1,080	1,130	1,180	102	104	106	109	111	114	117	119	122	-
jobs lost in charcoal chain	(3,234)	(3,409)	(3,590)	(3,778)	811	829	848	868	888	908	929	950	972	-
Permanent jobs created	2,185	2,260	2,337	2,416	1,344	1,375	1,407	1,439	1,472	1,506	1,541	1,576	1,613	-
Income new jobs (million US$)	3.28	3.39	3.50	3.62	2.02	2.06	2.11	2.16	2.21	2.26	2.31	2.36	2.42	-
Health Benefits (million US$)	1.65	3.38	5.19	7.08	7.24	7.41	7.58	7.75	7.93	8.11	8.30	8.49	8.69	-

10.8 Electricity scenario, costs & benefits

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	€
Urban households shifting to LPG : none under this scenario															
Electricity subsidy to consumers at current prices. Includes direct and indirect subsidies:			30%	23%	17%	13%	9%	7%	5%	4%	3%	2%	2%	1%	
Costs		47.2	66.4	58.6	50.9	43.7	37.2	27.8	21.0	15.9	12.0	9.2	7.0	5.3	402
Electricity production subsidy at current prices. Subsidies may be implemented via a favourable feed-in tariff or via tenders:															
Costs		31.5	44.3	57.7	71.7	86.2	101.5	103.8	106.2	108.6	111.1	113.7	116.3	119.0	1,172
Reforestation scheme : None under this scenario															
Electric Cookstove Dissemination : 30% of population receive 25% subsidy to electric stoves															
No of households urban		4.0	4.0	4.0	4.0	4.0									
Costs		49.8	49.8	49.8	49.8	49.8									249
Natural forest management: Management of existing forest cover															
Prod forest area (million ha)	26.8	26.7	26.7	26.6	26.6	26.7	26.7	26.9	27.0	27.1	27.2	27.3	27.4	27.6	
Per ha. costs of management		5	5	5	5	5	5	5	5	5	5	5	5	5	
% where management is applied		1%	1%	2%	3%	4%	6%	9%	13%	20%	28%	41%	60%	86%	
Costs		1.3	1.9	2.8	4.1	5.9	8.6	12.5	18.2	26.5	38.5	56.1	81.7	119.1	377
Investments in transmission and distribution		53.6	56.0	58.5	61.1	63.8	66.5	10.2	10.4	10.7	10.9	11.2	11.4	11.7	
GRAND TOTAL COSTS	1.9	183.4	218.4	227.4	237.5	249.4	213.8	154.3	155.8	161.6	172.6	190.2	216.5	255.1	2,638

2013-2025 cost (€)	2,635,995,997
cost 5 yr (€)	1,116,078,856

Benefits	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
new elec clients	206,595	216,099	225,930	236,099	246,616	257,493	31,943	32,678	33,429	34,198	34,985	35,790	36,613	1,628,468
new lpg clients	(29,992)	26,317	29,623	33,275	37,308	41,760	46,675	52,098	58,080	64,679	71,956	79,979	88,823	600,580
charcoal saved (t/yr)	(60,884)	(124,377)	(133,520)	(143,231)	(153,554)	(164,536)	(5,612)	(10,218)	(15,377)	(21,148)	(27,593)	(34,782)	(42,792)	-
Fuel cost savings relative to BAU (million €)	1,6	2,4	3,3	4,3	5,3	6,4	6,2	6,0	5,8	5,7	5,5	5,4	5,3	
Job creation														
operators	2,066	2,161	2,259	2,361	2,466	2,575	319	327	334	342	350	358	366	
repair man	1,033	1,080	1,130	1,180	1,233	1,287	160	163	167	171	175	179	183	
retailers	516	540	565	590	617	644	80	82	84	85	87	89	92	
jobs lost charcoal chain	(1,042)	(2,129)	(2,285)	(2,451)	(2,628)	(2,816)	(96)	(175)	(263)	(362)	(472)	(595)	(732)	
Permanent jobs created	2,573	1,653	1,669	1,681	1,688	1,690	463	397	322	237	140	31	(92)	
Income from new jobs (million €)	3,86	2,48	2,50	2,52	2,53	2,53	0.69	0.59	0.48	0.35	0.21	0.046	(0.137)	
Health benefits (million €)	0.70	1,67	2,69	3,77	4,91	6,10	6,42	6,76	7,12	7,52	7,95	8,41	8,91	

10.9 Biomass scenario benefits

Benefits	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fuel cost savings relative to BAU (million €)	2.6	(3.5)	(9.1)	(8.4)	(8.4)	(7.2)	(7.5)	(7.8)	(8.1)	(8.4)	(8.7)	(9.1)	(9.4)
Cummulative jobs created													
Charcoal value chain	(376)	(1,281)	(2,883)	(4,022)	(4,389)	(4,490)	(4,594)	(4,699)	(4,807)	(4,918)	(5,031)	(5,147)	(5,265)
Cookstove builders	2,865	12,417	33,429	62,083	92,646	123,210	153,774	184,338	214,901	245,465	276,029	306,592	337,156
Pellet stove retailers	-	12,000	24,000	36,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000
Ethanol stove retailers	-	300	600	900	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Ethanol producers	-	300	600	900	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Forest managers	2,675	5,351	8,033	10,726	13,426	16,134	18,853	21,581	24,318	27,063	29,816	32,575	35,340
Permanent jobs created	5,165	29,087	63,779	106,586	152,083	185,254	218,433	251,620	284,812	318,011	351,214	384,421	417,631
Income from new jobs	7.7	43.6	95.7	159.9	228.1	277.9	327.6	377.4	427.2	477.0	526.8	576.6	626.4
Health benefits	0.7	3.5	6.2	8.1	8.5	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3