



THE WORLD BANK



ESTABLISHING A GREEN CHARCOAL VALUE CHAIN IN RWANDA

A Feasibility Study





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LIST OF ABBREVIATIONS

A/R	afforestation/reforestation
bbl	barrel
BEST	Biomass energy strategy
cbm	cubic meters
CCI	cross-cutting issues
CDM	Clean Development Mechanism
CoC	chain-of-custody
COMIFAC	Commission des forêts en Afrique Centrale (Commission of Forests in Central Africa)
DFP	District Forestry Plan
DIP	Decentralization Implementation Program
DLB	District Land Bureau
DNA	Designated National Authority
EAC	East African Community
EDPRS	Economic Development and Poverty Reduction Strategy
EICV	Enquête Intégrale sur les Conditions de Vie des ménages (Integrated Household Living Conditions Survey)
EMS	Environmental Management System
ENR	Environment and Natural Resources
ENRSP	Five-year Strategic Plan for the Environment and Natural Resources Sector
EWSA	Energy, Water and Sanitation Authority
FAO	Food and Agriculture Organization of the United Nations
FSC	Forest Stewardship Council
GDP	gross domestic product
GEF	Global Environmental Facility
GFC	Guyana Forestry Commission
GHG	greenhouse gases
GoR	Government of Rwanda
Gwh	gigawatt hour
ICDP	Integrated Conservation and Development Program
ICPS	Improved Charcoal Production System
ICS	improved cook stoves
ICT	Information and communication technology
IFDC	International Centre for Soil Fertility and Agricultural Development
IKM	information and knowledge management
km ²	square kilometer
kw	kilowatt
kwp	kilowatt-peak
l	liter
LG	local government(s)
m	meter
MAI	mean annual increment
MDG	Millennium Development Goals (UNDP)
MINAFET	Ministry of Foreign Affairs and Cooperation
MINAGRI	Ministry of Agriculture and Livestock
MINALOC	Ministry of Local Government, Good Governance, Community Development and Social Affairs
MINEDUC	Ministry of Education
MINELA	Ministry of Environment and Lands

MINICOFIN	Ministry of Finance and Economic Planning
MINICOM	Ministry of Commerce
MINIFOM	Ministry of Forestry and Mines
MININFRA	Ministry of Infrastructure
MININTER	Ministry of Internal Security
MINIRENA	Ministry of Natural Resources
MIS	market information system
MSME	micro, small and medium enterprises
NAFA	National Authority for the Management and Development of Forestry/ National Forestry Authority
NDBP	National Domestic Biogas Program
NDIS	National Decentralization Implementation Secretariat
NGO	non-governmental organization
NISR	National Institute of Statistics
NLC	National Land Center
NMHC	non-methane hydrocarbons
OGMR	Rwanda Geology and Mines Authority
PAREF	Reforestation for Renewable Energy in Rwanda
PEFC	Programme for the Endorsement of Forest Certification
PICs	products of incomplete combustion
PSC	Program Steering Committee
RADA	Rwanda Agriculture Development Agency
RBS	Rwanda Bureau of Standards
RDB	Rwanda Development Board
RDSF	Rwanda Decentralization Strategic Framework
REDD	Reducing Emissions from Deforestation and Degradation
REMA	Rwanda Environment Management Authority
RRA	Rwanda Revenue Authority
RURA	Rwanda Utilities Regulatory Agency
RWEM	rural wood-energy market
SCM	supply chain management system
SFM	sustainable forest management
SPAT	Strategic Programme for Agriculture Sector Transformation
SRC	short rotation coppice
TOF	trees outside forests
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
UWEM	urban wood energy market
VCM	voluntary carbon market
VCS	Voluntary Carbon Standard
VCUs	voluntary carbon units
WE-MIS	wood-energy market information system
WESP	wood-energy supply plan
WISDOM	Wood-fuel Integrated Supply/Demand Overview Mapping

CONVERSION FACTORS & EXCHANGE RATES

1 m ³	700 kg
1 stere	0.6 m ³

EXCHANGE RATES

EUR 1	RwF 813.69
USD 1	RwF 629.54



ACKNOWLEDGEMENTS

In 2010, the Government of Rwanda, through the Energy Sector in the Ministry of Infrastructure (MININFRA) and the World Bank, agreed to commission a study assessing the opportunities and potential for establishing a Green Charcoal sector in Rwanda along the entire value chain of charcoal production, including wood production, charcoaling, transport, wholesaling, trade and final consumption.

The present report is the final output of this work. It was prepared under the general supervision of Klas Sander, Task Team Leader, The World Bank and Gerard Hendriksen, Consultant, GEF Sustainable Energy Development Project (SEDP). Dr. Frank Richter of Eco-Consulting Group served as the technical author, with support from Sabin Murererehe for the fieldwork in Rwanda. The analysis and recommendations presented in this report took advantage of the experience and input of a large number of people involved in the charcoal sector, both inside and outside Rwanda. In addition to primary data collected during field visits, the analytical work builds strongly on the wealth of information available in Rwanda from earlier work such as the Biomass Energy Strategy, the Ministry of Natural Resources (MINIRENA) forest inventory and cooking energy surveys, the Rwanda WISDOM analysis, and other documentation. The field visits and consultations with other experts in Rwanda were carried out in late 2011. The work also greatly benefited from the stakeholder validation workshop organized by Energy, Water, and Sanitation Authority (EWSA) in September 2012¹.

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¹ Due to the fast development changes happening in Rwanda more data has been generated and some institutional changes have taken place when the report was finalized. This has been incorporated into the report as detailed as possible. Any remaining errors and inaccuracies of the report remain the sole responsibility of the authors. However, it is believed that those should not change the general findings and recommendations stated in the report.

FOREWORD



The Government of Rwanda gives high priority to improve access to energy in the country as a driver of economic and social development as well as for improving the wellbeing of its population. Much emphasis is given to accelerating connectivity to the electricity network and improving the quality of supply. The number of households connected to the grid has increased rapidly over the past few years from only 4.3% in 2006 to over 16 % in 2012 and ambitious plans are in place to increase this to 70% by 2017. This will require large investments in generation as well as in transmission and distribution systems.

In contrast to the importance of electricity for economic development, especially for commercial and industrial applications, a recent study indicates that only 4% of the households in Kigali use electricity for cooking. Outside of the capital city this percentage is negligible. Even though it is expected that electricity will become more important as a cooking energy as access increases and incomes rise, it is expected that households will predominantly still rely on wood-based biomass energy for cooking at least for a foreseeable future. For the period 2010/2011 the reliance on wood and charcoal as the primary cooking fuel was still 97% nationwide.

To respond to the need to manage this energy source responsibly and sustainably, The Ministry of Infrastructure (MININFRA) developed the Biomass Energy Strategy (BEST) in 2008/9 to compliment the Energy Policy which was mainly focused on electricity supply and fossil fuel energy. The BEST focuses on 4 key areas: 1) increased and sustainable supply of wood fuels and professionalizing the charcoal value chain, 2) increased efficiencies in the use of wood and charcoal, 3) promotion of alternative cooking fuels (LPG, peat, biogas) and 4) increased capacity of Government agencies dealing with biomass. MININFRA, and since 2011 the Energy, Water, and Sanitation Authority (EWSA), have actively contributed in these areas through facilitating markets for LPG and biogas, promoting more efficient cookstoves for urban and rural areas and supporting the charcoal chain with better technologies and organization. EWSA is grateful for the support it has received from development partners such as the World Bank and Global Environment Facility (GEF) through the Sustainable Energy Development Program which has provided much needed funds for accelerating activities in this sector. However, more efforts are needed to stay ahead of developments with a growing population and increasing incomes resulting in higher demand for biomass and other cooking fuels.

This Green Charcoal Report comes at an opportune time and provides a central overview of the current status of the sector. More importantly it gives ideas about possible wide ranging programs and needed investments to support the development of a well regulated and competitive market for a sustainable supply of charcoal which fits in the Government's energy policy and meets the ambitious environmental sustainability targets of our country.

I wish to express my sincere thanks to all of the institutions and individuals that contributed to the development of this valuable report.

Eng. Yussuf UWAMAHORO

Deputy Director General for Energy
Energy, Water and Sanitation Authority – EWSA



A INTRODUCTION

*As is the case for many Sub-Saharan African countries, **biomass is the most important source of energy in Rwanda. The contribution of biomass to the national energy balance remains high and is still estimated today to be around 85% [1]. Biomass remains by far the largest source of energy used in the country, especially for domestic cooking, and it is likely that this will continue for some time.***

Biomass is also an **important source of income and labor**. The value of firewood and charcoal in 2007 was on the order of 122 million USD, or 5% of GDP. What is more, some 50% of this value remains in rural areas where it is distributed among woodlot owners and charcoal burners [1]. In theory, biomass is a green source of energy. It is renewable meaning that if the resources that produce firewood and charcoal are properly managed, there will be an eternal supply of it – or at least until economically viable alternatives are available.

In the past, however, the production of charcoal in Rwanda was one of the factors that contributed to deforestation, although it was not the main factor: land clearing for agriculture, for habitation and for creating tea plantations did more for the destruction of natural forests than did the demand for charcoal. In the early 1980s, the region most affected by charcoal production in the past – the Bugasera region – had been denuded as a result of the growing demand for charcoal in the country's capital, Kigali. Today, this region is covered with Eucalyptus trees and it could effectively contribute again to the charcoal supply.

It is estimated that virtually all charcoal in Rwanda is now made from planted trees, on private as well as community land. A small contribution still stems from natural forests.

Rwanda would face serious problems if there were suddenly no more charcoal in the country. Not only because of the rural employment and income opportunities lost, but also because urban households would have trouble to find cooking fuels. There is no clear alternative fuel that provides the same service for a similar price. If all households adopted kerosene as their replacement cooking fuel – the next best and the least expensive alternative, kerosene imports would surge from an annual level of 20 thousand tonnes in 2007 to over 120 thousand tonnes. It would certainly create a major economic hurdle to cope with a kerosene import bill estimated at 120 million USD per year [1].

In contrast to its economic and environmental potential, the sector is generally not considered as a means to achieve long-term sustainable development, for example, as a low-carbon growth option contributing to energy security, sustainable forest management and poverty alleviation.

**IT IS ESTIMATED
THAT VIRTUALLY ALL
CHARCOAL IN RWANDA
IS NOW MADE FROM
PLANTED TREES, ON
PRIVATE AS WELL AS
COMMUNITY LAND.**

**EVEN THOUGH ALMOST
EVERY FARMER IN THE
COUNTRY HAS SET ASIDE
A SMALL PART OF HIS
LAND FOR EUCALYPTUS
TREES, FARMERS AND
CHARCOAL PRODUCERS
STILL ONLY EARN A
MINOR SHARE OF THE
OVERALL VALUE-ADDED**

Even though almost every farmer in the country has set aside a small part of his land for Eucalyptus trees, farmers and charcoal producers still only earn a minor share of the overall value-added. Indeed the charcoal trade is dominated by a small number of powerful and well-connected entrepreneurs.

If farm-gate prices for wood and charcoal are too low, farmers will not replace or maintain trees that they harvested. Therefore, it is understandable that **farmers do not like the heavy regulation governing the harvesting of trees that they planted themselves**. Over the last few years the Government and other institutions have supported tree plantations and the promotion of charcoaling techniques that make more efficient use of the available wood resources and also improve the quality of the produced charcoal. However, **mainly the traders in the charcoal sector have benefitted from these improvements** and not the charcoal producers, as they are not in direct contact with customers in urban areas.

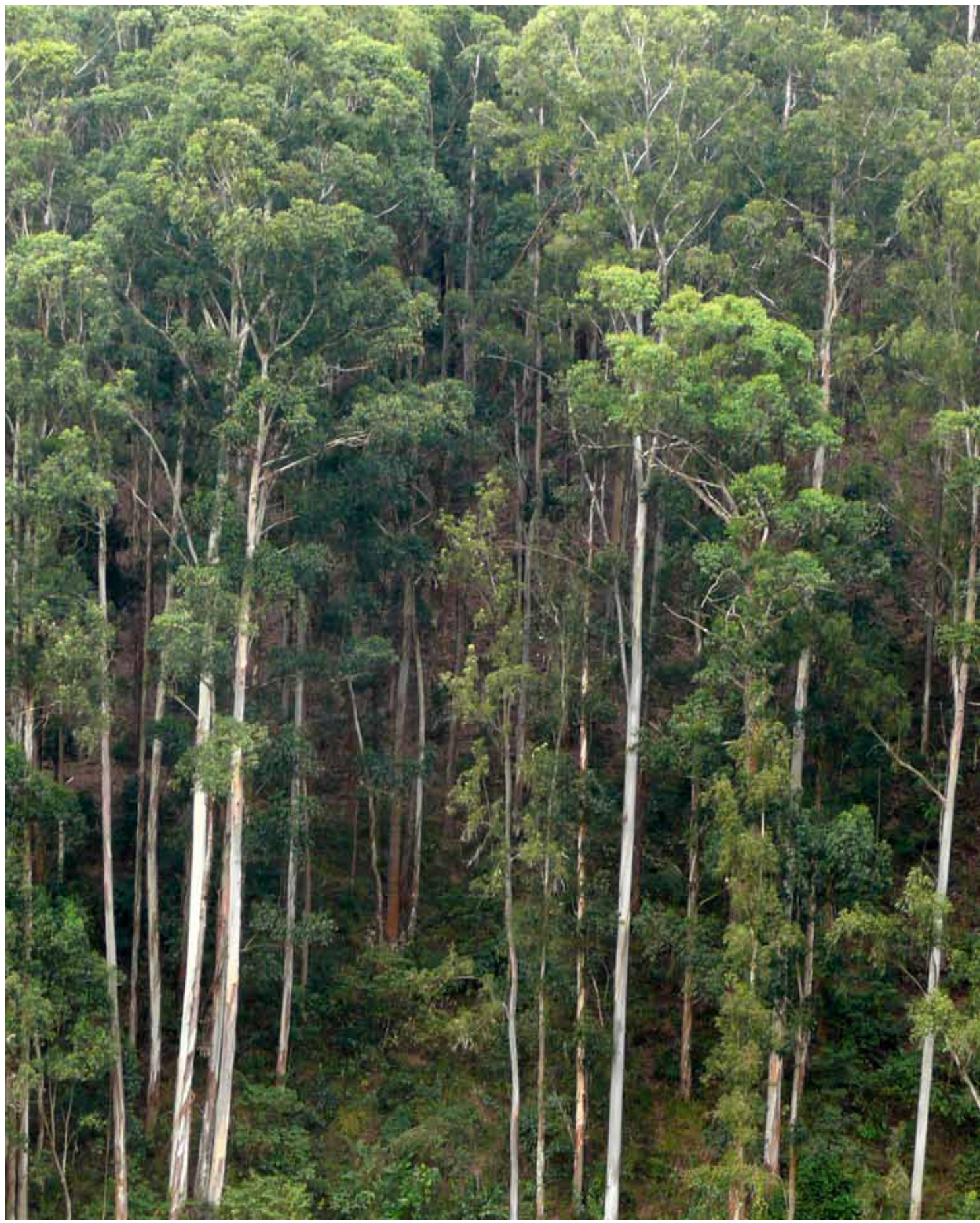
One possible solution could be a “green charcoal chain” where producers receive a price premium for sustainably produced charcoal. This price premium could potentially be achieved in two principle ways: (1) end consumers pay a price premium for charcoal that has been certified as produced in a sustainable manner according to standardized principles and criteria; and, (2) certified charcoal production is linked to carbon finance due to certified lower greenhouse gas (GHG) emissions along the charcoal value chain from forest to market. Due to the high price elasticity of demand for certified “green” charcoal (i.e., consumers are unwilling to pay a large price premium), the former is rather unlikely to be achieved. In contrast, certified GHG emissions along a sustainable, “green” charcoal chain could potentially provide additional value-added – and hence additional income – to tree growers and charcoal producers alike.

But modernizing the charcoal sector and bringing it out of its largely “informal” status carries another important benefit: Revenue collection could be significantly enhanced to leverage needed resources for investments in sustainable natural resource management and other aspects of economic development.

In this context, **the present feasibility study focuses on the elaboration of a road map to develop a modern and efficient charcoal value chain**. Box 1 summarizes the objectives of this study.

**BOX 1:
OBJECTIVES OF THE
STUDY**

- Summarize the structure of the charcoal value chain in Rwanda (from secondary documentation)
- Describe the principle elements of a “green” charcoal chain
- Outline the requirements for a “green” charcoal chain to be certifiable, i.e. needed reforms, such as the socio-organization of charcoal producers (kiln to wood vs. wood to kiln) as well as the provision of special permits favoring the “green” charcoal chain
- Describe possible policy tools to benefit from a certified “green” charcoal value chain, such as differential taxation (e.g. tax benefits for certified “green” charcoal)
- Describe in detail the potential for GHG emission reductions along a “green” charcoal chain
- Describe alternative carbon finance options (e.g. voluntary market versus CDM) along the charcoal value chain and illustrate the role of certification in the context of carbon finance
- Elaborate how promotion of Improved Cook Stoves (ICS) can be part of carbon finance options, although outside the charcoal value chain
- Design a road map for implementation/an implementation plan for a “green” charcoal chain, including certification
- Calculate the (up-front) investment needed to realize a “green” charcoal chain (a) in general and (b) as a pilot phase
- Develop ToR for the realization of a pilot phase to support the development of a “green” charcoal chain to be funded under the Global Environment Facility (GEF) project



B FRAMEWORK

B.1 RWANDA OVERVIEW

Table 1 gives an overview of some basic statistical figures.

Category	Value
Total area	2,634,000 ha
Land area	2,467,000 ha
Inland water	167,000 ha
Population	11,370,425 (2011)
Age structure	0–14 years: 42.9% (male 2,454,924/female 2,418,504)
Growth rate	15–64 years: 54.7% (male 3,097,956/female 3,123,910)
Density	65 years and over: 2.4% (male 110,218/female 164,913) (2011)
Climate	2.79%
Average temperature	408 inhabitants/km ² (2010)
Altitude	Two rainy seasons (February–April, November–January), mild in mountains with frost and snow
Main water bodies	24.6–27.6° C (hottest months: August–September)
Vegetation	From 1,000–4,500 m above sea level
GDP per capita	Highest point is Karisimbi volcano (4,507 m)
Inflation rate	Lake Kivu, Lake Muhazi, Lake Ihema, Lake Bulera, Lake Ruhondo, Lake Mugesera
Gini index	Ranges from dense equatorial forest in the north west to tropical savanna in the east
Agriculture	540 USD (2010)
Industries	7.4% (as of 2011)
Electricity – production	46.8
Electricity – consumption	Coffee, tea, pyrethrum, bananas, beans, sorghum, potatoes, livestock
Electrification rate	Cement, agricultural products, small-scale beverages, soap, furniture, shoes, plastic goods, textiles, cigarettes

TABLE 1:
RWANDA STATISTICS:
GEOGRAPHY AND
ECONOMICS

**THE EQUATORIAL
CLIMATE IS MODIFIED
BY THIS WIDELY
VARYING ALTITUDE
ACROSS THE COUNTRY.
IT LEADS TO A MORE
TEMPERATE CLIMATE
THAN IN MUCH OF THE
REST OF EAST AFRICA**

Category	Value
Oil – production	138.79 million kWh (2007)
Oil – consumption	210.13 million kWh (2007)
Oil – proven reserves	6% (urban 35%, rural 1%; 2007/2008)
Natural gas – production	5,300 bbl/day (2005)
Natural gas – proven reserves	0 bbl/day (2007)
Exports	170.8 million USD F.o.B. (2007)
Exports – commodities	Coffee, tea, hides, tin ore
Exports – partners	China (10.3%), Germany (9.7%), USA (4.3%) (2006)
Imports	472.5 million USD F.o.B. (2007)
Imports – commodities	Food, machinery and equipment, steel, petroleum products, cement and construction material
Imports – partners	Kenya (19.6%), Germany (7.9%), Uganda (6.8%), Belgium (5.1%) (2006)
Exchange rate	1,000 RwF = 1.5885 USD (2012)

Source: [3, modified, 4, 17, 22]

B.2 NATURAL RESOURCES

B.2.1 CLIMATE

Rwanda has a complex climate that is dominated by a strong seasonality and characterized by wide variations across the country. It is primarily a mountainous country, with an average altitude of 900 m in the southwest; 1,500 to 2,000 m in the south and centre; 1,800 to 3,000 m in the highlands of the north and the west; and, 3,000 to 4,500 m in the regions of the Congo-Nile Crest and the chain of volcanoes. The lowlands are principally situated in the Eastern Province.

This widely varying altitude modifies the equatorial climate across the country. It leads to a more temperate climate than in much of the rest of East Africa. **Average annual temperature in Rwanda ranges between 16°C and 20°C** though temperatures are much lower in the higher mountains [12].

The country has a particularly variable and complex pattern of rainfall within a range of tens of kilometers. **Average rainfall is around 1,250 mm** per annum. In broad terms, the annual cycle is bimodal **with two wet seasons: the long rains from mid-September to mid-December and from March to May**. The two wet seasons arise from the Inter-Tropical Convergence Zone (ITCZ) moving northwards and retreating southwards, respectively. Overall, there are significant inter-annual and spatial variations in the strength and timing of these rains. There are complex patterns of climate variability, which are due to many factors, notably the El Niño–Southern Oscillation (ENSO) events, though also to sea surface temperatures in the Indian and Atlantic Oceans. El Niño is associated

with abnormally wet conditions during the short rains and some El Niño events (such as in 1997) with extreme flooding. La Niña conditions are associated with unusually dry conditions as seen during the 2000 drought [12].

Given their high complexity and heterogeneity, **projections of future climate change are very uncertain** at the global scale. Analysis of historical temperatures in Kigali indicates that minimum temperatures have been rising faster than maximum temperatures but with a general overall rise in temperature particularly since 1992. All climate model scenarios show future increases in mean annual temperature of around 1.5 to 2.7°C by the 2050s [12].

Changes in precipitation are more uncertain. Climate model scenarios show that average annual rainfall will actually increase, particularly in some seasons, indicating a potential strengthening of the rains, which is important in relation to flood risk. However, some models show reductions in rainfall in some months. A shift in the timing of seasons is already being reported in certain regions and this could have a significant impact on agriculture [12].

B.2.2 HYDROGRAPHY

The Congo-Nile Ridge divides the country along the two watersheds of the Nile Basin and the Congo Basin, which account for 60% and 40% of Rwanda's total water, respectively. The Rwandan part of the Congo basin consists only of insignificant, short rivers that flow into Lake Kivu. The Nile Basin covers the greatest part of the territory. Most rivers originate from the slopes of the Congo-Nile Ridge [13].

B.2.3 SOIL CONDITIONS

Rwanda, the land of a thousand hills, is also characterized by numerous soil types whose development is affected by distinct variations in altitude and climatic parameters. The agricultural soil value varies from very poor in the eastern savannah to excellent, for example, at the shores of Lake Kivu. Six types of soil characterize Rwanda's pedology:

- Soil derived from schistose, sandstone and quartzite formations, dominating about 50% of total soil
- Soil derived from granite and gneissic formations, representing about 20% of total soil
- Soil derived from intrusive basic rocks, covering hardly 10% of the national territory
- Soil derived from recent volcanic materials, occupying 10% of the territory
- Soil derived from old volcanic materials, characterizing 4% of the territory
- Alluvial and colluvial soil, a feature of marshes in Rwanda, dominating 6% of the territory.

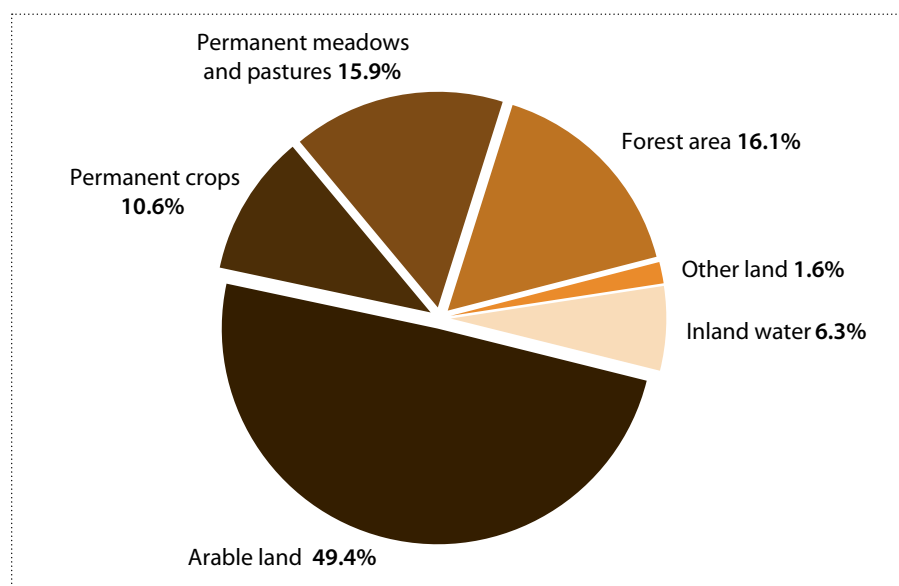
B.2.4 LAND USE

Figure 1 gives an overview of land use in Rwanda. **Almost 76% of rural land (2,467,000 ha) in Rwanda is used for growing crops and for pastoral farming, while 16% is forested.** Around 1.6% is classified as "other land", which refers to all

**RWANDA, THE LAND
OF A THOUSAND
HILLS, IS ALSO
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DISTINCT VARIATIONS
IN ALTITUDE AND
CLIMATIC PARAMETERS**

land that is neither agricultural nor forested, including built-up and related land, barren land and other wooded land [17].

**FIGURE 1:
LAND USE IN RWANDA**



Source: [17]

Six per cent of the land is occupied by inland water, a large part of which consists of lakes, such as Lake Kivu. Shared with the Democratic Republic of the Congo (DRC), some 102,800 ha of Lake Kivu are on the Rwandan side of the border [17].

According to the FAO Global Forest Resources Assessment (FRA), natural forests and manmade forests cover a total area of 435,000 ha of which 62,000 ha (15%) are natural forests and 373,000 ha (86%) represent forest plantations [19]. However, **official Rwandan statistics show an area of 215,739 ha and 114,837 ha for natural forests and forest plantations (> 0.5 ha), respectively** [20, 22]. In addition to these forest resources, according to the FAO definition of forests, there are others composed of small wood lots (with an area of less than 0.5 ha) and other **trees outside forests (TOF) that are believed to represent an area of 222,520 ha countrywide, equivalent to conventional forests** [20]. Nevertheless, it should be noted, that figures on TOFs vary dramatically between 5,300 and 222,520 ha [1, 2, 18, 19, 20, 22].

B.2.5 LAND DISTRIBUTION AND ACCESS TO LAND

According to the Organic Land Law, land in Rwanda is categorized into two sections: **individual and public land**. The latter is subdivided into two categories: **state land in the public domain and state land in the private domain**. State land in public domain includes national land reserves for environment conservation, land on which administrative buildings are erected, state roads and land containing lakes, rivers, streams and springs. State land in the private domain includes swamps that may be productive in terms of agriculture, vacant land with no owner, land purchased by the state, donation, land acquired through expropriation and land occupied by state owned forests. **Land in Rwanda is predominantly individual land** [28].

Land as an asset is taxable. Land tax serves as a significant source of revenue for local government. On developed land the tax is on immovable property at a rate determined by the district council between 0.1% and 0.2% of the property value. Where the plot has not yet been developed and is held under lease or “contrat de location”, tax is charged at a fixed rate per square meter depending on the district. Agricultural land below five hectares is exempt and fractions of a hectare are not considered. Separate rates apply for tourism sites and for mining and quarrying [28].

Access to land is a major challenge for Rwandan farmers. The average value for land size cultivated from the Integrated Household Living Conditions Survey or Enquête Intégrale sur les Conditions de Vie des ménages (EICV) 2 survey [14] is 0.81 ha (compared to 0.76 ha in EICV1). Based on the survey, farmers are classified in four categories based on the size of the land area they cultivate:

- Very small cultivators, less than 0.2 ha per farming household
- Small cultivators, between 0.2 and 0.7 ha
- Medium cultivators, from 0.7 to 5 ha
- Large farmers, more than 5 ha.

More than 60% of households cultivate less than 0.7 ha and more than a quarter cultivate less than a 0.2 of a hectare. Very few households cultivate large land areas. In general, the proportion of households in each of these land size categories has changed relatively little over the last 5 years. Unsurprisingly, land size category is related to a household’s consumption quintile. More than 70% of households in the lowest consumption quintile cultivated less than 0.7 ha and more than 50% of those in the top quintile cultivated more than 0.7 ha. By province, the Southern and Western provinces plus the city of Kigali, have the highest proportion of households in the very small cultivation category. The Eastern province has the largest proportion of cultivators in the medium and large category [14].

While the problem of insufficient access to land can be partly attributed to the high population density, another contributing factor is the highly unequal distribution of land. Rwanda has a high Gini coefficient in terms of land per capita of 0.48 [4, 14]). The highest per capita land quartile has control over about 8 to 20 times more land than households in the lowest quartile [15, 16]. It is important to distinguish between land ownership and land leasing. According to a new presidential order, land ownership must not exceed 25 ha. This order does not apply to leased land. There seems to be a growing trend for the most productive lands (e.g. marshlands) to be leased to investors or producer associations [2].

More than 90% of all households own some farming land. In that sense landlessness affects a very small proportion of the population. By quintile, there was a reduction in the proportion of landowners in the lowest quintile and an increase in the highest quintile within the last five years. This is consistent with the shift to greater reliance on wage labor in the lowest quintile. Lack of access to land may be an important driver of this trend. Among cultivating households, the very smallest cultivators rent in, sharecrop in or borrow a higher proportion of their cultivated area compared to larger farming categories. Across all farm-size categories, the proportion of cultivated area that was rented in or borrowed by the farmer rose over this period and the share that was owned fell [14].

WHILE THE PROBLEM OF INSUFFICIENT ACCESS TO LAND CAN BE PARTLY ATTRIBUTED TO THE HIGH POPULATION DENSITY, ANOTHER CONTRIBUTING FACTOR IS THE HIGHLY UNEQUAL DISTRIBUTION OF LAND.

Establishing a Green Charcoal Value Chain in Rwanda - A Feasibility Study

The country's administrative organization is guided by the principle of subsidiarity. The Central Government agencies' roles and responsibilities are mainly in policy formulation, regulation and support to local governments through capacity building, financing and monitoring and evaluation. Local governments with administrative entities are mainly in charge of implementing government policies and service delivery, and provide an avenue for citizen feedback and accountability.

The district is the basic political-administrative unit of the country. Districts are responsible for coordinating public service delivery and economic development. They are divided into 418 sectors, which are responsible for public service delivery as mandated by the districts. Districts and sectors have directly elected councils and are run by an executive committee selected by that council. Cells are the smallest political unit, providing a link between the people and the sectors.

A detailed map of Kigali Province, Rwanda, showing its administrative districts. The province is divided into four main regions: Northern Province (light grey), Eastern Province (light brown), Western Province (light blue), and Southern Province (yellow). The districts are labeled as follows: Northern Province includes Nyagatare, Gatsabo, Kicukiro, Gasabo, Nyarugenge, and Nyakubera; Eastern Province includes Kayanza, Kirehe, Ngora, Bugesera, and Kiruhura; Western Province includes Rubavu, Nyabihu, Gakenke, Rutsiro, Ngororero, Muhanga, Kamonyi, Karongi, Nyanza, Nyanagabe, Nyanuguru, Gisagara, and Huye; Southern Province includes Rubizi and Nyanagabe. The map also shows the locations of Kigali, Gashyamba, and Kibuye. A scale bar indicates distances up to 20 km, and a north arrow is present in the top right corner.

B.4 POPULATION

Rwanda is the most densely populated African country. Its population was estimated at **11.37 million** in 2011 by the CIA World Fact Book [4], which marks a steady and rapid increase from more than 2.0 million in 1950 and 5.2 million in 1980 [2]. The population is expected to reach 14.47 million in 2020. With an average of **about 408 inhabitants per km²**, pressure on the land is high [4]. Kigali has a very high population density of more than 1,500 people per km²; the northern regions of the country are also densely populated [2]. **For 2011, the natural growth rate is estimated to have been 2.7%**. Life expectancy at birth is about 58 years [4].

Habitation patterns have changed considerably. Over the last decade, Kigali has grown from around 300,000 to close to 1 million, and new rural settlements known as “Imidugudus” are emerging. Around 19% of total the population (2010) is living in urban areas and the annual rate of urbanization between 2010-15 is estimated to be 4.4% [4].

B.5 ECONOMIC BACKGROUND

Rwanda is a poor rural country with about 90% of the population engaged in (mainly subsistence) agriculture and some mineral and agro-processing. Tourism is now Rwanda’s primary foreign exchange earner and, in 2008, minerals overtook coffee and tea as Rwanda’s primary export. Minerals exports declined 40% in 2009-10 due to the global economic downturn. The 1994 genocide decimated Rwanda’s fragile economic base, severely impoverished the population, particularly women, and temporarily stalled the country’s ability to attract private and external investment. However, Rwanda has made substantial progress in stabilizing and rehabilitating its economy to pre-1994 levels. **GDP has rebounded with an average annual growth of 7-8%** since 2003 and inflation has been reduced to single digits [4]. Nonetheless, a significant percentage of the population still lives below the official poverty line.

Rwanda continues to receive substantial aid money and obtained IMF-World Bank Heavily Indebted Poor Country (HIPC) initiative debt relief in 2005-6. In recognition of Rwanda’s successful management of its macro economy, in 2010, the IMF graduated Rwanda to a Policy Support Instrument (PSI). Rwanda also received a Millennium Challenge Threshold Program in 2008. Africa’s most densely populated country is trying to overcome the limitations of its small, landlocked economy by leveraging regional trade. Rwanda joined the East African Community and is aligning its budget, trade and immigration policies with its regional partners [4].

The Government has embraced an expansionary fiscal policy to reduce poverty by improving education, infrastructure, foreign and domestic investment and pursuing market-oriented reforms. **The pace of reform has increased during 2007-8 and is reflected in Rwanda moving up from 148 in 2007 to 58 in 2011 on the World Bank’s Doing Business ranking** [6]. Rwanda was also deemed one of the fastest reforming countries.

During recent years, **Rwanda has made considerable gains on a number of focus areas** [5]:

- Primary school enrolment has risen sharply
- Access to health insurance was scaled up from 7 to 75% of the population between 2003 and 2008, leading to increased use of health services
- 65% of Rwandans now have access to an improved water source.

RWANDA IS A POOR RURAL COUNTRY WITH ABOUT 90% OF THE POPULATION ENGAGED IN (MAINLY SUBSISTENCE) AGRICULTURE AND SOME MINERAL AND AGRO-PROCESSING.

**DESPITE RWANDA'S
FERTILE ECOSYSTEM,
FOOD PRODUCTION
OFTEN DOES NOT KEEP
PACE WITH DEMAND,
REQUIRING FOOD
IMPORTS.**

Despite the gains in social services, growth has slowed. After the genocide and associated conflicts (1996-2000), real GDP grew at over 10% per year as the economy recovered from a low base. After a decade of economic and political stability, this post-conflict economic growth recovery effect was temporarily wearing off. GDP growth was in the range of 4 to 6% between 2004 and 2006. Estimates are that the economy grew by 8.5% in 2008, fueled, in large part, by a strong recovery in agriculture, which grew by nearly 15%, with the ongoing expansion of the crop intensification program. This contrasts with the 7.9% growth that occurred in 2007 which was driven by growth in the services and manufacturing sectors; agricultural output expanded by just less than 1% in 2007 due mainly to poor weather conditions which also contributed to a 50% decline in coffee output [5]. Anyhow, the **growth rates needed remain in the range of 4% to 6% in the long term**, to meet the GoR's 2020 poverty reduction targets [5, 8].

In August 2011, the Consumer Price Index (CPI, all urban general index) was at 111.3. This stands for an increase of 0.43% over the previous month which was 110.8. In annual change it increased by 7.52% compared to 7.14% in the previous month. The underlying inflation rate increased by 0.72% if compared to the previous month and increased by 8.15% on annual change. The annual average underlying inflation rate was 3.0% in August. In annual change, the increase in the general index is mainly due to the rising prices of food and non alcoholic beverages (10.25%), Housing, water, electricity, gas and other fuels (2.83%), transport (12.93%) and education (20.76%) which contributed +3.60% , +0.62%, +1.67% and +0.71% , respectively [23].

Rwanda is a member of the Common Market for Eastern and Southern Africa (COMESA) and of the Economic Community for the Great Lake Countries (CEPGL).

B.6 AGRICULTURE

Despite Rwanda's fertile ecosystem, food production often does not keep pace with demand, requiring food imports. As shown in section B.2, subsistence agriculture remains the predominant farming system in Rwanda, characterized by small family farms. In 2001, **agriculture contributed 46% to GDP in real terms and accounted for 87% of employment and 80% of exports**. In 2003, the contribution of agriculture to GDP declined to 43% as the service sector has been growing. It declined further to 36.4% in 2006. Despite this decline in the share of GDP, agriculture still employs about 86.3% of the country's working population and is a major source of livelihoods for a majority of the population. Agriculture, therefore, will continue to be the mainstay of the Rwandan economy for the foreseeable future [11]. However, around 30 to 50% of the rural population in a given year may not produce a marketable surplus [1].

That said, Rwanda's land resources are utilized in an inefficient and unsustainable manner. Landholdings in the country are very small with 50% cultivating less than 0.5 ha, and more than 25% cultivating less than 0.2 h (see also section B.2.5). The number of differently cropped plots within each farm ranges from one to 15 and crops are grown on steep slopes up to and above 55% [10]. This fragmentation makes the farming systems economically and technically unviable. The area used to cultivate major food crops each year was estimated at just 0.08 ha per person in 2008 [2]. However, land consolidation is on-going, particularly in some marshlands and inland valleys.

With its climatic, geographic and edaphic conditions, Rwanda has 12 main agricultural regions that are differently suited for a diversity of crops. While the central and western areas receive enough rain, the east is often subject to seasonal rainfall fluctuations, resulting occasionally in low agricultural production. Soil quality varies from excellent in the Imbo Region to very poor in the eastern savannah region. In areas devoted to food crop cultivation, the major crops are bananas (21%), beans (20%), cassava (9%), sweet potatoes (9%), potatoes (8%), maize (8%) and sorghum (8%) [2].

Rwandan agriculture is essentially rain fed and, in general, not artificially irrigated. Farming systems are characterized by the use of crop rotation and intercropping with plants that farmers have adapted to cope with land scarcity. Therefore, more than four crops can often be found growing at the same time on the same plot.

The great scarcity of land has forced farmers to abandon the use of fallow periods. Generally, areas of fallow land are almost non-existent in Rwanda [2]. Overexploitation associated with heavy rains, steep slopes, tillage systems and a lack of anti-erosion structures accelerates land degradation, lowers agricultural productivity and is a threat to food security. Soil loss per hectare from cropped hillsides ranges between 80 and 100 m³ per year [11]. Rwanda loses an estimated 945,200 t of organic material, 41,210 t of nitrogen, 280 t of phosphorus and 3,055 t of potassium each year through soil erosion [20].

Currently, a radical program of terracing is being implemented at district level through the contracts performance [2]. Land degradation and resulting deterioration in soil fertility have lowered soil productivity. Despite efforts to intensify agriculture, soil productivity has declined or remained stagnant. The combination of rapid population growth and limited availability of agricultural land in combination with low agricultural productivity has resulted in a number of mutually reinforcing problems in Rwanda's rural sector. It is necessary to increase labor productivity and incomes, but this is hampered by limited chances for market development [1].

Livestock has an important role in Rwandan agriculture as a provider of manure to fertilize plots. While livestock is much more extensive in the east, in the rest of the country it is intensive and characterized by zero grazing [2].

B.7 TRANSPORT

Over 90% of transport in the country takes place by road. There are no railways, and waterways are only used to a limited extent. Infrastructure bottlenecks in urban areas and limited access in rural areas have emerged as a significant constraint to continuing economic growth and human capital development. Vision 2020 (see section B.9.1.1) envisages the development of a railway network to join up with the Tanzanian and Ugandan railway systems [9]. Rwanda has a road network of around 14,000 km, 19% of which are paved [2].

Rwanda's transport sector is entirely dependent on imported fuel and consumes approximately 75% of imported petroleum products. In 2008, 167 million litres of gasoline and diesel were consumed. Demand is forecast to grow at around 10% per annum until 2020 [2]. Being a land-locked country, Rwanda has to import petroleum products using long and expensive routes. The main supply routes are through Kenya/Uganda and Tanzania. The limited choice of routes

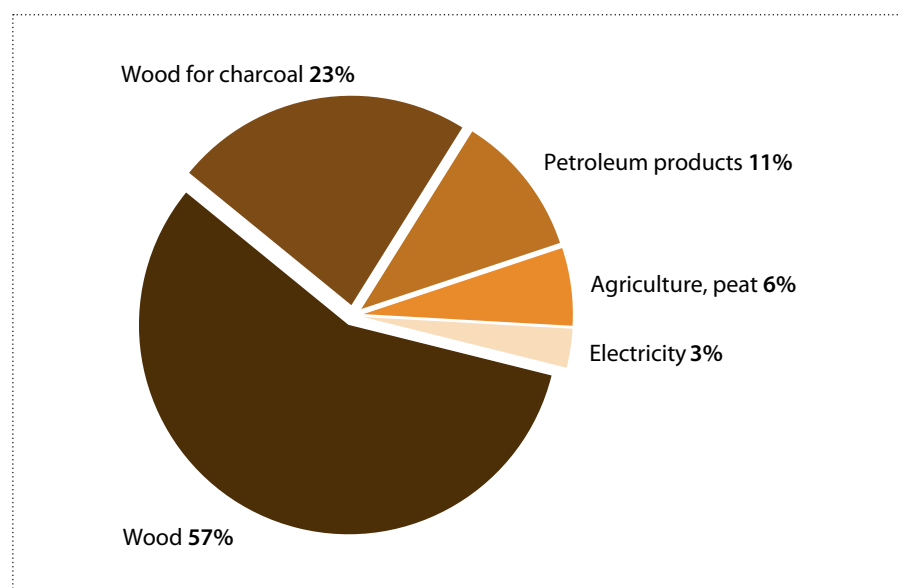
**THE GREAT SCARCITY
OF LAND HAS FORCED
FARMERS TO ABANDON
THE USE OF FALLOW
PERIODS.**

means that Rwanda is dependent on the political stability of the neighbouring regions and is particularly vulnerable to interruptions of supply. Together with fuel price fluctuations on the international market, this increases uncertainty surrounding the security of supply to the country.

B.8 THE ENERGY SECTOR IN RWANDA

Figure 3 illustrates the current primary energy supply situation in Rwanda. Although there is a downward trend, **today approximately 86% of primary energy comes from biomass** in the form of wood. It is used directly as a fuel (57%) or is converted into charcoal (23%) together with smaller amounts of crop residues and peat (6%). Of the 14% of non-biomass primary energy, petroleum products account for 11% and electricity for approximately 3% [21]. About **20-25% of the primary energy is lost in diesel power generation, charcoal making, electricity transmission and distribution losses** [1, 3]. Charcoal conversion losses amount to one-third of the total volume of wood used [1].

FIGURE 3:
PRIMARY ENERGY
BALANCE



Source: [1, 21]

Rwanda's demand for energy has grown rapidly by 25% per year due to **population growth and the increase in economic activities**. Rapid urbanization and industrial demands – combined with limited access to electricity and the high cost of petroleum products – add pressure on the wood fuel supply systems. Wood and charcoal remain the most significant – and often the only – fuels available to households and the productive sectors of the economy. Even in urban areas such as Kigali, all but the richest five per cent of households rely on charcoal for their thermal energy needs.

Rwanda is the most densely populated country in Africa but still has some of the lowest electricity access rates in the continent. **Only 13% of households are connected to grid power** [85], mainly in Kigali and other cities, and roughly 1% of the rural population uses electricity. **The electricity consumed in Rwanda has changed from almost entirely hydro-generated to largely thermal-generated at present**. This has been a result of a high demand for electricity and unexpectedly low reservoir levels [3]. At about 20 kWh to 25 kWh per year, the per capita consumption of electricity and oil products is among the lowest in the world and low even in

comparison to neighbouring countries. This is mainly due to the low electricity access and limited industrial production [5].

The available electricity generation capacity in Rwanda is at 69 MW [24]. Figure 4 shows the share of different electricity generation categories. Rwanda's electricity consumption is around 210 GWh, but only 138 GWh were produced within the country. 69 GWh are imported from Rusizi I power plant (DRC) as well as from Rusizi II (Uganda) [3].

Rwanda's Government is committed to diversify the country's sources of energy, and a number of large investments are underway (see below). **The country's electricity supply has been erratic in the early years of the decade because of the national grid's heavy reliance on hydroelectric power, which in turn depends on rainfall.** In the past years, poor rainfall caused several electricity shortages [3]. Although diversification of energy sources is a high priority, the Government of Rwanda continues to develop hydropower as the least cost generating resource. Rwanda's elevation provides abundant opportunities for hydroelectricity production. The Ministry of Infrastructure (MININFRA) has identified 333 potential sites for small hydropower plants with a capacity between 50 KW and 1 MW each [5]. Apart from shares in the regional hydropower plants, Sinelac and Ruzizi I (SNEL), Rwanda is not connected to any regional transmission network. The relative isolation of such a small power sector creates challenges as larger, more financially attractive options might not be feasible due to limited demand.

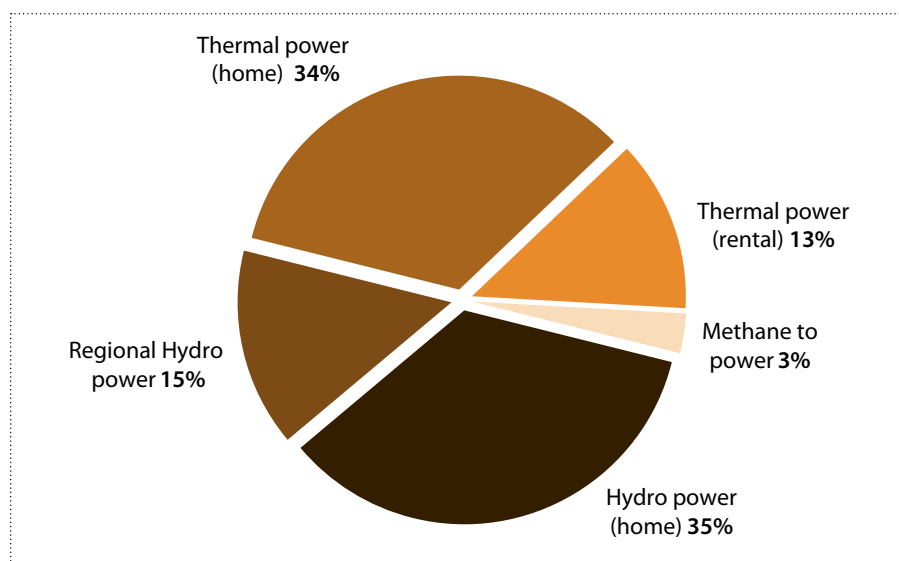


FIGURE 4:
ELECTRICITY GENERATION

Source: [24]

Electricity prices in Rwanda are therefore among the highest of all East African countries with around 123 RwF/kWh (0.20 USD, cf. Table 2) [3]. In addition to high inland transport costs from Eldoret or even Mombasa, imported oil products are also subject to various duties and taxes. As a result, on average, retail prices of petroleum products are about 100 per cent higher than acquisition costs f.o.b. main supply sources. The dependency on rental diesel capacity has resulted in Rwanda having one of the highest tariffs in Sub-Saharan Africa. Rapid increases in world oil prices, combined with ad valorem duties and taxes, have thus had a significant negative impact on the country's growth prospects. Imported petroleum products require additional power generation, imposing yet a further unavoidable burden on the macro economy [5].

TABLE 2:
PRIVATE CONSUMER
ENERGY PRICES IN RWANDA

Electricity (RwF/kWh)	Premium (RwF/l)	Gasoil (RwF/l)	Kerosene (RwF/l)	Charcoal (RwF/kg)
123	726	726	623	200

Source: [1, 21]

Rwanda's oil consumption averages about 5,300 barrels per day (bbl/day), which is almost all imported through the port of Mombasa, Kenya. Kerosene is used extensively in rural areas for lighting and, to some extent in urban areas, for cooking and lighting [3].

Rwanda has **natural gas reserves** identified as methane in Lake Kivu. Currently, 4.5 MW of electricity are generated in a pilot plant and other projects are underway. The reserves of methane gas deposits in Lake Kivu are estimated be sufficient for 350 MW of electricity power [3].

The **National Domestic Biogas Program (NDBP)** aims to install at least 15,000 biogas digesters in rural households to provide sufficient energy for cooking and lighting. So far, over 2,100 biogas digesters have been installed in rural households [84]. Biogas has also been used in prisons and schools where it is produced with waste from the latrines. Rwanda has even been internationally recognized for its achievement, which has reduced the cost of cooking in prisons by 40% [3].

To date, Africa's largest grid-connected **solar plant, Kigali Solaire**, is in operation at Mount Jali on the outskirts of Kigali. The plant feeds 250 kWp into the grid and plans are to expand to a capacity of 1 MWp [3].

The 5-year-electricity strategy (2011–17) aims to supply modern energy to all Rwandans and cover the existing energy deficit. The 2017 target for key energy sources (hydro, methane, geothermal and peat) is to generate an additional 1,000 MW from both indigenous and shared energy resources with neighbouring countries [85].

Rwanda is a signatory to the Clean Development Mechanism (CDM) and has therefore created a **Designated National Authority (DNA)**. A permanent secretariat has identified a number of projects for technological and socio-economic innovation such as energy saving lamps, hydropower, biogas, methane gas, solar for water purification and voluntary credits for reforestation, amongst others.

B.9 INSTITUTIONAL AND LEGAL FRAMEWORK RELATED TO BIOMASS ISSUES

B.9.1 POLICY CONTEXT

B.9.1.1 Planning documents guiding national development

Rwanda has elaborated a number of planning documents to guide national development over different time horizons. The nation's current priority socio-economic goals form the basis of the **Economic Development and Poverty Reduction Strategy (EDPRS)**, which covers the period 2008–12 [8]. The EDPRS is the medium-term programmatic framework for achieving the country's long-term

development aspirations as embodied in Rwanda Vision 2020 [9], as well as the intermediate targets in the 2015 **Millennium Development Goals (MDGs)**.

1. VISION 2020

The Vision 2020 seeks to transform Rwanda into a middle-income country by 2020. This will require achieving annual per capita income of USD 900 (USD 220 in 2000), a poverty rate of 30% (60% in 2000) and an average life expectancy of 55 years (49 years in 2000). **The Vision 2020 is based on six pillars:**

- Good governance and a capable state
- Human resource development and a knowledge based economy
- A private sector-led economy
- Infrastructure development
- Productive and market oriented agriculture
- Regional and international economic integration.

These pillars are interwoven with three cross-cutting issues (CCI): gender equality, protection of the environment and sustainable natural resource management, and science and technology.

With regard to energy, the **Vision 2020 focuses on the increase of energy production and diversification into alternative energy sources**. The Vision projects that by 2020, at least 35% of the population will be connected to electricity and the consumption of wood will decrease to 50% of national energy consumption. To ensure sustainable development, the Vision 2020 envisages the implementation of adequate land and water management techniques, coupled with a sound biodiversity policy. Vision 2020 sets the target for the forest cover to reach 30% of the national land area by 2020 and the protection rate against erosion to rise from 20% in 2000 to 90% by 2020.

**THE VISION 2020
SEEKS TO TRANSFORM
RWANDA INTO A
MIDDLE-INCOME
COUNTRY BY 2020.**

2. ECONOMIC DEVELOPMENT AND POVERTY REDUCTION STRATEGY (EDPRS)

The EDPRS builds on strong achievements in human capital development and **promotes three flagship programs**. They serve as a means to prioritize actions by the GoR, mobilize resources for development and improve policy implementation through more coordinated interventions across sectors [8]:

- **The first flagship**, sustainable growth for jobs and exports, will be driven by an ambitious, high quality public investment program aimed at systematically reducing the operational costs of business, increasing the capacity to innovate, and widening and strengthening the financial sector.
- **The second flagship**, Vision 2020 Umurenge, will accelerate the rate of poverty reduction by promoting pro-poor components of the national growth agenda. This will be achieved by releasing the productive capacity of the poor in rural areas through a combination of public works, promotion of cooperatives, credit packages and direct support.
- **The third flagship**, governance, provides an anchor for pro-poor growth by building on Rwanda's reputation as a country with a low incidence of corruption and a regional comparative advantage in soft infrastructure.

To implement the EDPRS strategy, the sectoral allocation of public expenditure is distributed to maintain momentum in the social sectors – education, health and water and sanitation – while also targeting agriculture, transport, information

and communication technology, energy, housing and urban development, good governance and rule of law, proper land use management and environmental protection.

In agriculture, the main programs include the intensification of sustainable production systems in crop cultivation and animal husbandry; building the technical and organizational capacity of farmers; promoting commodity chains and agribusiness; and, strengthening the institutional framework of the sector at the central and local levels.

Environmental and land priorities involve ecosystems, the rehabilitation of degraded areas and strengthening newly established central and decentralized institutions. Special attention is paid to sustainable land tenure security through the planning and management of land registration and rational land use, soil and water conservation, reforestation, preservation of biological diversity and mitigation of/adaptation to the consequences of climate change.

EDPRS recommends, amongst others, that the **forestry sector designs and implements a reforestation strategy with diverse species, an inventory and a mapping of national forest resources.** This will provide the basis for a ten-year national forestry plan and a joint strategy with the Ministry of Agriculture and Livestock (MINAGRI) to promote agro-forestry for non-wood uses, including medicinal uses, honey production, wild foods and handicraft production.

EDPRS further proposes an increase of forest and agro-forestry cover from 16 to 23.5% of the total surface land area (equivalent to 89,583 ha); reduction of annual wood consumption by 30% as compared to the 2002 figure; intensification of agro-forestry to up to 85% of farmlands; and, development of a strategy for involving the private sector in forest management.

In infrastructure, the objectives are to reduce transport costs within the country and between Rwanda and the outside world, and to ensure the security of energy supplies by increasing domestic energy production from several sources.

B.9.1.2 Sectoral policies related to biomass

Vision 2020 and EDPRS, together with the Constitution of Rwanda, build the framework for different sectoral policies. **Biomass is interlinked to many development sectors due to its cross-cutting nature.** Table 3 presents major national sectoral policies that are closely related to biomass. The most important ones are highlighted further below.

TABLE 3:
RELATIONSHIPS
BETWEEN SECTORAL
POLICIES/STRATEGIES
AND BIOMASS

Sector	Relationship
Environment	The National Environment Policy and Strategy acknowledges soil erosion and utilization of wood-fuels as two among the major environmental problems facing the country and proposes adequate forest and vegetation cover as one of the solutions.
Population	The National Population Policy recognizes environmental degradation as one of the causes of poverty in Rwanda and recommends that the ministry in charge of forestry should consider land degradation and deforestation as national priorities.
Action Plan for Soil conservation	This action plan elaborated by MINAGRI aims at enhancing soil fertility and water conservation through control of soil erosion. Among the priority actions proposed is agro-forestry using nitrogen fixing and multi-purpose trees.

Energy	In Rwanda, the majority of the population depends on biomass energy. The energy policy proposes to increase production and access to alternative energy for a larger number of people. Strategies proposed include dissemination and promotion of improved stoves as a means of saving wood.
Water	The water policy aims at equitable and sustainable access to clean water for all and enhancement of water resource management through reforestation of water catchment areas.
Agriculture	The National Agricultural Policy and the Agricultural Transformation Strategy aim at ensuring food security by means of increased agricultural production and income generation through crop intensification, diversification and improvement of agro-processing and marketing systems. The increase in agricultural production will be achieved mainly through improvement of soil fertility and erosion control. This is possible through promotion of agro-forestry practices.
Industry	The industrial policy and investment code aim to increase value addition to primary production to boost exports and create more jobs. This policy specifically mentions value addition to forest products through wood processing and woodwork (e.g. production of wooden panels, plywood, match making, etc.).
Gender	The gender policy clearly states the integration of gender issues in all development sectors to promote gender equity and equality. In Rwanda, forests and trees provide the bulk of energy used by most households. The collection of fuelwood is usually the responsibility of women and children. Easy access to forests/trees may eventually improve livelihoods of vulnerable groups, especially women and children.
Land	The overall goal of the land policy is to establish a land tenure system that ensures security for every Rwandan citizen. Thus, the land policy has the ambition to guarantee equal rights on land tenure for every user of the land, so as the latter may invest more in the land and use it rationally. Land tenure has a direct relationship to tree tenure.

Source: [25]

1. FOREST POLICY

The Republic of Rwanda's first written national forest policy was published in 2004. Due to rapid socio-economic and political changes since then, **the national forest policy has recently been revised to meet new challenges facing the sector** [25]. At the global level, new developments in the effort to mitigate climate effects and to adapt to global warming also call for a new interest in forests as carbon sinks, in addition to their traditional ecological and economic roles. The overall goal of the national forest policy is to make the forestry sector one of the bedrocks of the economy and to create a national ecological balance for sustainable benefits to all segments of the society.

The national forestry strategy builds on this revised national forestry policy, which has 14 guiding principles and also constitutes a guide for the implementation of the strategic forestry plan [25]:

- Sustainable Forest Management (SFM)
- Commercialization of forestry operations

- Species diversification
- Agro-forestry technologies
- Special management of ecologically and physically fragile areas to conserve biodiversity and protect areas prone to soil erosion and landslides
- Forestry research
- Stakeholder involvement and partnerships
- Forest management planning
- Private sector involvement
- Decentralized governance
- Management of forests to serve the common good irrespective of ownership because of the multiple roles of forests. (Therefore, any action taken in any forest will be regulated to safeguard the public interest).
- Livelihoods enhancement
- Gender and equity
- Internalization of current and future international forestry conventions, agreements and protocols into all strategies and interventions in the forest sector.

The **Ministry of Forests and Mines (MINIFOM)** has inherited the policy and strategies from its predecessors, respectively the Ministry of Internal Security (MINITERE) and the Ministry of Natural Resources (MINIRENA). The five-year **strategic plan of MINIRENA for the Environment and Natural Resources Sector (ENRSSP)** was approved in June 2009 (see below). The implementation of ENRSSP will ensure that a sustainable use of environmental goods and services, and a rational utilization of natural resources will contribute to national economic growth. The ENRSSP advocates sustainable management of forest and other biomass resources to meet the growing multiple needs for food, fibre, fodder, fuel and environmental services.

The **first legislation on forestry in Rwanda** was Law no. 47/88 enacted in December 1988 [26]. This law was not effectively implemented due to the Civil War that soon followed. Considering the socio-economic and political transformation of the country since its enactment, the need for its review was quite evident [25]. The **new forest law is now at its final stage** of enactment. The draft act reaffirms some fundamental principles [27]:

- The national forest policy elaborated by MINIRENA defines the general direction for implementation and is translated into a National Forestry Plan.
- Each district elaborates a forest management plan with the involvement of relevant public and private stakeholders.
- Management and protection of forests are to ensure that: (1) any negative impact on tree plantations is minimized, (2) development of private forestry and agro-forestry is stimulated, (3) special attention is paid to ecologically sensitive and environmentally vulnerable regions, (4) all forestry interventions will be rigorously planned, (5) forest husbandry practices are to be based on research findings, (6) privatization of public forest management is to be incremental, (7) any public or private forest must be used in consideration of national environmental and ecological interests, and (8) rare and threatened native flora species and fauna are protected.
- The institutional framework defined by the draft act includes the creation of the National Forest Authority and the National Forestry Fund (NFF) [27].

At regional level, Rwanda joined the COMIFAC, a regional organization in the Central Africa Organization aiming to promote cooperation among ten member countries for sound management of their forest resources. Through adhesion, Rwanda committed itself to a rational utilization of its resources in line with the objectives of COMIFAC. In 2007, Rwanda was admitted to the East African Community (EAC), a sub-regional forum with an economic and political agenda aimed at integrating Eastern African countries. This offers even greater opportunities for the forestry sector to play an increased role in Rwandan economic growth [20].

2. ENERGY POLICY

Rwanda's energy policy is mainly based on three documents: the **National Energy Policy** [21], the **National Energy Strategy for 2008-12** [21] and the **Biomass Energy Strategy (BEST) from 2008** [1]. The rationale behind these documents is that increased energy provision is a prerequisite for strong economic growth, which in turn is seen as a prerequisite for tackling poverty.

The new **National Energy Policy** by MININFRA was elaborated in 2008. It is an update of the 2004 Energy Policy statement. The update was needed to [21]:

- Set the National Energy Policy within Rwanda's long-term development plans and strategies
- Give particular attention to requirements for the progressive development of the electricity sector
- Have greater focus on household energy requirements and gender dimensions
- Bring the statement up-to-date by reflecting the latest developments in methane and renewable energies and their environmental implications
- State more clearly Rwanda's commitment to private sector participation and regional cooperation in energy.

The National Energy Policy includes general statements on overall objectives, the development of indigenous energy resources, the importance of energy efficiency, energy pricing and subsidy policies, the regulatory framework and sub-sectors. Most of the energy policy's attention is on increasing access to grid electricity, increasing power supplies and reducing Rwanda's dependence on imports for energy.

In the biomass sub-sector, the production of wood fuel and charcoal from plantations and woodlots is to be expanded and better managed, while the use of briquettes from underexploited forms of biomass (e.g. peat, papyrus and waste) will be promoted for cooking and heating, alongside kerosene, liquefied petroleum gas (LPG) and solar water heating. Small-scale biofuel projects will be supported, and careful research will be carried out to assess the potential for large-scale biofuel production in Rwanda.

Oil exploration is underway in the petroleum sector, and pipeline and rail projects will be analysed to reduce costs and enhance the security of petroleum product supplies. In the electricity sub-sector, access will be enhanced, particularly in rural areas, with costs being reduced and the sources diversified [2, 21].

The National Energy Strategy covering 2008-20 complements updated policy [21]. The strategy outlines the current and future (forecasts) energy situation,

and describes the main programs through which MININFRA is promoting the National Energy Policy objectives.

3. ENVIRONMENTAL POLICY

The National Environmental Policy has been in place since November 2003. It contains policy statements and strategic options for population and land-use management, management and utilization of natural resources and other socio-economic sectors, as well as the necessary arrangements for the implementation of the policy. The policy provides a framework for the reconciliation of the three pillars of sustainable development, namely environment, social and economic issues. The Five-Year Strategic Plan for the Environment and Natural Resources Sector (ENRSP) [29] articulates the main priorities for the sector and the strategies to be undertaken over the period 2009-13.

The overall objective of the ENR sector strategy is to develop sustainable capacities to ensure that environment and natural resources are utilized and managed productively in support of sustainable national development in line with EDPRS targets, MDGs and Vision 2020 aspirations. **This will be realized through eight objectives:**

- Equitable, productive and sustainable use and management of land resources
- Sustainable utilization of water resources through integrated management and conservation
- Adequate and sustainable supply of forest and biomass resources to meet the growing demands for food, fibre, fodder, fuel and environmental services
- Promoting productive, efficient and environmentally sensitive mineral exploration and exploitation
- Restoring, conserving and sustaining management of ecosystems to ensure their continued and enhanced functioning
- Raising awareness of and integrating environmental sustainability principles in all key sectors of the EDPRS
- Strengthening policy and legislative frameworks for sustainable environment and natural resource management by harmonizing policies with legal and regulatory instruments within sectors, and with regional and international frameworks
- Increasing the human and institutional capacity of national and decentralized entities, including civil society and private sector.

This strategy is also an integrated framework for implementing 13 multilateral environmental agreements that the GoR ratified at various points in time and that are presently part of the national priority agenda.

The legal framework for the management of the environment was put in place by the Government of Rwanda with the Organic Law No. 4/2005 of April 2005, which established modalities to protect, safeguard and promote the environment in Rwanda. That law governs the environment in its broadest term (e.g. land, agriculture, forests, water, biodiversity, etc.).

4. LAND POLICY

The National Land Policy is an important part of the regulatory and political framework for reforms related to land use, land tenure and land legislation in Rwanda. It is intended to overcome the previously existing duality of written law and the widely-practiced customary law affecting land in Rwanda. Among the policy's aims is to improve the security of land tenure (e.g. through land registration and land titling) and to encourage more efficient and sustainable use of agricultural land, especially on productive marshlands (e.g. through land consolidation and land use master plans, and by overcoming subsistence-based agriculture). The National Land Policy provides the basis for several other legal and political regulations concerning land use and land tenure [30].

The objective of the National Land Policy is to establish a land administration and land use management system that **guarantees secure tenure for all users, promotes productive and sustainable use of rural and urban land resources and ensures protection of the environment**. Specifically, the policy seeks to [28]:

- Establish mechanisms that procure security of land tenure for the promotion of investments in land
- Promote proper allocation of land and use of land resources, according to their potential
- Discourage land fragmentation and promote consolidated use to optimize production by establishing appropriate mechanisms and incentives
- Orient land management towards more profitable and sustainable production, by making good choices among methods of land development
- Promote techniques that protect land resources from all forms of land degradation
- Establish institutional frameworks and regulatory instruments that enable land to become more valuable as an economic asset
- Streamline and put in place orderly and equitable land allocation, including in land transactions, to relieve pressure on land and control inappropriate development and speculation in land markets
- Sensitize the public and promote their active participation in decision making at all levels to ensure environmental protection and good practices in land management
- Ensure the sustainable use of wetlands.

The Ministry of Environment and Lands (former MINITERE) has developed a strategic road map for **Land Tenure Reform as a framework** for implementing the National Land Policy and the Organic Law determining land use and management in Rwanda [28].

The Land Law [31] regulates different forms of rural as well as urban land tenure. Furthermore, it regulates the management, organization and exploitation of land. Among other regulations, the law provides the basis for land consolidation by prohibiting the reduction of parcels of land of one hectare or less that are reserved for agriculture.

5. DECENTRALIZATION

The **National Decentralization Policy** of 2000 seeks to establish and empower decentralized administration in the areas of devolution, delegation and de-concentration. The strategic objectives of the decentralization policy are: (1) to empower and mobilize local people to participate in the formulation, implementation and monitoring of development programs; (2) to make the local authorities directly responsible vis-à-vis their communities; (3) to promote participatory, bottom-up approaches at central and local levels; and (4) to develop a sustainable economic planning mechanism based on efficient management of local resources [1].

The **Rwanda Decentralization Strategic Framework** (RDSF) [7] has been developed to guide the implementation of the GoR decentralization policy as set out in the 2000 Policy Paper. The RDSF serves as a reference framework for current and future decentralization interventions in Rwanda. It goes beyond sectoral policy in that decentralization is a transversal process that imposes itself as the principal focus of governance reform, the designated motor for the coherence of governance and, finally, as an important vehicle for collaboration between the Government and its national and international development partners. Through five strategic areas, the **RDSF creates the critical conditions for consolidating Rwanda's decentralization policy**:

- Effective management and implementation of decentralization policy
- Citizen participation, transparency and accountability
- Efficiency and effectiveness of local governments in local economic development, poverty reduction and service delivery
- Fiscal and financial decentralization
- Monitoring, evaluation and management information system.

The RDSF will be implemented through a five-year **national Decentralization Implementation Program** (DIP). In a separate document, the DIP will provide a programming framework that more specifically articulates the outputs, priority programs and activities for the decentralization process over the next five years. Steering, oversight and supervision of its implementation will be ensured by a Program Steering Committee (PSC).

Fiscal and financial decentralization consists of the devolution of the financial resources and decision-making powers to sub-national governments that will allow them to implement the functions and responsibilities that have been delegated to them. The recently adopted Fiscal and Financial Decentralization Policy provides two main ways of attaining these objectives:

- First, the districts are empowered to collect their own revenues locally from taxation (e.g. property tax, rental income and trade licenses), user charges and other forms of locally raised revenues.
- Second, local governments (LG) receive increasing amounts of financial resources, which are transferred as grants from the centre.

On 31 December 2005, Law No 29/2005 determining the administrative entities of the Republic of Rwanda was gazetted. It represents the legal basis for the **Local Administration Reform Policy** adopted in 2005.

The decentralized levels now have more actual power in decision-making and planning and more resources as well. The responsibilities assigned to decentralized

entities and authorities have also been redefined (cf. Table 4). **Districts have become the entities in charge of planning and coordinating development plans and programs as well as resource mobilization**, while the sectors and cells become the executing bodies. Districts and sectors are staffed with qualified agents: at least five executives in each district and four in each sector. Districts are responsible for promoting and developing agriculture, animal husbandry, forestry, tourism and environmental conservation, within the framework of District Community Development Plans. They manage budgets that are directly transferred from the Central Government and are in charge of collecting some taxes. They can sign partnership agreements with donors, and are accountable for the management of project funds from bilateral and multilateral cooperation [1].

Level of administration	Responsibility/Role
National	<ul style="list-style-type: none"> • Develop policies, programs and principles which govern the country • Mobilize resources to enable program implementation • Build capacity of the population and of entities that implement programs prepared at national level • Evaluate and monitor the implementation of set policies and programs
Province	<ul style="list-style-type: none"> • Co-ordinate district planning with national policies • Develop the economy by relying on locally available materials • Co-ordinate district planning with sufficient budget to implement it • Ensure districts implement policies whose objective is governance that supports a culture of peace, transparency and participation of citizens in decision making • Ensure district governance and administration are in line with national policies, laws and regulations • Ensure district development is based on scientific research
District	<ul style="list-style-type: none"> • Determine, co-ordinate and implement development plans • Promote good relationships and cooperation with other districts • Ensure urban, economic and demographic development and enhance poles of development • Build the capacity of sectors to provide better services to the population • Develop and implement district development plans • Co-ordinate and analyse vital statistics which indicate socio-economic development of the population • Coordinate district development programs and give better services to the population, delivered at sector level • Emphasize transparent management of public resources • Mobilize funds to invest in the district • Put emphasis on scientific research in the district development • Mobilize funds and other resources

**TABLE 4:
ROLES AND
RESPONSIBILITIES OF
VARIOUS LAYERS OF
ADMINISTRATION**

Sector	<ul style="list-style-type: none"> • Monitor and co-ordinate cell activities • Solve population problems and deliver basic services • Ensure security of people and their property • Sensitize the population about Government policies and programs • Provide basic services • Analyse population problems and design development plans in which the population participates • Collect basic statistics on which development activities shall be based • Ensure proper management of public resources • Coordinate specific Government programs
Cell	<ul style="list-style-type: none"> • Assist “Umudugudu” levels of administration to co-operate better with sector technical staff • Assist the population to participate in different Government programs • Assist the “Umudugudu” to realize its objectives • Link the “Umudugudu” level of administration with that of the sector • Collect basic statistics and deliver them to the sector • Analyse population problems, co-ordinate their aspirations, prioritize them and take to the sectors those problems which are beyond the means of cells • Resolve conflicts and fight injustice • Promote education and good social behaviour
Umudugudu	<ul style="list-style-type: none"> • Promote better co-operation and coexistence among the population • Assist the population to keep peace and security, hygiene, maintain infrastructure, protect the environment, and participate in communal work (“umugan-da”) and other Government programs • Collect basic statistics and deliver them to institutions which analyse, utilize and store them

Source: [7]

6. AGRICULTURE

The GoR adopted a **National Agricultural Policy** in 2004. It aims at reducing rural poverty and contributing to sustainable food security through: (1) modernized agriculture at the household level; (2) innovative, professional and specialized jobs to generate more rural off-farm income and more market oriented development; (3) more integrated and diversified agriculture, regionally specialized to ensure food security for the population and a fair distribution of resources and income; and, (4) the preservation of the environment and natural resources.

The **Strategic Programme for Agriculture Sector Transformation** (SPAT) was adopted in 2005 to implement the National Agricultural Policy. It recognizes Peasant Organizations (POs) as key partners and includes support activities for strengthening their capacity and increasing their participation in the agricultural development process. Finally, there is an active policy to promote equal rights for men and women. Gender issues are proactively addressed in all economic development sectors and are included in all policies [1].

B.9.2 INSTITUTIONAL OVERVIEW

In Rwanda, management of environmental issues is shared by several ministries, decentralized organs (districts and sectors), public institutions (Rwanda Environment Management Authority (REMA)), local and international non-governmental organizations (NGOs) and research and/or higher education institutions. **The following institutions play a role in the biomass energy sector:**

- Ministry of Infrastructure (MININFRA)
- Ministry of Natural Resources (MINIRENA)
- Ministry of Agriculture and Animal Resources (MINAGRI)
- Ministry of Environment and Lands (MINELA)
- Ministry of Local Government, Good Governance, Community Development and Social Affairs (MINALOC)
- Ministry of Finance and Economic Planning (MINICOFIN).

MININFRA is responsible for energy policy and following up on policy implementation. The Ministry deals with the user aspects of biomass energy, including the rational use of energy. As such, it is interested in promoting energy efficient equipment as well as the use of alternative fuels.

In 2010, the Energy, Water and Sanitation Authority (EWSA) was created. Among others, EWSA has the following tasks: (1) coordination of all activities related to programs aimed at developing and exploiting energy sources, (2) protection of Lake Kivu, its shores and people residing around it during methane gas extraction activities, (3) proper management of electricity infrastructure, gas, petroleum products, water and sanitation, and, (4) establishing a system for transportation and waste management.

The **Rwanda Utilities Regulatory Agency (RURA)** makes regulations relating to electricity generation, transmission, distribution and utilization including license fees, permits as well as grid, service and safety codes. In addition, the agency is responsible for establishing a tariff structure, investigated approved tariffs and rates charges. The Rwanda Bureau of Standards (RBS), a public institution established in 2002, is responsible for the quality of equipment, materials and products. The Ministry facilitates resource mobilization in areas where market forces fail to ensure adequate energy services.

The responsibility to **manage public forests and plantations** was transferred from **MINAGRI** to **MINIRENA** in 2003. The mission statement of MINIRENA consists of realizing rational management of lands, favouring the development of viable human settlement and assuring conservation and protection of the environment in view of sustainable human development. Therefore MINIRENA provides services to the population, the public and private sector, and to different development partners. MINIRENA **deals with land ownership issues and with public forestry resources, including parks and plantations**. It also intervenes through regulation, such as mandating that trees – including trees planted by individuals on their own land – can only be cut if they are mature.

MINIRENA is also the parent institution of REMA and of the National Forestry Agency (NAFA). **REMA is responsible for the following** [29, 33]:

- To coordinate activities undertaken by environmental protection institutions and promote the integration of environmental issues into development policies, projects and programs with the aim of ensuring appropriate

management and rational use of environmental resources on the basis of sustainable production for the improved well-being of the people of Rwanda

- To coordinate the implementation of Government policies and decisions taken by the Board of Governors, and ensure the integration of environmental issues in national planning, and in concerned departments and institutions within the Government
- To advise the Government on legislation and other measures relating to environmental management or the implementation of relevant international environmental conventions, treaties and agreements as and when necessary
- To make proposals to the Government in the field of environmental policies and strategies.

NAFA is the supreme forestry development authority in Rwanda. Law No. 17/2008 of 20/06/2008, which established NAFA, also determines its organization, functioning and responsibilities. The law stipulates that the ministry in charge of forests supervises NAFA. Accordingly, NAFA signs a performance contract with the Ministry. This contract defines the powers, rights and responsibilities of each party in fulfilling the responsibilities of NAFA. It is in charge of supervision, follow up and ensuring that issues relating to forestry receive attention in all national development plans. In particular, **NAFA's responsibilities are** [32]:

- Participating in designing the policies and strategies relating to forestry as well as promoting agro-forestry and ensuring the implementation of such policies and strategies
- Advising the Government on policies, strategies and legislation related to forestry management as well as to the implementation of international conventions relating to forestry and the protection of natural resources such as land, water and forest biodiversity in forestry areas
- Supporting organs that are in charge of fighting soil erosion with the aim of safeguarding forestry and environment
- Preparing national programs in matters of reforestation and forestry management, helping districts to prepare their own forestry management, and processing and supervising the implementation of such programs
- Advising, assisting and encouraging private sector stakeholders to participate in reforestation activities, their effective management and making them productive
- Making and updating the list of tree species to be planted in the country and where, according to the type of soil and expected usage, and providing advice and instructions on the trees or related products to be imported or exported
- Ensuring the management and exploitation of public forest resources
- Undertaking research, investigations, studies and other relevant activities on the importance of forestry in the national economy and on the exploitation of forestry products and disseminating the findings
- Disseminating research findings on technology of planting trees in land for cultivation, pastures and in specific cases of reforestation; on efficient forest maintenance and utilization of such resources for income generation; on rational utilization of the forests and related products; and, on collecting data on forestry and related products
- Preparing technical norms for activities related to reforestation, protection and rational utilization of forests as well as adding value to forestry products

- Evaluating and closely monitoring development programs to adhere to standards in the management and rational utilization of forests
- Developing relationships with other institutions and international organizations as related to forestry activities.

The relationships of NAFA with local administrative entities are reflected in the following:

- NAFA is expected to support the local administrative entities in implementing all the programs of reforestation, forestry management and development.
- NAFA is to offer technical advice so that the decisions of the district council and instructions in the environment sector do not prejudice the good management of forestry.
- Daily, local administrative entities are expected to ensure a program of preparing nursery, reforestation, forestry maintenance and harvesting, and provide a report to NAFA management.
- Local administrative entities are to monitor all activities relating to the rational use of forestry products in accordance with existing laws and regulations and the nature and necessities of the district.

MINAGRI, the Ministry of Agriculture and Animal Resources, is in charge of agricultural and livestock development. As such, it is interested in increasing the productivity of smallholder plantations as well as in developing off-farm activities to complement agricultural income.

Following the National Land Policy and the Organic Land Law enactment, land in Rwanda is governed through the following institutions of central and local government [28]:

- The Ministry of Environment and Lands (MINELA), which is responsible for addressing issues of policy, in particular through ministerial orders and/or orders that set out laws and procedures for the administration, planning and allocation of land
- The Land Commission, which bears the principal responsibility for overseeing the implementation of the Organic Land Law. Land Commissions are established by presidential order at national, Kigali City and district levels
- The National Land Centre (NLC) is a new institution described under Law No. 20/2009 of 29/07/2009 that makes provisions for key land related functions of spatial planning, survey and land administration within a single institution under a single management framework. NLC is the central implementing agency for land reforms
- The Office of the Registrar of Land Titles (ORLT) is prescribed in the Organic Land Law and established by Presidential Order No. 53/01 of 12/10/2006, which determines the structure, powers and functioning of ORLT. The Office has principally the power of signing certificates of land titles and long-term leases
- District Land Bureaus (DLB's) focus on land use planning and administration at the district, town and municipality level
- Sectors and Cells Land Committees: Each sector and cell has a land committee, which has an important part to play as the first point of contact for land registration and land use planning.

MINILOC is the representative of the district authorities, which are increasingly aware of the markets for wood-fuels and how these can contribute to local development. The National Decentralization Implementation Secretariat (NDIS), set up as an agency under the MINALOC, is charged with the organization and management of long-term, decentralization policy implementation, primarily in collaboration with [7]:

- Specialized units in MINECOFIN and the Ministry of Public Service and Labor (MIFOTRA)
- Decentralization Focal Points in ministries and provinces, local governments, national level federations and local level private sector and civil society organizations
- National and international development partners.

MINECOFIN is, in principle, in charge of taxation [1].

Table 5 presents the key stakeholders of the forestry sector and related issues.

**TABLE 5:
STAKEHOLDER
MAPPING FOR
BIOMASS RELATED
ISSUES**

Institution	Responsibility/Role
Ministry of Forestry and Mines (MINIFOM)	Overall policy oversight: monitoring and institutional support, resource mobilization, allocation and accountability, promotion of forestry sector at national and international levels
Ministry of Environment and Lands (MINELA)	Overall environment and land policy oversight, including environment conservation, land tenure regularization and creation of forest cadastral system
Ministry of Agriculture and Animal Resources (MINAGRI)	Promotion of agro-forestry and tree planting on farm and grazing lands, sensitization of farmers on the role of forests in soil erosion control
Ministry of Local Government (MINALOC)	Sensitization and involvement of decentralized structures and communities in rational management of existing forests and reforestation
Ministry of Internal Security (MININTER)/Districts	To assist in reinforcing the forest law and other related regulations on the protection and commercialization of forest products
Ministry of Finance and Economic Planning (MINECOFIN)	Mobilization of funds for the implementation of forestry policy and in the collection and processing of forestry related statistics
Ministry of Education (MINEDUC)/Student Financial Agency Rwanda (SFAR)	Sensitization of school communities in tree planting culture and rational forest management, provision of scholarships in forestry related fields, integration of forestry courses in national education programs
Ministry of Science and Technology	Help wood and non-wood industry in Rwanda to access up-to date processing technologies for timber and non timber products
Ministry of Commerce (MINICOM)	Issue trading licenses to forest product traders, collaborate with NAFA to elaborate regulations of commercialization of forest products



Ministry of Infrastructure (MININFRA)	Construction of forest access roads, policy on alternative sources of energy such as biogas, briquettes of residues, solar energy, etc.
Ministry of Disaster Management	Coordinate all activities related to disaster management including wild fires and other hazards
National Forestry Authority (NAFA)	Coordination of forest management and agro-forestry development in the country
Rwanda Environment Management Authority (REMA)	Setting of environmental standards and monitoring of rehabilitation of degraded lands
Rwanda Revenue Authority (RRA)	Setting of appropriate taxes and royalties for forest products
National Land Center (NLC)	Land administration and land tenure security through registration and land use planning
Rwanda Development Board (RDB)	Promotion of investment in the forestry sector taking into account its peculiarities
Local civil society organizations (ARECO Rwanda Nziza, ECOFOREST, etc.)	Promotion of tree planting, tree nursery practices, soil conservation, watershed management, biodiversity conservation , etc.
Private sector	Investment in forest management and forest products processing, utilization, value addition and commercialization

Source: [20]





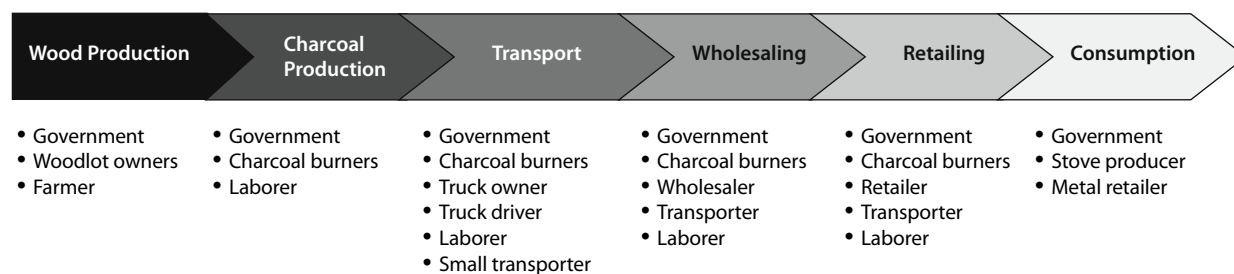
STATUS OF THE CHARCOAL SECTOR IN RWANDA

C.1 CHARCOAL VALUE CHAIN

The observation that charcoal does not receive the policy attention it deserves may in part be explained by a crucial lack of baseline data and certain structural governance deficits.

Investigating the sequence of charcoal production and marketing in all its facets is key to any systematic improvement. The value chain approach provides a convenient means to this end, adding knowledge, innovative insights and technology to each link. It enables policy makers to create favourable framework conditions that promote competitive enterprises, sustainable jobs and income for local people. Furthermore, it allows impact-oriented monitoring of policy actions. If charcoal production and its use are to contribute to sustainable development and poverty alleviation, the entire charcoal value chain needs to be addressed in a holistic manner [34]. As shown in Figure 5, the structure of the Rwandan charcoal value chain is complex, comprising many different actors with varying interests and stakes.

FIGURE 5:
BASIC STRUCTURE OF
THE CHARCOAL VALUE
CHAIN IN RWANDA



Source: [35]

This chapter describes elements of the charcoal sector in Rwanda, from wood production and harvest to final charcoal consumption:

- Forest management and wood production (cf. section C.2)
- Exploitation and transformation of charcoal (cf. section C.3)
- Transport and commercialization of charcoal (cf. section C.4)
- Utilization of charcoal (cf. section C.5).

Attention is paid to technical, socio-economic and environmental aspects. It should be noted that the analysis is mainly based on available documentation and some control samples in the field.

C.2 FOREST MANAGEMENT AND WOOD PRODUCTION

Rwanda has a long history of plantation activities. A program of forest plantations – many on marginal lands, some as buffer zones around the protected natural forests – began soon after independence. It is estimated that between 1960 and 1990, the total area under forest plantations grew from around 24,500 to 247,500 ha. During the same period, the protected national forests – in particular the Akagera National Park – suffered small (about 10%) loss of their resource base, while lands designated as hunting areas and forest galleries suffered a very heavy loss (about 75%). The population was also encouraged to plant trees wherever and whenever possible, at the community as well as individual level. However, large areas were lost during the war and genocide – primarily for fuel needs of armies and displaced persons – and since then, for agriculture and resettlement [5].

According to official statistics [20, 22], Rwandan forests cover 330,576 ha, comprising 215,739 ha of natural forests and 114,837 ha of forest plantations (> 0.5 ha). However, data on forest cover (> 0.5 ha) from different sources vary considerably (cf. Table 6) from 240,742 to 447,230 ha. Nevertheless, these data do not include forest plantations of less than 0.5 ha and isolated trees, so called TOFs. Estimates on surfaces covered by TOFs range from 5,300 to 222,520 ha (cf. B.2.4). In the following table, official values from MINIFOM are used for further calculations.

TABLE 6:
FOREST COVER IN
RWANDA ACCORDING
TO DATA SOURCE

Forest type	MINIFOM (ha)	ISAR ¹ (ha)	BEST (ha)	FAO (ha)
Natural forests	215,739	125,907	206,523	62,000
Forest plantations (> 0.5 ha)	114,837	114,835	240,707	373,000
Sub-total	330,576	240,742	447,230	435,000
Forest plantations (< 0.5 ha) /trees outside forests	222,520	No data		
5,300 - 190,000	61,000			
Total	553,098	No data	452,530 - 637,230	496,000

Explanations:

1. Natural forest cover is different from the official data, because the area of Akagera National Park was underestimated at 1,276 ha while it is thought to be at least 90,000 ha.

Source: [1, 19, 20, 36]

Figure 6 illustrates the importance of the forest cover (> 0.5 ha) by province. The Western and the Southern Provinces are the main forest areas in Rwanda.

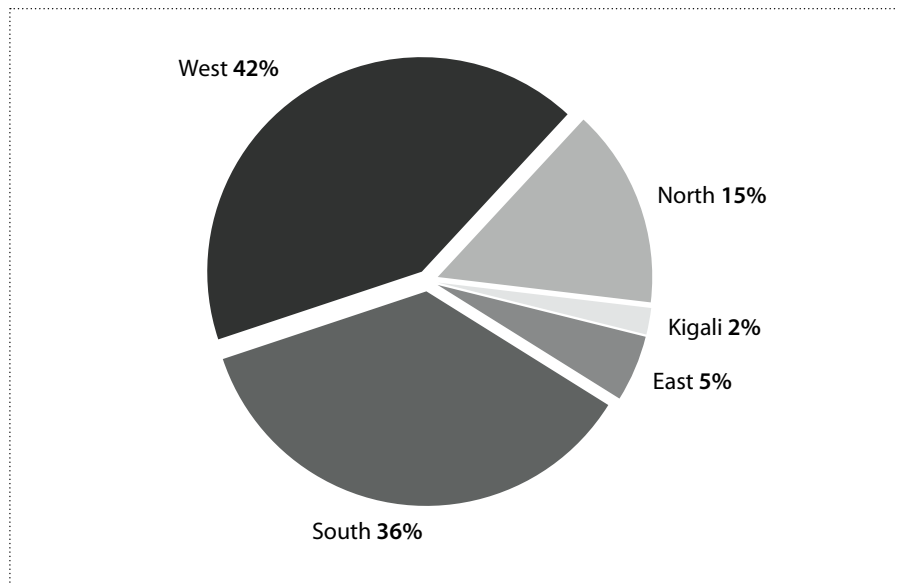


FIGURE 6:
FOREST COVER BY
PROVINCE

Source: [36]

Natural forests are mainly protected areas (cf. Figure 7), either national parks (Akagera, Nyungwe, Volcanoes) or forest reserves (Gishwati, Mukura). Natural forests include various ecosystems like mountain, savannah, gallery and swamp forests. The area of natural forests decreased by about 65% from 634,000 ha in 1960 to 215,000 ha in 1999 [20]. However, the Forest Resources Assessment (FRA) indicates that the area of natural forests in Rwanda remained stable over the last 20 years [19].

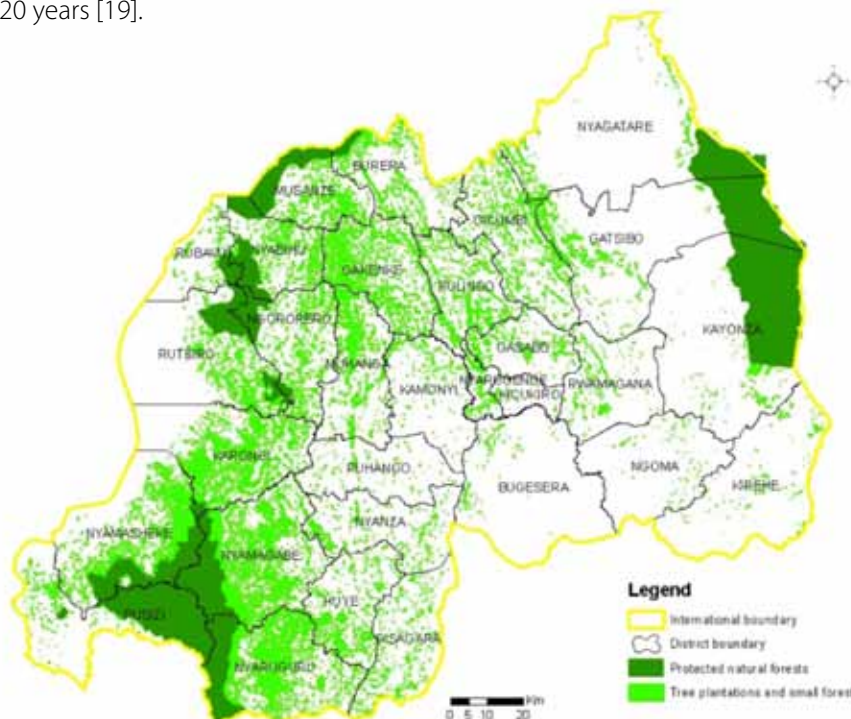


FIGURE 7:
FOREST COVER MAP

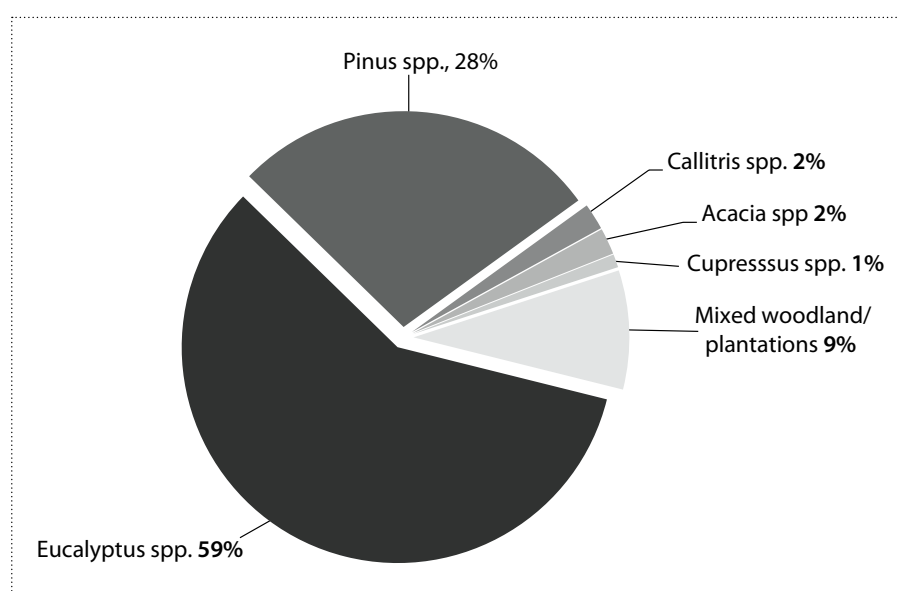
Source: [41]

Generally, natural forests are now well protected and do not show signs of illegal human activity. Today, practically all charcoal in Rwanda is derived from trees that have been planted on government, private or community land. Charcoal production from natural forests is almost non-existent.



In contrast to natural forests, **the area of forest plantations increased by around 2.5% per year** [19]. Mono-specific plantations cover 91.3% while mixed stands 8.7% of the plantation area. Eucalyptus is the dominant species, occupying 59% of total plantation areas. Especially in the Nyamagabe region, homogeneous plantations of Pinus cover 28.3% of the planted forests. Species like Acacia, Callitris and Cupressus account for another 5% of the described plantation area (cf. Figure 8) [37].

FIGURE 8:
FOREST PLANTATIONS
BY SPECIES



Source: [37]

State and district owned plantations (> 0.5 ha) account for up to 65% of the planted areas [36], covering 74,644 ha (cf. Figure 9), not including plantations of less than 0.5 ha and isolated trees in or on the side of fields.

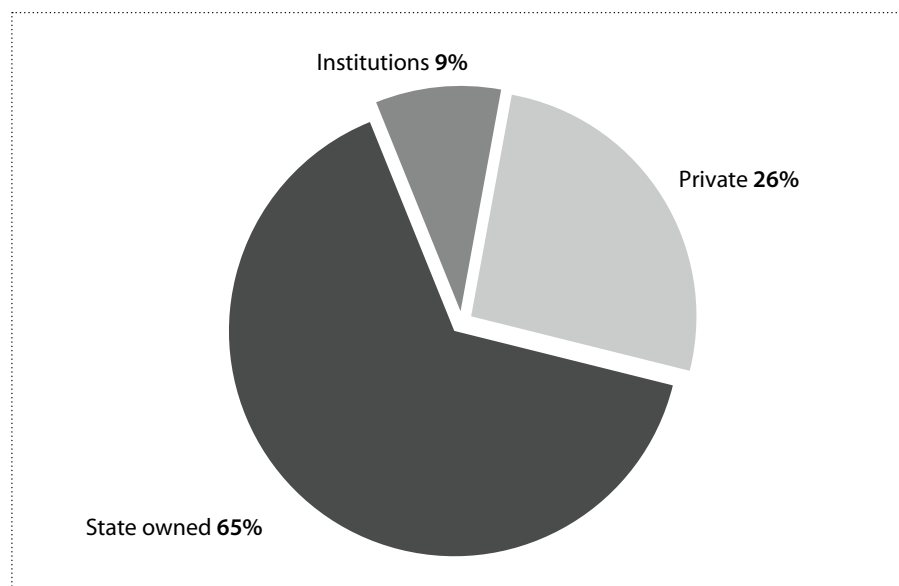


FIGURE 9:
OWNERSHIP OF
PLANTATIONS

Source: [36]

Numerous public plantations were planted in response to a necessity felt by most decision makers. However, there is a lack of clear objectives regarding their management and utilization. This has led to a deficit of silvicultural treatments and, as result, to progressive degradation.

In addition, **most public plantations are over-aged and characterized by decreasing productivity.** About 90% of public plantations show signs of uncontrolled human activities. Illegal logging occurred in 78% of observed stands [37]. Illegal tree felling is less frequent in Pinus plantations. Eucalyptus stands showed the greatest number of illegal activities. Eucalyptus is not only used as construction wood but also for firewood and charcoal making, which are the greatest needs of the rural population [1].

Farmers have become aware that with secure land tenure (cf. section B.2.5) and rising wood fuel prices, it is profitable to invest in tree planting, produce poles for construction and gain fuelwood and wood for charcoal making. According to a study realized by CARE International, the average number of trees planted annually by rural households is 18 [39].

Private plantations cover 35% of forest plantation areas (> 0.5 ha), which are equivalent to 40,192 ha. They include stands owned by farmers and land owners (29,857 ha), and by institutions (10,335 ha) such as private companies, cooperatives, and religious and education institutions, investment funds, NGOs, etc.

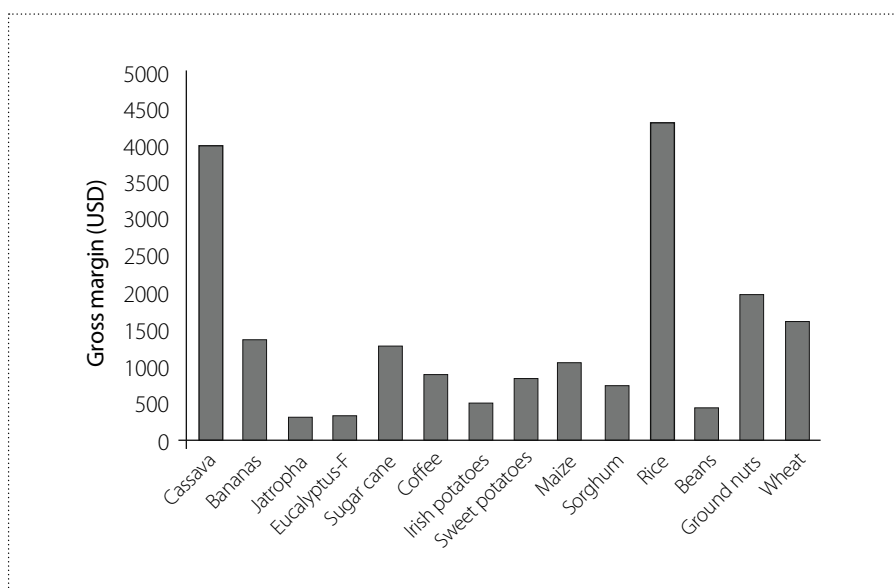
According to the Biomass Energy Strategy (BEST) survey [1], **traded wood and wood-fuels come mostly from plantations of less than 2 ha. 89% of plantation owners had a plantation of less than 2 ha covering 54% of planted areas; and 8% of private plantations that contribute to wood-energy supply channels are of less than 0.5 ha.** These family farms contribute substantially to the supply of energy. The wood products from these trees satisfy their own needs for poles, stakes and firewood, but can also serve as a source of income in case of unforeseen events or when a relatively large sum of money is required at once, such as for payment of school fees or health expenses [1]. However, there is neither viable data about quantities of supply nor more detailed figures about plantation areas.

As already indicated in Table 6 above, there is a lot of uncertainty regarding small plantations lots (< 0.5 ha).

Eucalyptus is the predominant species in private plantations. Main species are *E. camadulensis* and *E. maideni*. Owners plant most of their private stands (61%); some were inherited (19%) or purchased (18%) [1]. As indicated by rural surveys, 76% of interviewed farmers would like to plant more trees [39]. In general, there is a lack of adequate investment in tree plantations and plantation owners neglect silvicultural treatments. Exceptions are tea factories, which depend on fuelwood for their production processes. Most tea factories manage their own plantations of 30 and more hectares by means of professional staff. Compared to private, small-scale plantations, the productivity of those plantations is much higher, reaching an annual productivity of 20 to 30 m³/ha/yr [35].

Nevertheless, even with low productivity levels, 100% of interviewed plantation owners are satisfied with the financial profitability of their stands [35]. **Economic studies [42] on plantation crops verified that growing Eucalyptus in Rwanda on agricultural land has a positive gross margin.** However, other crops like cassava, rice and groundnuts have a higher gross margin (cf. Figure 10). The demographic pressure on land forces farmers to exploit marginal areas that have been specifically allocated for forestation and/or pasture. Economic analysis of use of marginal lands shows that it is not profitable to grow any crops in these areas. Only with Eucalyptus plantations is it possible to generate a positive net operating income of around 360 USD/ha/yr. Other studies indicate that the profitability of small-scale Eucalyptus plantations when compared to tea plantations is 47% higher. In particular, Eucalyptus has the lowest production costs and thus the high demand for its wood results in a profitable price.

**FIGURE 10:
GROSS MARGINS FOR
1 HECTARE SELECTED
CROPS IN RWANDA**



Source: [42]

According to Rwanda Agriculture Research Institute (ISAR) data [37], the **productivity of private and public plantations, basal area, dominant height and volume** varies from one region to another. At national level, the number of stems per hectare averages 654, the average basal area is estimated to be 15.88 m²/ha, while the average total volume, all species included, amounts to 122.61

m³ per hectare. In general, districts in the Western and the Southern Provinces show the highest values in productivity and standing timber volume. Based on ISAR data, **the mean annual increment (MAI) of Eucalyptus species is 5.5 m³/ha/yr. This appears below the productivity levels expected for these regions under adequate forest management practices** [18]. Table 7 gives a summary of standing timber volume and MAI by species group and provinces, according to recently published Woodfuels Integrated Supply/Demand Overview Mapping (WISDOM) data. Even these adjusted MAI figures seem to be very low.

Species group	Province					Total
	East	North	West	South	Kigali	
Total standing timber volume (m³/ha)						
Eucalyptus et al.	48.9	58.0	136.6	115.4	53.0	103.1
Pinus spp.	132.5	152.4	201.9	156.1	260.2	173.2
Productivity (m³/ha/yr)						
Eucalyptus et al.	7.2	7.1	12.5	9.5	4.9	9.5
Pinus spp.	8.6	13.0	14.2	12.7	13.0	13.0

Source: [18]

TABLE 7:
STANDING TIMBER
VOLUME AND PLANTATION
PRODUCTIVITY

Table 8 gives theoretical estimates for wood-fuel supply based on two MAI data (5.5 and 9.5 m³/ha/yr) and different data on forest cover (cf. Table 6). In applying official MINIFOM statistical data on forest cover, **the sustainable supply would range between 1.1 million (MAI=5.5) and 2.0 million t of biomass, i.e. 40% and 75% of the estimated demand of 2.7 million t/yr** [19] (cf. section C.5). However, if FRA data are used for the calculation, the actual sustainable wood-fuel supply ranges between 1.5 and 2.5 million t/yr or 55 to 95% of actual demand. This wide bandwidth of estimates shows how difficult it is to evaluate wood-fuel supply objectively.

Forest type	MINIFOM	BEST ¹	BEST ²	FAO
	(m ³ /yr)	(ha)	(ha)	(ha)
Scenario 1, based on a MAI of 5.5 m³/ha/yr⁴				
Private forest plantation (> 0.5 ha)	198,955	417,025	417,025	646,223
Public forest plantation (> 0.5 ha)	369,488	774,475	774,475	1,200,128
Sub-total forest plantation (> 0.5 ha)	568,443	1,191,500	1,191,500	1,846,350
Forest plantation (< 0.5 ha)/ trees outside forests	1,101,474	26,235	940,500	301,950
Total	1,669,917	1,217,735	2,132,000	2,148,300
Equivalent in oven dry biomass (t/yr)	1,168,942	852,414	1,492,400	1,503,810
Scenario 2, based on a MAI of 9.5 m³/ha/yr				
Private forest plantation (> 0.5 ha)	343,650	720,316	720,316	1,116,203

TABLE 8:
ESTIMATED SUSTAINABLE
ANNUAL WOOD-FUEL
SUPPLY IN RWANDA, BASED
ON DATA SOURCE

Public forest plantation (> 0.5 ha)	638,207	1,337,729	1,337,729	2,072,948
Sub-total forest plantation (> 0.5 ha)	981,856	2,058,045	2,058,045	3,189,150
Forest plantation (< 0.5 ha)/ trees outside forests	1,902,546	45,315	1,624,500	521,550
Total	2,884,402	2,103,360	3,682,545	3,710,700
Equivalent in oven dry biomass (t/yr) ³	2,019,082	1,472,352	2,577,781	2,597,490

Explanations:

1. Worse case scenario for forest plantations < 0.5 ha as shown in the BEST study [1]
2. Best case scenario for forest plantations < 0.5 ha as shown in the BEST study [1]
3. Calculated with an average wood density of 0.7 t/m³ [18]
4. Based on ISAR data and 90% of MAI usable as wood fuel [37, 38]
5. Based on WISDOM data and 90% of MAI usable as wood fuel [18, 38]

Source: [1, 18, 19, 20, 36, 37, 38]

Table 9 gives an idea of the importance of charcoal production by district and Figure 11 illustrates charcoal flows to Kigali. The major tree plantations for charcoal production are in the west and in the south of the country. According to the BEST study, more than 97% of charcoal comes from private tree plantations in Rwanda [1, 39].

TABLE 9:
IMPORTANCE OF
CHARCOAL PRODUCTION
BY DISTRICT

Importance of districts		
Low	Medium	High
Gasabo	Rubavu	Nyamagabe
Kicukiro	Ngororero	Nyaruguru
Nyagatare	Rusizi	Karongi
Gatsibo	Nyabihu	Nyamasheke
Nyarugenge	Gakenke	Rutsiro
Kayonza	Rulindo	Muhanga
Rwamagana	Ruhango	Gicumbi
Bugesera	Kamonyi	Nyanza
Ngoma	Huye	
Kirehe	Gisagara	
	Musanze	
	Burera	

Source: [35]

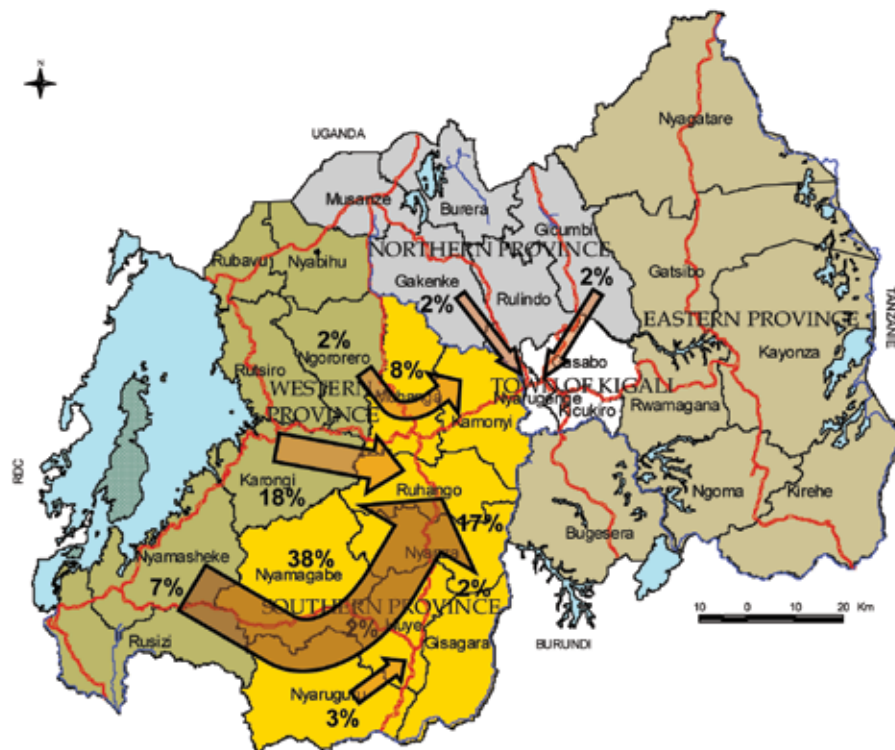


FIGURE 11:
CHARCOAL PRODUCTION
FLOWS IN RWANDA

Source: [39, modified]

C.3 EXPLOITATION AND TRANSFORMATION OF CHARCOAL

C.3.1 EXPLOITATION OF WOOD-FUELS

In comparison to other countries (e.g. Madagascar), there is a strict disjunction between private plantation owners and charcoal burners. The owner takes charge of the plantation management and sells the standing timber stock to charcoal burners or fuelwood wholesalers. Exploitation of the stands and further transformation to charcoal is, in more than 90% of cases, done by charcoal burners. This is already a sign for a specialization within the charcoal value chain.

There are three categories of charcoal producers: master, foreman and labourer. **A charcoal master** actively searches for wood to carbonize, negotiates with plantation owners and invests in the purchase of trees. The charcoal master could be a professional charcoal burner with financial backing or a “big” transporter. Recently, businessmen from Kigali are increasingly trying to get a foot in the charcoal chain, buying up plantations everywhere in the country. The charcoal master first deals with a plantation owner; both agree on a price. On average, a standing timber volume of 100 m³ costs around 300,000 FRW (477 USD) [35]. The charcoal master is also responsible for contacting the local authorities and applying for the necessary cutting permits.

With decentralization, districts increasingly intervene in the charcoal supply chain. Regimentation and procedures change from district to district:

- Several districts prohibit the production of charcoal during part of the year (generally the dry season)
- Others prohibit any exploitation of wood whatsoever
- In some districts, exploitation and charcoal production is possible without exception.

Theoretically, the legal procedures for the exploitation of plantations are:

- **Plantation < 0.5 ha:** No attestation or permit required
- **Plantation 0.5 to 2.0 ha:** An attestation is required, which could be obtained at sector level; this attestation is free of charge
- **Plantation > 2.0 ha:** A cutting permit is required that must be obtained at district level; a service charge must be paid. The cutting permit is valid for three months. In addition, the buyer has to pay a tax of 1% of the standing timber value.

However, this is not yet practiced in all districts, and often there remain uncertainties about regulations and procedures. In most districts, cutting permits are required. Service fees for the issue of permits range between 1,500 and 25,000 FRW. After applying for a permit, an inspection will take place to decide if the trees can be cut. There have been complaints by several charcoal burners that it would take up to two months to obtain a permit. By contrast, official NAFA statements claim that concluding a cutting permit procedure would only take an average of 2 to 3 weeks [35]. Charcoal burners have also claimed that it remained unclear for how long the permit was valid. Among the districts, permit time spans vary from one to four weeks [1].

Farmers experience considerable difficulties in applying for exploitation permits. Excessive restrictions and administrative requirements tend to delay management operations. They also markedly increase the transaction cost of forestry production, thus increasing the risk of corruption. Furthermore, permits prescribe tight time frames for both forest harvesting and subsequent conversion into charcoal. This must appear counterproductive in that it invites conversion of insufficiently seasoned wood, resulting in considerable efficiency losses during the charcoaling process. The farmers consulted unanimously agreed that the administrative requirements for harvesting trees that they planted themselves were the most pressing burden they face in exercising their business.

A **foreman** works for a charcoal master or, in some rare cases, for a wood owner, and manages the labourers. In general, he is not paid on a salary basis but receives a share of the net margins [35]. Labourers are paid a salary or a share of output [43]. Actually, the most frequently applied system is an output-oriented payment; labourers receive between 500 and 1000 FRW per sac produced [35].

The actual logging is done with axes or “coupe-coupes” (machetes) in teams of 4 to 6 labourers. In rare cases chain saws are used. The whole process of cutting down trees, disbranching, cutting to the standard 4 m length (and in some cases splitting), including transport to the kiln site, takes between 20 and 25 man-days for a standing timber volume of 60 to 80 m³ [35].

C.3.2 TRANSFORMATION OF CHARCOAL

Felled trees are moved to a levelled area. Kilns are traditionally 4 m long, 3 m wide and 1.5 to 2 m high (between 10 to 14 m³) [43]. Wood normally dries for one to two weeks before carbonization. **Most charcoal burners use a traditional mound kiln or a rectangular hill-side kiln**, which is a mound-type kiln with a platform dug out in the hillside on which wood is stacked and covered first with leaves and then with soil [1]. Split and dried wood is packed in the kiln, then covered with leaves and mud, leaving a small window for ignition. After ignition, wooden poles are pushed through the roof of the kiln to create a simulated chimney, which improves the conversion rate. Under supervision of the foreman, the labourers – on a rotational basis – remain on site at their kiln for the carbonization period to prevent fire hazard and control carbonization by closing secondary chimneys that might reduce efficiency. For a standard-sized kiln, carbonization takes two weeks.

In general, such kilns produce between 25 and 35 standard bags of charcoal. The average weight of a standard sac is 33 kg, coming up to a charcoal production of 825 to 1,155 kg per kiln. However there are larger sacs, containing 50 to 60 kg of charcoal (cf. C.4). As in most African countries, carbonization **efficiency of traditional Rwandan kilns ranges from 12 to 14%** [1, 18, 35, 39]. As a rule, one can say that a traditional kiln produces 1.5 bags per stere. **Most of the charcoal burners are poor and have few or no formal skills.** Thus, they learn the trade by watching others, which limits innovation and development of the sector.

Charcoal is sold in maize sacks whose capacity is increased by a woven extension.

- Two types can be distinguished, (1) standard and (2) large bags
- Standard bag: contains roughly 33 to 38 kg of charcoal (50 kg maize)
- Large bag: contains 50 to 60 kg of charcoal (70 kg or 90 kg maize)
- The exact weight depend on species of wood used.

BOX 2: CHARCOAL BAGS

Traditional kilns are the norm, but there are also some charcoal burners, especially those formed by CARE International, IFDC or CAMCO who are applying more **efficient kilns such as the Casamance kiln or several types of rectangular kilns with chimneys**. Nevertheless, many charcoal burners claim that their manufacturing is expensive, particularly the purchase and welding together of the chimney. These types of modern kilns reach efficiencies of 20 to 28%. In general, 2.5 to a maximum of 3.0 bags per stere can be produced.

When the charcoal has cooled down it is bagged. Bagging of a standard kiln takes around 10 man-days [35]. Packed bags are taken from the kiln to the closest roadside, watched by a guardian until a transporter buys them. A standard bag, purchased at roadside costs between 3,500 and 4,000 RFW. The loading of the truck is done either by the producers or by buyers themselves. In general, labourers are paid 100 RFW per bag loaded. In some cases bags are transported to an intermediary charcoal depot, where the charcoal is stocked for local/regional consumption (cf. section C.4).

Charcoal is produced throughout the year, although there are seasonal fluctuations. Production is at its highest during the rainy season. Production volumes per month vary considerably and viable estimates are difficult to obtain.

Studies from other countries indicate that the environmental effects of small-scale charcoal production are considerable. The conversion of wood carbon to charcoal carbon is highly inefficient, resulting in products of incomplete combustion (PICs) entering the atmosphere. PICs have a negative impact on both health and the environment. They cause respiratory infections and, in the long term, cancer. They also have a higher global warming potential relative to CO₂. Although they vary according to the type of kiln used, the average emission factors are fairly significant. This results in **traditional, non-efficient charcoal fuel cycles being among the most greenhouse gas intensive in the world** [44].

BOX 3: CHARCOAL PRODUCTION AND EMISSIONS

- The by-products of charcoal production are pyroacids, primary acetic acid, methanol, tars, heavy oils and water, the majority of which is emitted into the environment with the kiln exhaust.
- Emissions into the air include gaseous emissions of carbon monoxide (CO), carbon dioxide (CO₂), methane, ethane and volatile organic compounds (VOC); emissions of particulate matter (PM) coming from the uncombusted tars and charcoal dust, and pyroacids that may form aerosol emissions.
- The level of emissions depends highly on the technology used for production, the temperature developed during the pyrolysis as well as on the moisture content of the wood. For example, emissions from traditional charcoal production methods in several African countries expressed in g per kg of charcoal produced are given as 450 to 550 for CO₂, 700 for CH₄, 450 to 650 for CO and 10-700 for NMHC (non-methane hydrocarbons). Such emission levels, especially that of methane, which has a high global warming potential (GWP), can be perceived as having significant environmental impact both regionally and globally.
- The main reason for these rather high levels of air emissions is the incomplete combustion of wood and gaseous by-products of charcoal production that are directly emitted into the atmosphere. In Africa, the emissions are usually released as part of the smoke into the atmosphere, posing an air pollution problem. When inhaled the smoke can result in serious health issues for the charcoal producers.
- Another pollutant produced in charcoal making is charcoal dust, a black powdery residue that disperses quickly into the air and can cause respiratory illnesses.

Source: [45]

C.4 TRANSPORT AND COMMERCIALIZATION OF CHARCOAL

The chain link “transport and marketing” is characterized by a multiplicity and diversity of players. Generally, players are involved individually; contracts with other market actors rarely exist.

In Rwanda, the wood-fuel sector directly employs about 20,000 people (as in 2011). They include 7,000 loggers engaged in felling, sizing and stacking the wood and about 8,000 charcoal burners, most of them in the impoverished rural areas of the Southern and Western Provinces. About 200 to 300 transporters and 2,000 charcoal vendors in the urban areas are also directly employed in the sector. The wood-fuel sector has a major economic impact both nationally in rural areas.

It is estimated that the turnover from charcoal alone for the whole of Rwanda is about 67 million USD [42], equivalent to more than 2% of GDP [1]. This shows that business generated by the essentially informal charcoal sector is substantial.

Depending on the circuit followed by charcoal from producer to consumer, various actors are involved, including charcoal producers, collectors, transporters, wholesalers and retailers. In general, it is possible to differentiate between the following players:

- **Woodlot owner:** Sells the standing timber to charcoal producer
- **Charcoal producer (master):** Buys standing timber from plantation owners and engages staff (charcoal burners). Generally, s/he sells the charcoal to collector-transporters or wholesalers
- **Producer-transporter:** Some charcoal producers organize the transport of their products to Kigali by themselves
- **Charcoal burner (foreman, labourer):** Realizes the exploitation and the transformation of wood, as well as the transport from the production site to the next accessible road. In general, labourers are paid on a salary basis or on an output basis
- **Local/regional transporter:** Ensures transport to the nearest rural charcoal depot or to the nearest urban centre, mostly with pick-ups or small trucks. For small quantities even with bicycles
- **Local/regional wholesaler:** Sells charcoal bags in rural charcoal depots or directly to retailers in urban centres like Butare
- **Local/regional retailer:** Sells the charcoal in local shops or directly to consumers
- **Exporter-retailer:** Buys the charcoal directly from charcoal producers or from local/regional wholesalers and transports and sells the product in neighbouring countries, especially DRC
- **Collector-transporter:** Is searching actively for charcoal produced in “his” region, negotiates with different producers and rents a truck for the transport to Kigali

- **Transporter:** Owner of a truck, paid by charcoal producers or wholesaler
- **Wholesaler:** Buys the charcoal directly from the producer at the production site or from middlemen in urban centres. Sells the charcoal, generally in bags, to retailers or consumers
- **Retailer:** Buys charcoal from wholesalers and sells the product in small bags of 0.5 to 1.0 kg to consumers. Retailers include vendors who sell charcoal door-to-door
- **Consumer:** Buys the charcoal from wholesalers and retailers or in some cases directly from charcoal producers
- **Producer to consumer:** A small-scale producer takes the charcoal directly to the consumer. The producer may have well-established customers or may be an itinerant trader, selling to whomever wishes to buy
- **Producer to buyer to consumer:** A buyer purchases the charcoal from the producer and takes it directly to consumers' homes
- **Producer to primary buyer to secondary buyer to tertiary buyer to consumer:** A more complex option in which there are both wholesale and retail markets.

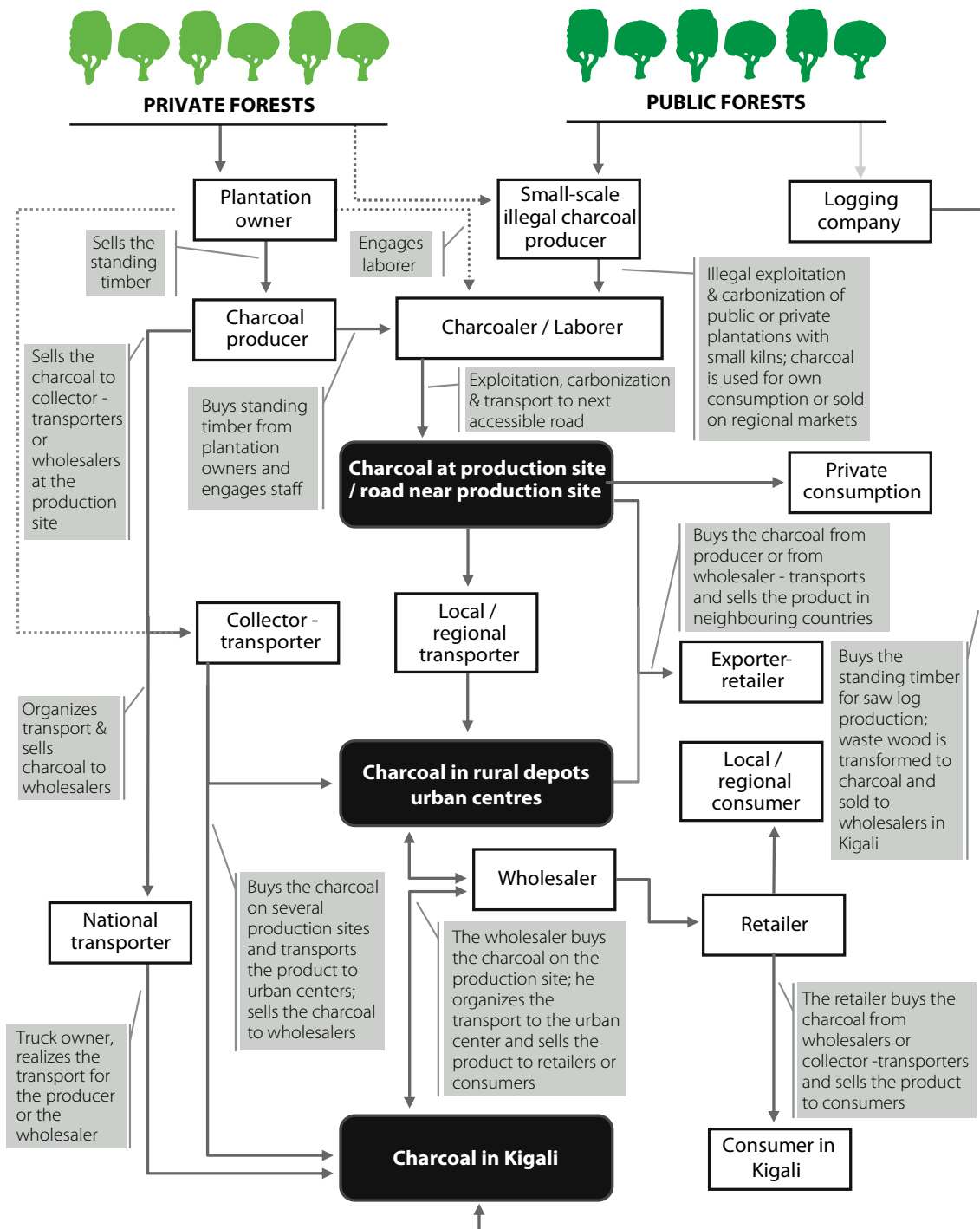
Charcoal is packaged in a distinctive way, using rice or maize sacks and fan palm leaves or twine ropes. A standard bag contains 33 to 38 kg, a large bag 50 to 60 kg of charcoal, depending on the species of tree used. The upper visible part of the bag contains larger bricks of charcoal than the rest of the bag to attract buyers.

The charcoal producer/the seller takes responsibility for transporting the charcoal from the production site to the roadside closest to the kiln. There a guardian remains with the bags until a transporter comes along to buy them. The most common forms of transport at this stage are **head loading and bicycles**. Charcoal producers sell their products to collector-transporters or wholesalers. In some rare cases producers organize by themselves the transport to urban centres and sell their products directly to wholesalers. Producers are increasingly developing links with specific charcoal transporters or wholesalers. Prices at roadside differ along certain criteria:

- **Type of species used for charcoal production:** Acacia-charcoal is more expensive than the typical Eucalyptus charcoal (approx. 20% more)
- **Type of carbonization technique used:** Charcoal produced with "modern" kilns has generally a better quality and receives a price premium of about 15%
- **Distance to main road:** The farther away charcoal is produced from the main road, the lower the price
- **Quantity:** The more bags available at the production site, the higher the price per bag
- **Season:** Most districts do not allow charcoal production during the dry season, so producers get better prices.

Charcoal is transported either directly to the next regional market or to the roadside to await buyers. Bicycle transporters are also involved in repacking the charcoal. Often they purchase large bags and repack the charcoal into standard bags for resale. According to the BEST study [1], charcoal is collected along the roads (55%), via intermediaries (16%), and sometimes through a prearranged deal whereby transporters advance money to finance the cutting and carbonization.

FIGURE 12:
STRUCTURE OF THE CHARCOAL CHAIN



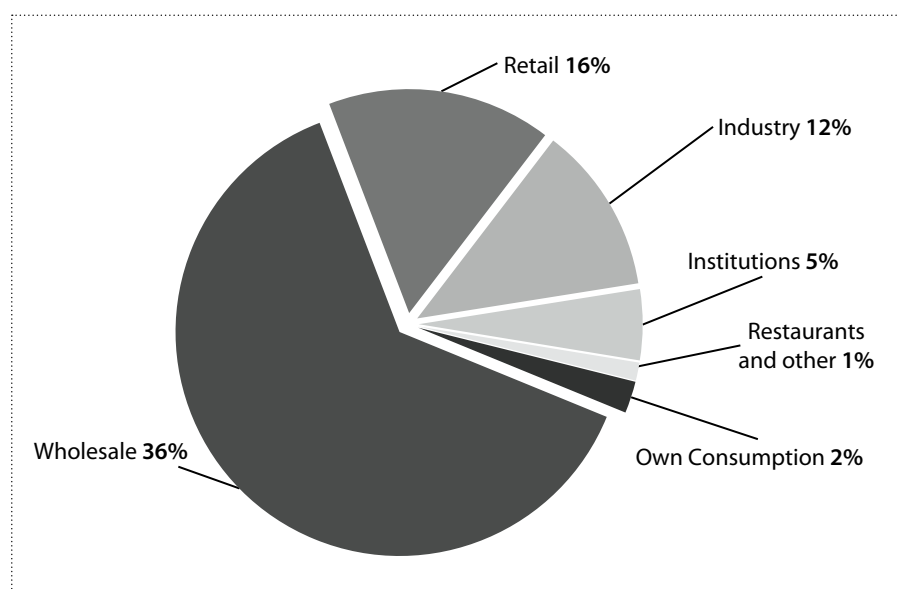
Source: [35]

Some transporters are specialized in the transport of charcoal. In general they are using **pick-up trucks or light trucks** with a loading capacity of 150-250 bags. Other small-scale transporters transport just 1-3 bags in their vehicle, a quantity within the allowable limits of “personal use”. A wood transport permit is needed from district authorities to bring products to the market. For charcoal, the permit is limited to a particular sector where the bags can be collected and also limited in time. In general, the transporter has to show the tree cutting permit before a transport permit can be obtained. The price varies per district: It ranges between 5,000 and 20,000 RwF per truck. Most transporters of charcoal complain that officials stopping the car insist on receiving personal taxes for letting transporters continue their journey. These taxes are typically in the order of 10,000 to 15,000 RwF [35].

The **average transport distance per truck** from the collection points to Kigali is 77 kilometres. Almost all of the large trucks transporting fuelwood and/or charcoal are headed for the city of Kigali. The smaller pickup trucks, bicycles and head loads travel shorter distances and sell in local markets [46].

Most transporters sell in wholesale markets as indicated in Figure 13. Other industries or energy consuming institutions (e.g. brick burning, construction, bakeries, tea and sugar processing) will typically procure their supplies from the wholesale markets. Some of the larger brick burners and prisons will contract with wood-fuel vendors directly for their supplies, or they have their own trucks and do the work themselves [46].

FIGURE 13:
RELATIVE MARKET VOLUMES



Source: [46]

Wholesalers who buy the charcoal from producers usually transport it to **wholesale or retail markets** in town. Some traders buy the charcoal at wholesale markets from primary assemblers and sell on the charcoal at wholesale prices. Others take charcoal directly from producer to consumer, travelling every day or less often, depending on the distances involved. Some traders repack the charcoal into smaller bags. The amount of charcoal held by traders varies: some move just a few bags per day, while large-scale traders can transact up to 500 bags [35, 46].

Retailers may sell charcoal door-to-door or at retail markets. In most markets visited, charcoal was sold outside the market at special places shared by several traders. Some households buy charcoal directly from producers or wholesalers if they travel through the charcoal producing areas.

Purchasing by sack is mainly done by high-income or larger families. Low income classes buy small units, which are more expensive, as the local sellers first discharge the charcoal from sacks and repack it in bucks or small heaps to maximize the profit. Poor people often buy that second category of measures (bucks and heaps), using charcoal to economize expenditures for household energy. **At retail markets**, charcoal is sold in small units, the most common of which are 0.5 and 1.0 kg. In some cases, sellers offer the charcoal in paper bags.

Sales prices for charcoal at different stages of the value chain vary as a function of the channels used and number of players involved (cf. Table 10).

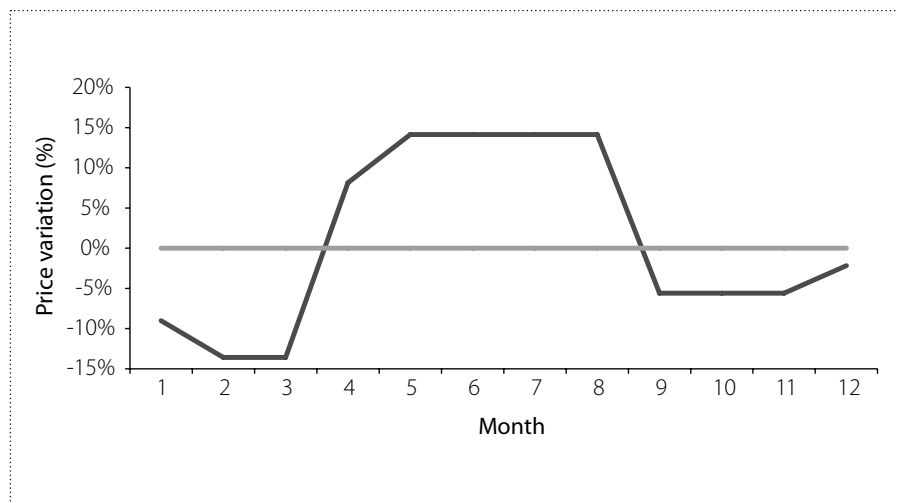
Point of sale	Selling price		
	(RwF/bag)	(RwF/kg)	(USD/kg)
Production site/nearest accessible road/traditional kiln	2,500–3,500	76–106	0.14–0.19
Production site/nearest accessible road/modern kiln	3,000–4,000	91–121	0.17–0.22
Along main roads/rural villages	3,500–4,500	106–136	0.19–0.25
Urban centre outside Kigali	4,000–6,000	121–182	0.22–0.33
Export to DRC (wholesaler/retailer)	8,000–12,000	242–364	0.44–0.66
Kigali (wholesaler)	5,300–7,000	161–212	0.29–0.39
Kigali (retailer)	5,830–7,700	177–233	0.32–0.42

Source: [35]

TABLE 10:
SELLING PRICE OF CHARCOAL

The selling price at the production site ranges between 76 to 106 RwF/kg. However, prices for better quality charcoal produced with modern kilns (type Casamancaise) are from 91-121 RwF/kg. Along main roads or at villages, charcoal is sold at about 106-136 RwF/kg. Collectors and wholesalers sell the product in bulk at 121-182 RwF/kg in urban centres outside Kigali, and in Kigali, at 161-212 RwF/kg. In some towns, like Rossisi or Musanze, prices may be even higher than in Kigali, reaching 250 RwF/kg. One particularity concerns export prices in DRC, which can vary between 242 and 364 RwF/kg. Consumer prices at retail markets range from 177 to 233 RwF/kg. Figure 14 shows monthly fluctuations of charcoal prices in Kigali. The main reasons for the variations are charcoal bans during the dry season and, to a lesser extent, reduced accessibility of some regions during the rainy season.

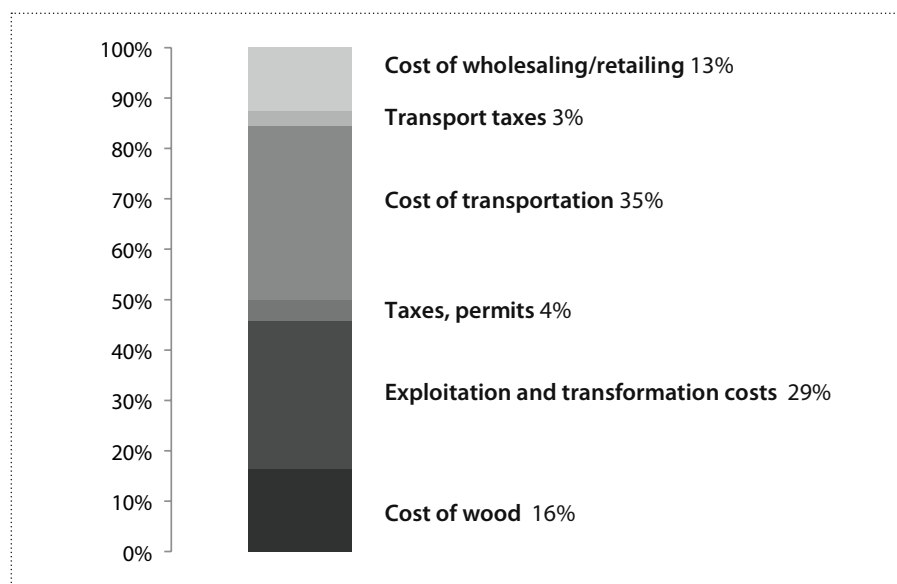
FIGURE 14:
RELATIVE ANNUAL PRICE
FLUCTUATIONS IN KIGALI IN
RELATION TO THE ANNUAL
AVERAGE PRICE



Source: [46]

Pricing includes: the cost of wood, charcoaling (cutting, carbonization, extraction, bag filling and transport to roadside), taxes, the cutting permit, carbonization cost, transport, market fees and private taxes. Figure 15 presents the price structure of charcoal.

FIGURE 15:
PRICE STRUCTURE OF
CHARCOAL



Source: [1, modified]

The cost of wood represents 16% of the consumer price. The cost of charcoaling adds another 29% and the roadside-price equals nearly 50% of the final consumer price. Transport and related charges and taxes add around 42% and wholesaling and retailing together add 13% of the final price. In total, some 49% of the retail value in Kigali stays in the rural areas as income for the farmers, charcoal burners and labourers, and 51% is used to transport and distribute charcoal in town [1].

C.5 UTILIZATION OF CHARCOAL

Fuelwood and agricultural residues comprise the two most dominant energy sources in Rwanda, followed by charcoal. Commercial energy sources like LPG or kerosene remain insignificant, and nearly non-existent in all prefectures except for Kigali Urban and Gisenyi. Households spend an average of 12% of their incomes on energy [40]. According to a study carried out by The World Bank [46], the average consumption of fuelwood and charcoal alone was 1.45 + 0.48 kg, or 1.93 kg per person per day, in 2000. These figures are substantially higher than .33 kg per person per day, the level documented in the 1991 ESMAP report [47]. The FAO ForeSTAT estimates for Rwanda are even higher: It assumes an annual per capita consumption of more than 1 m³ of wood applied to the entire population.

However, actual data on wood-fuel consumption give lower per capita estimates: 314 kg/yr for fuelwood and 134 kg/yr for charcoal [1, 18].

Table 11 gives a summary of the annual per capita fuelwood and charcoal consumption in Rwanda.

Wood-fuels (type)	Stoves (type)	Consumption per household (kg/HH/yr)	Consumption per capita (kg/capita/yr)
Fuelwood	Traditional/three stones	1,642	355
	Improved	1,263	273
	Average	1,453	314
Charcoal	Traditional	700	152
	Improved	538	117
	Average	619	134

TABLE 11:
FUELWOOD AND CHARCOAL
CONSUMPTION

Source: [1, 18, modified]

Rwanda is one of a few countries in Africa where improved cooking stoves (ICS), including charcoal stoves, have penetrated deeply. In the early 1990s, an ESMAP-funded improved stoves program was undertaken [47]. Much of the human and institutional capital built in this program was destroyed during the Genocide. However, these stoves continue to be produced and used, and have spread from Kigali and other cities to new locations. This and other new programs have led to a variety of stove models, with efficiencies greater than traditional cook stoves, that are currently being produced, sold, and used in Kigali. These include [1, 5]:

- All-metal models such as the DUB 10
- All-ceramic models handmade by local potters
- Mixed metal/ceramic stoves
- A metal/ceramic stove, known locally as the “canamakd,” which originated from the Kenya Ceramic Jiko (KCJ)
- The KCJ
- A modified model of the Rondereza with a ceramic fire basket.

**IMPROVED STOVE
DESIGNS ACHIEVE
ECONOMIES OF ABOUT
40% FOR FIREWOOD
STOVES**

A recently approved GEF project (Rwanda: Sustainable Energy Development Project (SEDP)), is, among others, designed to reinforce the promotion of improved stoves by supporting the process of “industrialization” of stove production.

On average, **improved stove designs achieve economies of about 40% for firewood stoves** [40] and 25% to 35% for charcoal stoves [5]. It is estimated that around 50% of Rwandan households own an ICS [21]. However, according to a study realized by CARE International [40], **41% of ICS-owners never use their stoves**, 11% irregularly and only 48% at all times. Nevertheless, there is a strong relationship between wood-scarcity, ICS-penetration and wood-fuel consumption [43]:

- Regions of higher penetration, especially the Northern Province, utilize fewer wood-fuels. Annual per capita consumption in the districts of Musanze and Ngororero ranges between 291 and 297 kg
- Regions of low penetration like the districts of Nyaruguru, Ruhango or Nyamagabe: Annual per capita consumption varies between 860 and 1,147 kg.

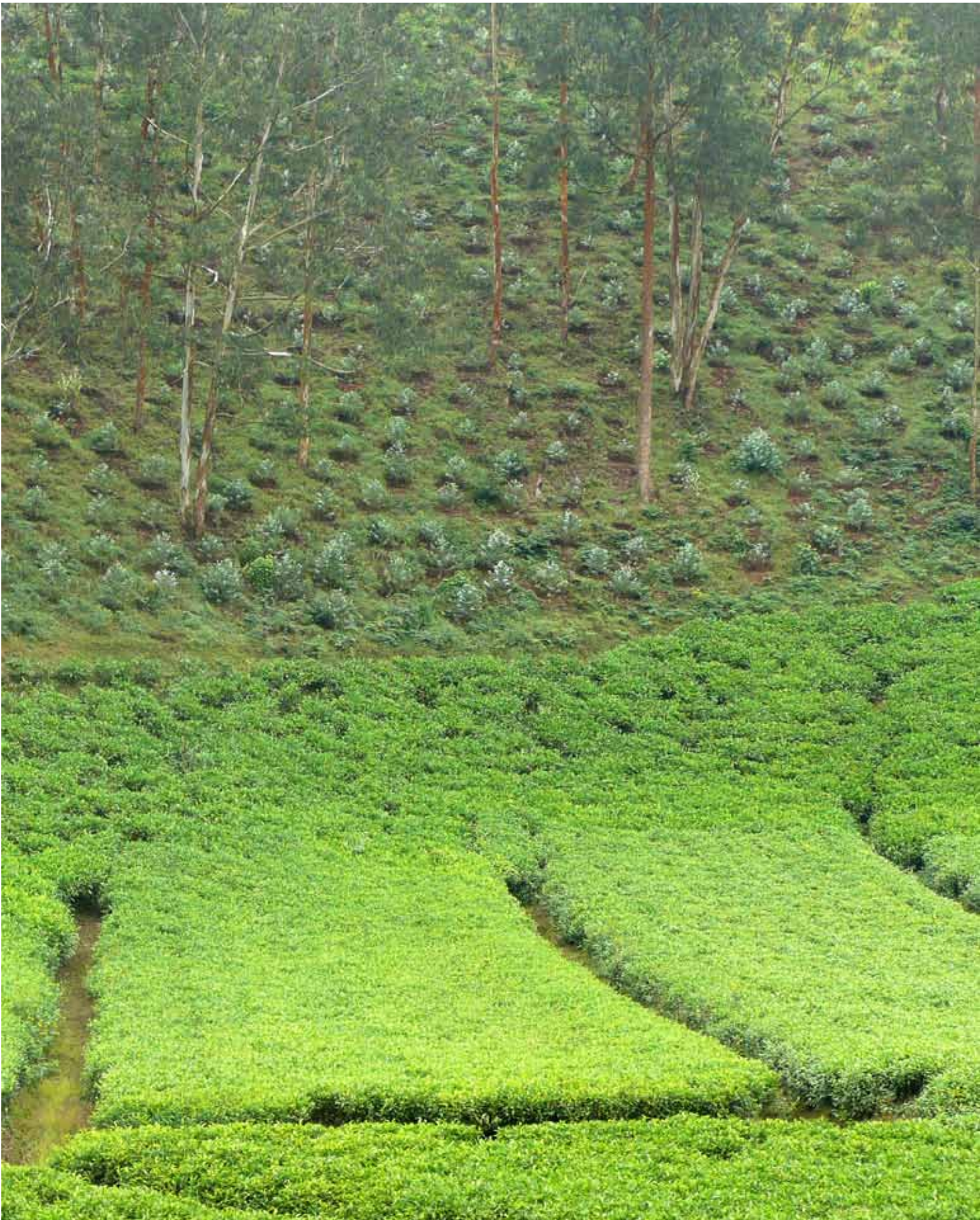
Total residential wood-fuel consumption in Rwanda is estimated at 2.7 million t/yr [18]. Kigali alone accounts for an annual charcoal consumption of 120,000 t [1], equivalent to 1.2 million m³ or 850,000 t of wood.

Institutional and commercial customers account for a relatively small but concentrated demand for charcoal. Due to lack of data on consumption by restaurants, bakeries, hotels, etc., the estimation of this component may be 10% of urban HH consumption, adding up to 73,000 t/yr. Concerning the industrial demand of wood-fuel, there are two important players: tea factories and brick making. Total consumption by tea factories is estimated at 26,000 t/yr. In principle, fuelwood should not be used for making bricks because it is forbidden by law. In reality, fuelwood is still used in combination with other fuels that include exhausted oil and sawmill residues. However, statistical data on wood-fuel consumption for brick making are lacking. A significant amount of fuelwood is used in the public sector, by secondary schools and by prisons. The total consumption by institutional consumers is estimated at 47,000 t/yr [18].

In applying the above data, the total consumption of wood-fuels in Rwanda comes to 2.8 million tonnes per year. It is estimated that charcoal (converted into wood equivalents) accounts for around 40 to 50% of total wood-fuel consumption.

In comparison, the estimated sustainable annual wood-fuel supply in Rwanda ranges between 1.47 and 2.60 million tonnes of biomass (cf. C.2). In consequence, between 52 and 92% of the national wood-fuel consumption is satisfied in a sustainable manner.





D GETTING GREEN

D.1 RATIONALE FOR PROMOTING A GREEN CHARCOAL VALUE CHAIN

As shown in the previous chapter, wood-energy has great social, economic and environmental importance in Rwanda. Unfortunately, wood-energy – especially charcoal – is ill-reputed as an energy of the past, considered dirty and inefficient.

It is expected to be replaced as quickly as possible by alternative energy sources like LPG. This conflicts sharply not only with the everyday significance of wood-based fuels for the Rwandan population, but likewise **with the high and obvious potential of wood-fuels as an environmentally friendly, renewable, socially adapted, clean and low-risk energy source.**

The **contribution of wood-fuels to the Rwandan economy** is significant and surpasses other economic sectors, like the export value of coffee or the total value of maize production [1]. 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 production and processing**. 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 Rwandan society.

Wood-fuels – 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. chips, pellets, gasification and liquefaction), 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.

Using charcoal can **create incentives for landowners and farmers to manage woodlands better** and to invest in fuelwood plantations. Sustainable production of charcoal helps **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 in implementing low-carbon growth

THE CONTRIBUTION OF WOOD-FUELS TO THE RWANDAN ECONOMY IS SIGNIFICANT AND SURPASSES OTHER ECONOMIC SECTORS

strategies. 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 country.

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

There is a **well-established link between household energy and the MDGs** (cf. Figure 16), with measures for increasing sustainable biomass production and improving cooking technology both cited MDG-consistent targets. Freeing up time and lessening drudgery can allow more time to engage in income-generating activities. As well, increased employment in the biomass sector can provide poverty relief to numerous households and help achieve poverty reduction targets. The availability of affordable cooking fuels and better cooking efficiency can help reduce hunger while lowering time pressure on children to collect fuels. This has the potential to increase school enrolment and improve 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 improved health outcomes for those exposed to IAP, with a particularly important objective to reduce child mortality [51].

FIGURE 16:
ENERGY AND THE MDGS

Eradicate extreme poverty and hunger

- Increased modern energy is essential to generate jobs, industrial activities, transportation, and modernized agriculture in Africa.
- Most African staple foods need processing, conservation and cooking, and these require modern energy for a reasonable quality of life.

Achieve universal primary education

- Good educational facilities need electricity for teaching aids and the homes of students and teachers.
- Many children, especially girls, do not attend school to satisfy family subsistence needs.

Promote gender equality and empower women

- Lack of access to modern fuels and electricity affects women and so leads to gender inequality.
- Household activities mostly done by women could be made easier with modern energy and save time. Time saved could be used for more productive activities.

Reduce child mortality

- Diseases caused by poor quality water, and respiratory illness caused by indoor air pollution from traditional fuels and stoves, directly contribute to infant and child mortality.

Improved maternal health

- Women are disproportionately affected by indoor air pollution and water- and food-borne illnesses.
- Lack of electricity in health clinics, poor illumination in night deliveries, and daily household chores all contribute to poor maternal health, especially in rural areas.

Combat HIV/AIDS, malaria and other diseases

- Electricity for communication (radio and television) is needed to spread important public health information to combat deadly diseases.
- Electricity is needed for illumination, refrigeration, sterilization, etc. for effective health services.

Ensure environmental sustainability

- Energy production, distribution and consumption in Africa has many adverse effects on the local, regional and global environment, including indoor and air pollution, and land degradation.
- Cleaner energy systems are needed to address environmental sustainability.

Develop a global partnership for development

- The World Summit for Sustainable Development called for partnerships between public entities, development agencies, civil society and the private sector to support sustainable development, including the delivery of affordable, reliable and environmentally sustainable energy services.

Source: [60]

D.2 THE ENERGY TARGET DIAMOND

Modernization of the charcoal sector requires a consensual vision statement from all relevant government authorities on promoting sustainable charcoal production. All activities within the modernization process should address four basic principles: (1) environmental and climate friendliness, (2) security of supply, (3) economic efficiency and compliance, and (4) health and safety requirements. Figure 17 illustrates the energy target diamond.

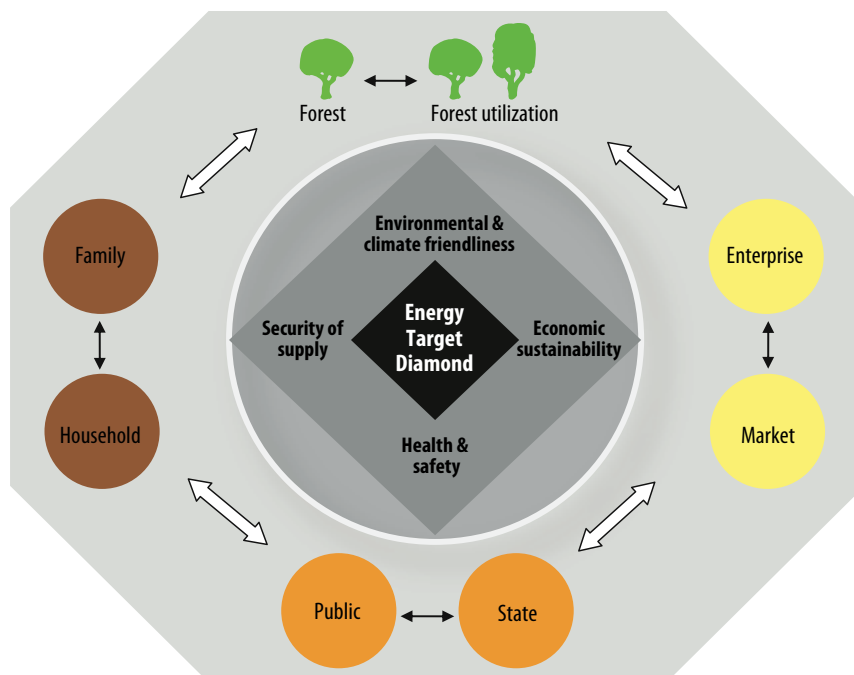


FIGURE 17:
ENERGY TARGET
DIAMOND AND ITS
INTERRELATIONSHIPS

Source: [49]



These principles apply to the nexus of forest resource 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 “green” charcoal value chain will be to reorganize these linkages so as to comply with the principles.





To be really effective, a vision statement must be mainstreamed 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.

D.3 STEPWISE INTO THE FUTURE

The modernization of the charcoal value chain entails a stepwise process (see Table 12) that requires continuous refinement and/or adaptation of respective framework conditions, organizational and procedural aspects, and technological development.

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 depends on economic development, specifically per capita GDP purchasing power parity. This calls for 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.

TABLE 12:
COMPARISON OF STAGES OF WOOD-FUEL PRODUCTION CHAIN MODERNIZATION

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
Management type	Open access	Open access/ sustainable	Sustainable/certified	Certified
Exploitation type	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 
Efficiency	12 to 14%	18 to 28%	28 to 34%	>30%
Emissions (g per kg charcoal produced)	CO ₂ : 450 to 550 CH ₄ : ~ 700 CO: 450 to 650			CO ₂ : ~400 CH ₄ : ~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 m ³	2,800 ppm	1,700 ppm	<1,000 ppm	< 250 ppm
Energy type	Thermal energy	Thermal energy	Thermal energy, electric energy	Thermal energy, electric energy, chemical energy
Conversion type	Combustion	Combustion	Combustion, gasification	Combustion, gasification, liquefaction

Source: [50, modified]





GREENING THE CHARCOAL VALUE CHAIN

E.1 GREEN AVENUES OF INTERVENTION

Despite continuing population and land pressures, Rwanda is one of only three countries in Central and Western Africa to achieve a major reversal in the trend of declining forest cover. The country has fixed an ambitious goal of achieving 30% forest cover of total land area by 2020. The Government of Rwanda has taken a lead in developing a visionary forest policy and Rwanda recently won a United Nations-backed gold award for its forest promotion policies.

The country is in the initial stages of building a formalized and sustainable wood energy sector with significant potential for poverty alleviation. Furthermore, there is a readiness to adopt improved kiln technologies and the dissemination of improved stoves is continuously increasing. However, as described in chapter C, there is, at all levels of the charcoal value chain, an urgent need for enhancement.

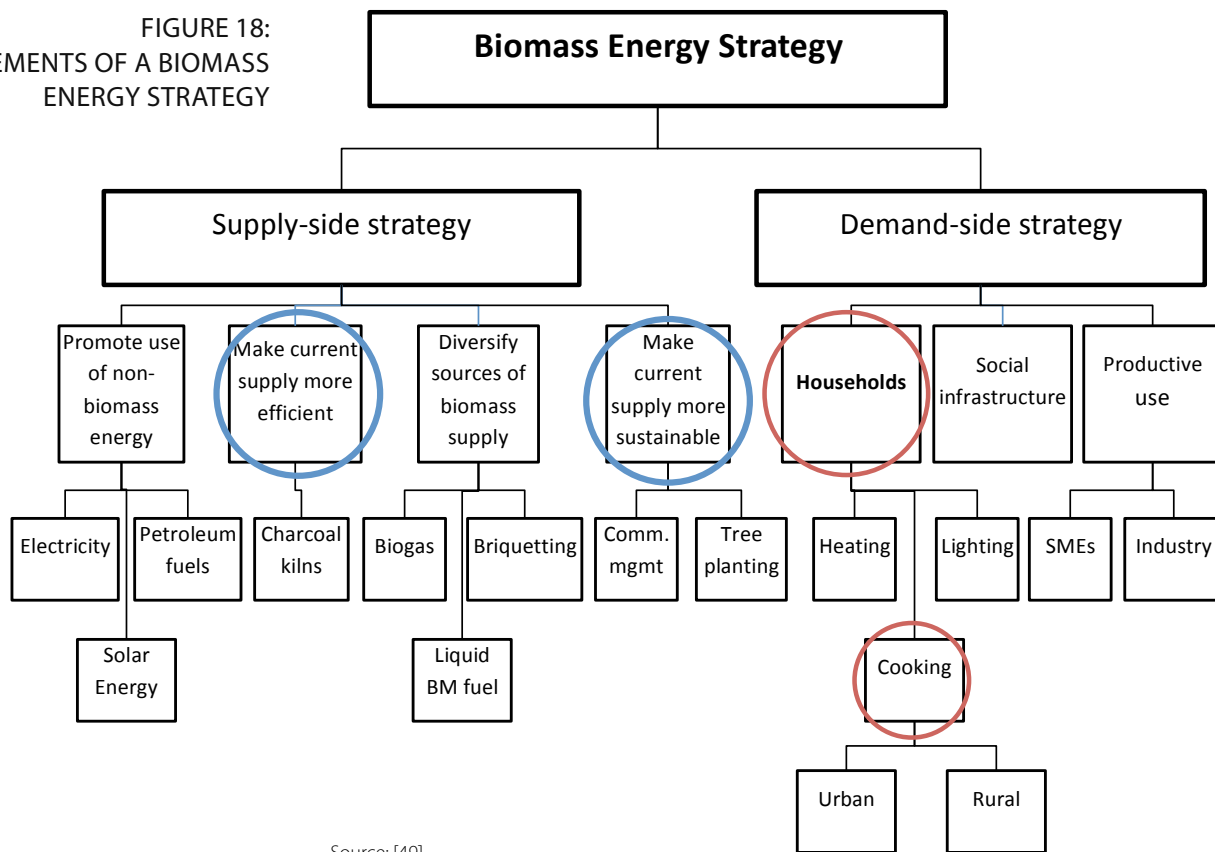
Biomass energy strategies commonly approach their subject along two principal avenues: supply and demand.

- “Supply” denotes all aspects of production, utilization, conversion, transport and marketing/distribution of biomass-based fuels.
- “Demand” covers all aspects of use and consumption (including provision of required technical appliances, such as stoves or similar technology).

The interventions proposed in the following sections aim to contribute to the modernization of the wood-energy sector in Rwanda. The interventions focus on the supply and demand of charcoal, sourced through plantation management or harvested from TOF (cf. Figure 18). Other biomass fuels, including novel technologies such as biogas and agro-fuels are not covered; neither are such renewable energy sources as solar power, hydropower, wind power and the like. Proposed activities and strategies do not aim to replace a biomass strategy, rather they are an integral part of it.

THE GOVERNMENT OF RWANDA HAS TAKEN A LEAD IN DEVELOPING A VISIONARY FOREST POLICY AND RWANDA RECENTLY WON A UNITED NATIONS-BACKED GOLD AWARD FOR ITS FOREST PROMOTION POLICIES.

FIGURE 18:
ELEMENTS OF A BIOMASS
ENERGY STRATEGY



Source: [49]

Nearly all recommendations of this study 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 charcoal production, trade and consumption are extensive and intertwined, the issues in the charcoal 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, render them sustainable.

The recommendations refer to five basic avenues of intervention: (1) production of wood for charcoal making in the narrower sense; (2) introduction of modern conversion technologies for charcoal-production; (3) improvement of the commercial network; (4) improvement of combustion technologies; and, (5) the introduction of adequate framework conditions.

Assisting local players to introduce efficient production options, conversion or combustion technologies calls for two basic modes of support, knowledge transfer and 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” are already included in the BEST strategy [1]. There is, in fact, a wealth of experience and lessons to draw on. The recommendations, thus, deliberately abstain from any attempt to “reinvent the wheel”. Instead, **the challenge lies in speeding up the development of the charcoal sector and in putting it on sound footing.**

Sustainable wood production

- Elaboration of wood-energy supply plans
- Updating and adaptating district forestry plans
- Guarantee of adequate land tenure/user rights for wood-fuel production
- Rehabilitation and better management of public forest plantations
- Increasing productivity of existing private forest and agro forestry resources
- Increasing private forest area and agro forestry resources
- Testing short rotation coppice

Exploitation and transformation of wood-fuels

- Simplification and harmonization of administrative procedures for cutting permits
- Improvement of carbonization technologies
- Test and introduction of semi-industrial kilns
- Development of concepts for the grading and packaging of charcoal
- Introduction of new technologies allowing the utilization of charcoal dust

Transport and commercialization of charcoal

- Improvement of transport efficiency
- Organization of commercial networks
- Development of a market information system

Utilization of wood-fuels

- Increasing efficiency of cooking devices

Framework conditions

- Introduction of adequate forest taxation procedures and law enforcement
- Implementation of a traceability system
- Promotion of innovative financing mechanisms
- Improvement of governance capacity to reorganize the charcoal production sector
- Setting up a monitoring and evaluation system
- Lobbying and PR measures

**FIGURE 19:
SUMMARY OF PROPOSED
AVENUES OF INTERVENTION**

E.2 ACTIVITIES RELATED TO SUSTAINABLE WOOD PRODUCTION

E.2.1 SUMMARY OF ACTIVITIES RELATED TO SUSTAINABLE WOOD PRODUCTION

Table 13 gives an overview of proposed activities related to sustainable wood production.

TABLE 13:
SUMMARY OF ACTIVITIES
RELATED TO SUSTAINABLE
WOOD PRODUCTION

Activity
<ul style="list-style-type: none"> • Elaboration of wood-energy supply plans • Updating and adapting district forestry plans • Guarantee of adequate land tenure/user rights for wood-fuel production • Rehabilitation and better management of public forest plantations • Increasing productivity of existing private forest and agro-forestry resources • Increasing private forest area and agro-forestry resources • Testing short rotation coppice

E.2.2 ELABORATION OF WOOD-ENERGY SUPPLY PLANS

The elaboration (and implementation) of wood-energy supply plans (WESP, schéma d'approvisionnement en bois-énergie) is one of the priority areas and a **prerequisite for the modernization of the charcoal sector**.

A comprehensive and spatial-explicit vision of supply and demand is an essential pre-requisite for wood-energy planning and strategy formulation at local and national levels. Synergies among institutions for an integrated multi-sectoral approach are absolutely vital. WISDOM Rwanda provides a first comprehensive and spatial vision for Rwanda. However, existing data on forest resources < 0.5 ha must be interpreted carefully (cf. section C.2) and a specific inventory should be undertaken to get accurate and reliable area data. These data have to be integrated in the **existing WISDOM database**. WISDOM Rwanda could be used as the basic data source for the elaboration of the WESPs, especially concerning the cities of Kigali, Butare, Gisenyi, Cyangugu and Ruhengeri.

The WESP has to include the following steps:

- Update the forest cover inventory
- Identify wood supply zones/basins and assess accessible wood-fuel resources by zones
- Project demand from cities and rural areas for wood-fuels, timber and other wood products
- Analyse charcoal flows, including exports to DRC
- Identify priority areas for intervention
- Identify types of intervention in each zone and each link of the value chain
- Identify necessary infrastructures, especially rural and urban wood markets (cf. section E.4.3)
- Prioritize the implementation of action plans by area

- Define clear rules for sharing of responsibilities and coordination between FD staff and communities for forest/plantation management.

WESPs are generally elaborated for ten years and implementation will be by catchment area at district and village level.

E.2.3 UPDATING AND ADAPTING DISTRICT FORESTRY PLANS

In the last years, district forestry plans (DFP) have been developed for several districts (e.g. Nyaruguru, Rulindo, Gusabo, Ruhago and Gicumbi). These DFPs already include simple management plans for public forests, fixing objectives, exploitation or reconversion goals. DFPs are also means to boost decentralization and stimulate the involvement of districts and sectors in the rational management of forest resources within their territories. Practically speaking, **existing DFPs have to be updated after the elaboration of WESPs**. The WESPs (see section E.2.2) form the basis for programming forest and plantation areas that should be exploited, protected or rejuvenated, as well as the required investments. **In this context, the interventions should focus on:**

- **Simplifying DFP** through the introduction/elaboration of standardized tools and procedures (standardized management/exploitation plans, ToR for contracts), among others
- **Setting up assistant schemes** (facilities for professional groups, information/awareness and training tools, recruitment and training of rural animators, information workshops for local authorities and officials)
- **Develop simplified management plans** for (individual) public forests
- **Support districts and sectors to implement programmed forestry activities**, especially in priority areas
- Assess professional and technical capacity needs and **design appropriate capacity development plans** for performance and achievement of objectives fixed in the DFPs.

E.2.4 GUARANTEE OF ADEQUATE LAND TENURE/USER RIGHTS FOR WOOD-FUEL PRODUCTION

It is widely recognized that security of land tenure is one of the most significant framework conditions necessary for sustainable forest management. Recent comparative studies show clearly the relationship between insecure tenure, poor economic performance, social instability, degradation of natural resources, and critical biodiversity losses [52]. No blueprint approaches or patent remedies are available to solve tenure problems and challenges. **Several actions could be taken to support the security of tenure:**

- Identification, documentation and subsequent reconciliation of claims to forest areas (see also section E.2.2)
- Creation of a forest cadastral system
- Clear assignation of rights, obligations and responsibilities in respect of forest resources, both within communities (for both men and women) and pertaining to third parties
- Establishment/empowerment and capacity development for community-based institutions in charge of forest resources

- Agreed and documented approaches to conflict-resolution and enforcement mechanisms.

E.2.5 REHABILITATION AND BETTER MANAGEMENT OF PUBLIC FOREST PLANTATIONS

State and district plantations should be integrated into the wood-energy circuit. These public forests have to be localized and mapped (see also section E.2.3) and simple management plans have to be set up. For the management of public forests there are several options:

- Introduction of **participatory forest management** by newly established local user groups living adjacent to these forests on a contract basis
- **Privatization of the management** of state- or district-owned plantations through service contracts signed with specialized forest management groups and/or professional charcoal producer groups
- **Promotion of joint management arrangements** to foster good relations on fragmented forest areas; and establishment of Forest Management Units (FMUs) sufficiently large to enable sustainable forest management (SFM) through forest associations, cooperative arrangements or Public-Private Partnerships (PPP).

Overaged, non-productive public forest plantations (cf. section C.2) should be exploited as quickly as possible and reconverted into productive wood-fuel stands. Experience has shown that the conversion of old pine in Eucalyptus stands results in highly productive and profitable fuelwood plantations.

Eucalyptus is the tree of choice for plantation forestry in Rwanda, due to the various species with genetically determined site-tolerance, high productivity, high survival rates, sprouting capacity and resistance to diseases, pests, and browsing damage. Farmers are not even willing to consider any alternatives. Even still, **there is need to diversify plantations with a focus on indigenous species** that contribute to biodiversity conservation and are better adapted to fragile ecosystems. Reforestation on state and/or district land should be regarded as an opportunity for demonstrating advanced techniques and species selection for charcoal production. Still, it would be wrong to forbid farmers to plant Eucalyptus. Technical advisory support and provision of incentives are more likely to succeed as they recognize the farmers' right to make individual management decisions.

E.2.6 INCREASING PRODUCTIVITY OF EXISTING PRIVATE FOREST AND AGRO-FORESTRY RESOURCES

Due to increasing population pressure and scarce land resources, the possibilities for new forest plantations are very limited (cf. section E.2.7). On the other hand, productivity of private (and public) plantations is very low (cf. section C.2). **Improving the management of existing tree formations is one of the key elements for the modernization of the charcoal value chain in Rwanda.** Best practices, like the SORWATHE plantation, owned by a tea factory near Gicumbi, have proved that **sustainable yields of 20 to 30 m³/ha/yr can be obtained with simple and non-expensive management measures:**

- Selection of good tree varieties with rapid growth
- Control of erosion within plantations
- Reduction of stump height for better coppicing
- Regular maintenance (thinning)
- Removal of dead and damaged trees
- Addition of fertilizer (if possible).

In applying these “good tree management” practices it is possible to increase profit margins from Eucalyptus plantations by 44% [39]. **Activities to boost the productivity of existing private forest and agro-forestry resources mainly concern:**

- Enhancing capacity development of farmers
- Promoting the creation of farmer “forest associations” or farmer groups
- Implementation of awareness campaigns
- Establishment of agro-forestry and forest plantation demonstration farms to exhibit “good tree management” for charcoal production
- Dissemination of best practices in farm forestry
- Support of farmer groups to establish and manage tree nurseries for commercial purposes
- Support in investment costs to assist farmers to increase the productivity of their lands (e.g. better seedlings and fertilizers).

E.2.7 INCREASING THE AREA OF PRIVATE FORESTS AND AGRO-FORESTRY RESOURCES

By the end of the 1980s, options for extending cultivated areas by clearing new land were almost exhausted. The expansion of cultivation mainly involved a reduction in the fallow period or the occupation of marginal lands. In light of the increased difficulties farmers face in gaining access to land, especially marshlands, further research is needed to determine how agricultural land is currently used. Extrapolating the current trends in agricultural productivity, land use and food demand analysis shows that there are no agricultural areas available for the cultivation of forestry plantation [2]. **Only marginal lands are available for wood-energy.** Presently, the potential on marginal land cannot be measured on the basis of statistical data. Assuming that 3% of existing agricultural land is classified as marginal [2], **the potential for increasing forest resources would be around 75,000 ha.** These areas have **to be mapped** within the context of the elaboration and update of DFP (cf. section E.2.3).

It is important to appreciate that, apart from the forest sector, many of the positive interventions to support reforestation originate in other sectors such as agriculture and energy. Combined with an increasingly safe and stable land tenure system and rising market prices, a new dynamic development for reforestation may be induced on a local level.

The experience of the PAREF program (“Reforestation for Renewable Energy in Rwanda” 2008-2012 of the Netherlands-Rwandan Cooperation) indicates that farmers need to be involved in the development of specific reforestation and afforestation programs. It is a demand driven approach to which interested farmers and planters must contribute by their own means (e.g. labor and manure

from compost). Contributions in-kind or in money have to be considered for investments in erosion-control measures.

In addition, seed multiplication is vital to ensure that certified and superior seeds of the right species are available. More seeds may be required, particularly of agro-forestry species, fruit trees and fruit bushes, for trying to intensify farming with a greater number of trees [1].

Figures on the cost of reforestation obtained through document analysis and discussions vary considerably in regard to land clearance, erosion control and digging holes, depending on topographic features and relief, and soil properties. **The full cost for the establishment and maintenance of one hectare varies between 260 and 870 USD [48].**

E.2.8 TEST OF SHORT ROTATION PLANTATIONS

Since the oil crisis, many European and North American researchers focused on the selection of fast growing species capable of producing a significant amount of biomass in short rotation cycles.

In this context, **short rotation crops will also be an option to increase the supply of wood energy in Rwanda. The very short rotation coppice (SRC)** is a variant of the method of silvicultural treatment, simple coppice. The peculiarity of the SRC is that very short rotation and stands are exploited annually or within a 2-year rotation period. The goal is to produce maximum biomass in the shortest possible time. According to experience, the annual production of woody species ranges between 30 to 40 m³/ha [53]. However, **SRC requires special treatment.** To be successful, this operation must complete a number of conditions:

- The selection of species
- The choice of culture
- The development of harvesting techniques
- Transport and packaging
- The type of stove used.

This SRC value chain should be analysed and optimized at all stages to be competitive with other forms of wood-energy. Generally the wood produced by SRC is commercialized as wood chips for energy purposes. However, in the framework of a “green” charcoal chain, the SRC could be tested as a production technology focusing on the auto-consumption of producers. Eucalyptus-SRCs may be a promising energy crop with a very favourable energy balance. Produced wood could be used directly as wood sticks in specific stoves or transformed to charcoal in small-scale metal kilns [50].

E.3 ACTIVITIES RELATED TO THE EXPLOITATION AND TRANSFORMATION OF WOOD-FUELS

E.3.1 SUMMARY OF ACTIVITIES RELATED TO THE EXPLOITATION AND TRANSFORMATION OF WOOD-FUELS

Table 14 gives an overview of proposed activities related to the exploitation and transformation of wood-fuels.

Activity

Simplification and harmonization of administrative procedures for cutting permits Improvement of carbonization technologies Testing and introduction of semi-industrial kilns Development of concepts for the grading and packaging of charcoal Introduction of new technologies allowing the utilization of charcoal dust
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TABLE 14:
SUMMARY OF ACTIVITIES
RELATED TO EXPLOITATION
AND TRANSFORMATION OF
WOOD-FUELS

E.3.2 SIMPLIFICATION AND HARMONIZATION OF ADMINISTRATIVE PROCEDURES

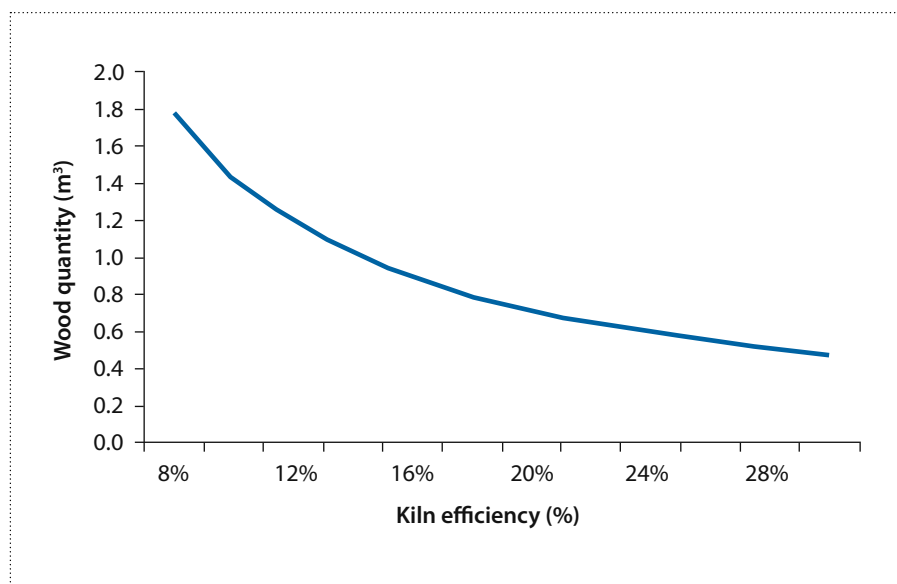
The application for necessary cutting permits is one of the first steps of the exploitations phase. It would be beneficial for all actors if procedures for obtaining permits and paying taxes were clear, simple, and not the lengthy, non-transparent and motivation breaking process as observed by all actors (see also section E.6.1). Thus, formalization of the charcoal sector requires clarification of all administrative procedures and related costs. More details on related activities are given in section E.6.2.

E.3.3 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 20 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 20:
AMOUNT OF WOOD
NEEDED TO PRODUCE
100KG OF CHARCOAL



Source: [50]

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

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 for the technology to be applied.**

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

However, semi-industrial kilns are more permanent structures, which require that the wood be transported to the kiln. Given the challenges that individual charcoal producers already face to make minimal technology improvements such as chimneys, semi-industrial technology can only be established through larger scale private investments. One possibility involves joint investments by formerly individual charcoal producers, for example, by creating producer associations or cooperatives. In addition, the mosaic of private, small-scale forest plantations in Rwanda combined with the hilly terrain, seems not to be suitable for the introduction of semi-industrial stationary kilns.

Different types of improved kilns have been tested and disseminated in Rwanda, and a wealth of experience and lessons is available for practitioners to draw on. Improved models include non-permanent Casamance kilns, rectangular kilns using one or two chimneys, stationary brick kilns and 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. On average, it will be possible to obtain kiln efficiencies between 20 and 25% [1, 35, 38, 39].

Traditionally, charcoal is considered to be a poor man's trade and other members of society look down upon the actors. They are not formally organized in associations like in other sectors, but rather operate individually, hence lacking a collective voice and bargaining power to push for their agenda within the government.

Charcoal producers in general suffer from the price dictate of regional charcoal traders, especially those in "remote" areas due to bad road conditions. The creation of cooperatives or associations would enforce the negotiating power of charcoal burners vis-à-vis the traders. Increasing income will open up the possibility of purchasing a truck and engaging in direct marketing by entering into contracts with large consumers.

Projects in Rwanda have already started providing training and guidance for value chain development, including the facilitation of association building. Especially at the level of wood and charcoal producers, the establishment of "business development clusters" should be promoted. Charcoal Producers Associations 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 and linking charcoal burners to financial markets and market information. Pertinent market information includes not only the prices of fuel-wood, charcoal and transport, but also prices of other wood products.

Charcoal burners should be assisted with organizing themselves to have a voice, for instance, by way of an informal national committee. For example, at the national and district 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
- Raise awareness that charcoal producers should provide each labourer with protective clothing
- Organize exchange study visits among its members to learn from best practices
- Organize training for members on the financial and administrative management of a charcoal business.

Promoting improved kiln technology requires providing financial resources to potential investors. Due to the increased costs of improved kiln technology, **seed funding in the form of "one-time" input subsidies** may be a policy option. If these 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 continuously 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 an energy source or to increase the efficiency of charcoal production. Unfortunately, however, these technologies have high initial investment costs.

E.3.4 TEST AND INTRODUCTION OF SEMI-INDUSTRIAL KILNS

The establishment of semi-industrial or industrial kiln technology depends upon larger-scale private investors. In these cases, wood-sourcing should preferably come through outgrower schemes or other benefit-sharing arrangements. This would allow the local population to continue earning a steady income through the charcoal sector. However, **the best possibility to test the introduction of semi-industrial stationary kilns would be on larger public forest plantations.** The relicts of the old World Bank financed Eucalyptus plantations around Kigali would be an ideal source of wood supply for these kinds of kilns.

In a first attempt, it is advisable to test **the so-called Improved Charcoal Production System (ICPS)**, or “Adam-retort”, at selected pilot sites. This type of kiln has already been tested and vulgarized in Kenya, Burundi and India [54]. **Main features of the ICPS are [55]:**

- 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 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% (as compared to a traditional kiln)
- High investment costs compared to traditional kilns
- About 3 m³ of biomass (corresponding to approx. 600 to 900 kg of wood, coconut shells, compacted saw-dust briquettes, etc., dry weight, water 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 corresponds to about 1 tonne of charcoal per week and unit
- Only waste wood or residual biomass needs to be burnt (50 kg) in a separate fire box to dry and heat the wood and initiate the carbonization process during the 1st phase.

E.3.5 DEVELOPMENT OF CONCEPTS FOR THE GRADING AND PACKAGING OF CHARCOAL

The production of charcoal with traditional or improved carbonization technologies is generally characterized by the uneven quality of the product, especially the uneven sizing of the charcoal. This does not facilitate the loading of bags or the final utilization by local end-users. It is therefore advisable to increase the quality through better calibration of the charcoal produced. In that regard, high-end buyers could kick-start the new approach, e.g. supermarkets, hotels, up-scale restaurants, tourist camps/lodges.

Currently, the charcoal produced is filled in bags of 33 kg or 50 kg (cf. Box 2), which limits the possibilities of transport. It also limits sales to consumers interested in larger or smaller bags. Thus, **improving the packaging of charcoal** should be considered.

E.3.6 INTRODUCTION OF NEW TECHNOLOGIES ALLOWING THE UTILIZATION OF CHARCOAL DUST

A large quantity of small pieces of charcoal that cannot be packaged in bags, remains at the production site. Also, downstream in the value chain at wholesale and retail points, it is likely that charcoal dust accumulates. At the moment, this dust is discarded. **Given the high amount of charcoal consumed in Rwanda, the potential quantity of charcoal dust in urban trading sites alone probably ranges between 10,000 and 20,000 t.** This dust can be transformed into charcoal briquettes, made from charcoal dust compactly massed by a binder. 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 the production site or – ever better – at wood-energy markets in rural and urban areas (cf. section E.4.3).

In the short term, briquettes made from charcoal dust provide an efficient use of wasted resources and could be competitive in price as well as usage. How cheap this fuel could finally become depends on the development of the production process, its costs and methods. With the right level of support, it is possible to create small enterprises that provide economically viable alternatives to the current fuels available in Rwanda.

E.4 ACTIVITIES RELATED TO TRANSPORT AND COMMERCIALIZATION OF CHARCOAL

E.4.1 SUMMARY OF ACTIVITIES RELATED TO TRANSPORT AND COMMERCIALIZATION OF CHARCOAL

Table 15 gives an overview of proposed activities related to transport and commercialization of charcoal.

Activity
<ul style="list-style-type: none"> Improvement of transport efficiency Organization of commercial networks Development of a market information system

TABLE 15:
SUMMARY OF ACTIVITIES
RELATED TO TRANSPORT AND
COMMERCIALIZATION OF
CHARCOAL

E.4.2 IMPROVEMENT OF TRANSPORT EFFICIENCY

In Rwanda, national and international transportation are dominated by the road sector. About 75% of all imported petroleum is consumed within the transport sector and transport costs are quite high [2]. This has a significant effect on prices in Rwanda, as lack of modal competition and demand for imported fuel make transport costly. Currently over 40% of the cost of goods is attributed to transportation, keeping prices high. **Within the charcoal value chain, transport accounts for about 38% of the total charcoal price** (cf. section C.4).

Carbon-dioxide emissions, mainly from the transport sector, are significant. Whilst not separately accounted for, **GHG emissions from transport are approximately 13% of Rwanda's total emissions**. Local pollution is a concern due to the age and condition of the Rwandan fleet. Ozone levels exceed both US and Japanese environmental standards [56]. EDPRS and Vision 2020 identify the poor state of infrastructure, high cost and restricted access to services as key obstacles to achieving development objectives.

Efficient petroleum use is determined by the standard of vehicles, the quality of the transport systems and the use of most energy efficient transport means. **In the context of the charcoal value chain, the loading of trucks plays a crucial role**. For example, at police checkpoints, inadequate securing of the load is frequently criticized and used as an argument to demand so-called "private taxes".

Because of poor loading, transport **capacities are underutilized**. It is estimated that **10 to 15% of transportation costs could be saved** through an optimized utilization of the existing loading capacity. Given charcoal's fragility, excessive handling and transporting over long distances can increase the amount of fines up to 40%, greatly reducing its economic value [74]. **Estimations of damages in transit come to approximately 10% of the product value** [35].

In the context of reducing costs related to transport, there is a strong need to assist charcoal collectors and transporters to optimize transport capacities. The **utilization of suitable plastic boxes** seems to be a good approach and should be introduced at a larger scale. Furthermore, **better packaging of charcoal will contribute to easing the introduction of a national traceability system** (see also section E.6.3). Bulk transport of charcoal could also increase transport volumes and reduce losses and costs.

E.4.3 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 organizing the charcoal sector and assisting charcoal burners to obtain better prices**. These charcoal depots have to be managed like micro, small or medium enterprises (MSME) and subject to standard financial rules.

Based on the experiences of CARE, **centralized rural charcoal depots** could be set up in all districts that produce charcoal. The depots could serve as reloading and wholesaling points, formalizing 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 to. The spatial distribution of the rural markets depends on the distribution of production sites/forests.

This system was first introduced in the late 1990s in Niger, Mali and Chad under the title “rural firewood market system”, albeit with different, country-specific approaches (cf. Box 4). 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 making a significant contribution to responsible resource management, pro-poor empowerment, decentralization and good governance.

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 centrepiece 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 urban areas.

**BOX 4:
RURAL WOOD-FUEL
MARKET APPROACH**

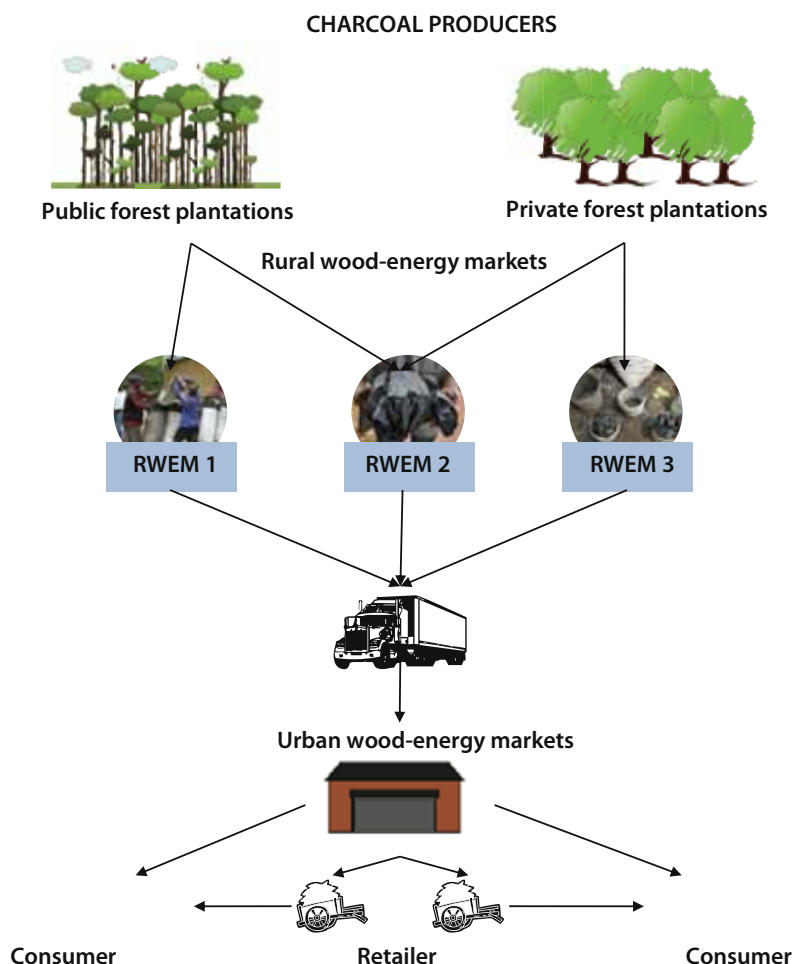
Source: [48]

The rural charcoal markets/depots should be organized within a network of several rural markets/depots supplying a network of urban charcoal depots. Urban charcoal markets/depots have to be set up in all district capitals and in Kigali. Urban markets/depots offer the possibility to centralize the charcoal flows from different districts or sectors. Figure 21 below gives an idea of the commercial network formed by rural and urban wood-energy markets.

Rural and urban charcoal markets/depots also offer the opportunity for producers to diversify their product lines to target different consumer groups. In the medium run, **the charcoal markets/depots could evolve 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 in section E.3.6, many small pieces of charcoal accumulate at 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 Rwanda 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 E.6.3).

FIGURE 21:
COMMERCIAL NETWORK
OF RURAL AND URBAN
WOOD-ENERGY MARKETS



Source: [57, modified]

E.4.4 DEVELOPMENT OF A MARKET INFORMATION SYSTEM

The modernization of wood-energy value chains goes along with some far-reaching changes. There are concerns that poor small-scale charcoal producers could be in a disadvantageous position to adjust to new market conditions. These producers are the least organized group in the supply chain. Most of them have small-scale operations, use traditional techniques, depend on family labor and have little capital to invest. Producers with access to capital, technology and logistics may be best positioned to reap the benefits. As a result of increased competition, poor small-scale producers may turn out as the losers of the modernization process. **To grasp new opportunities for trade and income requires information as well as communication and commitment from other chain partners** [58].

Information is a critical resource in the operation and management of value chains. 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. However, as there are many “small” charcoal producers, and less than perfect information for stakeholders in the wood-energy sector, the market is susceptible 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 forced to sell their products to middlemen at dumped prices.

This knowledge deficit on the part of the charcoal producers may greatly be reduced if they were 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 wholesalers, retailers, consumers, researchers and policy makers.

The Government of Rwanda has launched an IT platform to provide market information. The eRwanda Project, an ICT for Development project, intends to ensure that smallholder farmers get updated information about market prices for their products. In particular, the so-called e-SOKO Project provides market price information via mobile phones to rural farmers and cooperatives who, in the past, suffered from a lack of market price information. Previously, they were isolated or deprived from communications and trade across markets, borders and in the region. The system is a database, which covers more than 60 agricultural commodities in the country's 41 markets, all accessible through SMS. Subscribers enter a "short code" with the name of the commodity and the market of interest, to get in return an SMS message with the product's price quote of the day [86, 87].

Based on this experience, the development of a **market information system (MIS), or even the 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.** This includes suppliers, manufacturers, wholesalers, retailers and final customers.

In a first step, the focus should be on the development of an MIS centred on flows, quantities and prices of wood-energy, particularly charcoal. Most existing MIS systems, (e.g. for agricultural products) are based on a computer network. However, in general, data collection and access remain hurdles due to lack of computer maintenance and ICT infrastructure in Rwanda. Compared to a restricted number of PCs in Rwanda, there are now 4.6 million mobile phones in operation. The number of mobile-phone users in Rwanda jumped 51% in 2010, boosted by increased competition, lower taxes and promotions by operators. Mobiles are increasingly used in rural villages and it is estimated that the number of users in Rwanda will reach 5 million. **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 mobile screens and text capacities. An MIS developed for agricultural products in Bangladesh, for example, uses simplified codes for agricultural produce and market operations [58]. The future WE-MIS could, for example, collect up-to-date market information via cell phone or computer. Market investigators or the managers of rural and urban wood-energy markets collect up-to-date prices and quantities, and send information via cell phone text message into a database managed on an SMS server. The server would then be accessible to clients requesting price information for wood-energy products via text. These text messages would both request and receive price information. A prototype of a similar system was tested both for data collection and dissemination of 50 agricultural items in Bangladesh [58].

The system provides full awareness to 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 to 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, wholesalers and retailers, but also to the Government. It would also help bring the charcoal/wood-energy sector to a more equitable level
- The WE-MIS will boost rural development due to better functioning markets and more empowered charcoal/wood-energy producers.

E.5 ACTIVITIES RELATED TO THE UTILIZATION OF WOOD-FUELS

Improved cook stoves (ICS) are an obvious energy-saving solution for urban and rural households in Rwanda. However, given the high penetration rate of stoves in Rwanda, the incremental impacts of additional stove programs are limited. Nevertheless, the promotion of ICS has a high ranking in the country's policy agenda and, given the very high prices for wood fuels in Rwanda, there are opportunities to launch scale-up activities. The Forum of Energy Ministers of Africa (FEMA) estimates the **scale-up potential for the adaptation of ICS to 3 million units** [60].

Besides the promotion of ICS already adopted within the country, the strategy should focus on **introducing entirely new highly efficient stoves**. As mentioned in the BEST study, very high efficient and modern looking wood and charcoal stoves have recently become available and are being tested. These stoves can also burn agricultural residues without smoke and could be a good modern solution for some categories of rural households [1].

However, highly efficient stoves are expensive. To reduce the cost of the stoves and create economic incentives to replace old, inefficient cook stove models, the **promotion and distribution of ICS should be linked with funding for climate-related projects** (cf. section E.6.4).

This would require **standardization and labelling of stoves to certify their safety and efficiency**. The certification should cover wood and charcoal stoves, but also kerosene and LPG stoves. The Rwanda Bureau of Standards (RBS) could be involved in testing programs, setting technical standards and elaborating evaluation procedures. In the medium run, all cooking devices should be covered by certification in the form of an independent appliance labelling system to visualize energy efficient equipment.

Some technical support will be needed to **certify or qualify the stoves**. **Stove manufacturers should be assisted** to produce more energy efficient models for which a large market can be expected in the near future as a result of promotional activities [1]. Manufacturers should be involved from the planning stage so they can provide their inputs in the program. Capacity development has to be gradual so that manufacturers have time to adapt to changing markets. The **implementation of a micro-credit policy** needs to be treated as a priority to facilitate market development and help manufacturers to get started.

An awareness and publicity campaign is needed to inform end-users about the standards, the label and the benefits of switching to more efficient equipment. The information campaign should also include the environmental, ecological and health impact of ICS use. However, the focus of the publicity campaign is on the label, which shows that this particular type of equipment indeed meets the minimum standards and thus can be expected to be energy efficient and save the user money.

Specialized trading sites for efficient stoves should be promoted. To this end, ICS could be sold together with “green” charcoal at RWEM or UWEM (cf. section E.4.3). One additional option to boost the “green” energy market is that the Government takes tax exoneration measures specifically for “green” energy merchandizing.

E.6 ACTIVITIES RELATED TO FRAMEWORK CONDITIONS

E.6.1 SUMMARY OF ACTIVITIES RELATED TO FRAMEWORK CONDITIONS

Table 16 gives an overview of proposed activities related to framework conditions.

Activity
<ul style="list-style-type: none"> • Introduction of adequate forest taxation procedures and law enforcement • Implementation of a traceability system • Promotion of innovative financing mechanisms • Improvement of governance capacity to reorganize the charcoal production sector • Setting up a monitoring and evaluation system • Lobbying and PR measures

TABLE 16:
SUMMARY OF ACTIVITIES
RELATED TO FRAMEWORK
CONDITIONS

E.6.2 FORESTRY TAXATION

A modern, competitive and efficient charcoal 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 to farmers, trees are just like any other agricultural

crop: If profitability decreases, the trees will be replaced quickly as seen in Rwanda's past. Rwanda will then face another period of deforestation. Intrinsic values such as biodiversity, carbon sequestration, recreation, aesthetics, clean air etc., will not feed families in rural areas [61].

Excessive bureaucracy and overstretched administrative requirements (e.g., delays in granting permits, ban on selling Eucalyptus poles for scaffolding) **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 could be a step forward. However, to guarantee efficient tax collection, the system has to be backed up by law enforcement. Rwanda has high reforestation rates on private land and restricted illegal exploitation in public forests in combination with high wood-energy prices and a high tax recovery rate. Therefore, a classical differential taxation approach ([48, 49, 50]), as was introduced in Chad (cf. Box 5), seems not to be adapted to the situation in Rwanda.

In return for a simplified taxation and permit system, plantation owners and charcoal producers would be bound to enter into a formal agreement with the forest service to manage the woodland sustainably and, as an example, to use improved kiln technologies.

BOX 5: DIFFERENTIAL TAXATION IN CHAD

The World Bank Household Energy Project (Chad) pursued a community-based wood-fuel production scheme through: (i) strengthening community tenure and use rights and (ii) establishing differential taxation. Political and legal regulatory frameworks were created during a preparatory phase (1998-2000). The operations phase (2000-2003) focused on practical implementation. Differential taxation served to: (a) return 90% of tax revenues to communities and local management structures (LMS) and (b) discourage unregulated exploitation of open-access areas by means of a surcharge. Illegal logging and tax evasion carried a four-fold surcharge plus additional fines. Strict controls and law enforcement (at city-limit checkpoints) ensured the system would operate. This arrangement created a strong incentive for sustainable forest management, as illustrated by the participation of more than 100 villages (with a total area of 450,000 ha) within just four years. The retail price of fuelwood increased by 20% after two years. Fuelwood gained its "true" price and communities were convinced to further invest in forest management. Anyhow, the project's success alarmed certain interest groups, whose influence subsequently eroded the policy commitments and national ownership. The Government reversed its policy, enacted a blanket charcoal ban and used force to nullify community tenure rights. Thus, the basis for operating differential taxation was lost, causing the newly introduced system to collapse. However, the model serves as an example of what can be accomplished with appropriate policies.

Source: [48]

By taxing the transport of charcoal and fuelwood only, the system is comparatively easy to control and promotes efficient administration. This contrasts with more extensive and highly decentralized systems based on the

granting of wood-fuel cutting permits. **Such a transport tax would replace all existing individual wood-related taxes and permits**, including the cutting permit. Transporters pay the tax and every charcoal bag has to be accompanied by a certificate of tax payment. Only accredited transporters (with a registration number) are authorized to pick up charcoal from RWEMs and UWEMs. The payment of the transport tax takes place directly at the rural or urban wood-energy markets (cf. section E.4.3). Any charcoal transported without a certificate of tax payment is subject to a higher level of tax, which has to be paid at the control post.

According to a formula, tax revenues are distributed between the different actors such as the manager of the RWEM/UWEM, sector and district administrations and the National Forest Fund. With reference to the BEST study, there is a proposal to set the new unique transport tax at 10% of the primary market price [1]. In applying an average charcoal price of 106 RwF/kg (3,500 RwF/standard sac) and in assuming a total annual national charcoal consumption of 120,000 t per year, **the total annual transport tax would amount to 2.5 million USD.**

Policy formulation and design of regulatory instruments remain ineffective unless backed up by strong institutions capable of law enforcement. Approaches such as the wood-energy market scheme depend upon transparent fulfilment of management contracts, protection of tenure rights and road checks of charcoal transports on the main entry roads to urban areas (cf. Box 6). Enforcement capacity equally 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. Similarly, worthwhile market incentives, some form of enforcement and a high level of integrity are needed among the actors involved.

In Mozambique, one of the most important elements of the current forest control system is based on roadside checkpoints between logging sites and major ports and cities, where government controllers check timber volumes by category and track licensing compliance (registered volumes are also used for tax collection purposes). The work of these fixed checkpoints is also complemented, when possible, by mobile patrols.

A new law forbids the circulation of large trucks at night. Major checkpoints coincide with police posts and therefore operate 24 hours. Those transporting forest products during the night are halted by the police, immediately fined and undergo further controls/investigation. In remote areas, however, road checkpoints are only manned during the day because of lack of equipment and human resources. There are plans to have all checkpoints working 24 hours a day and to delegate forest law enforcement authority to an official agent (customs officer, police officer, etc.) in the absence of forest law enforcers on the checkpoint.

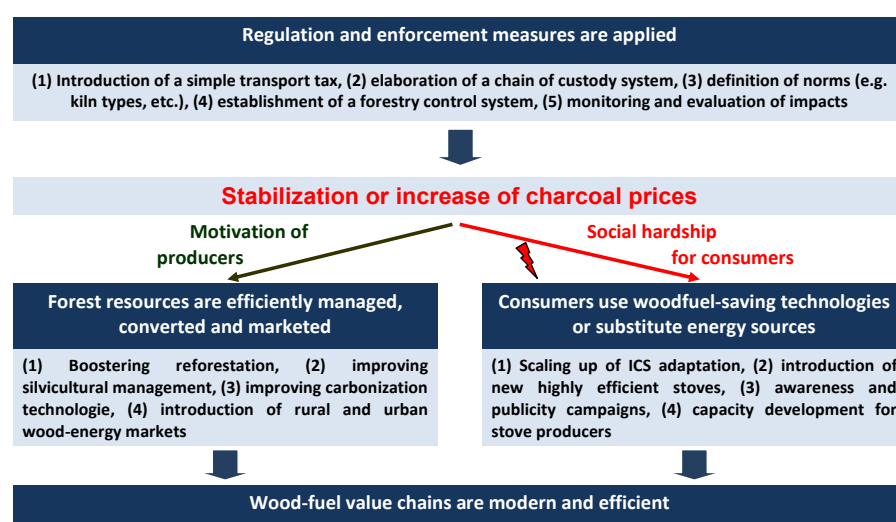
This system works reasonably well (as proven by the considerable amount of fines that are charged every year). However, one weakness appears to be the lack of qualified personnel.

BOX 6:
ROAD CHECKPOINTS: THE
EXAMPLE OF MOZAMBIQUE

Source: [71]

Regulation and law enforcement are major forces that influence and interact with all other components of a modern wood-fuel supply strategy (cf. Figure 22). Improving forestry taxation and law enforcement should lead to a series of reactions: (1) increased revenue collection and (2) stabilization or even a price increase for charcoal. In return, the price increase should provide incentives for counter-action: (1) investments in forest and plantation management, (2) adoption of improved kilns, (3) proliferation of improved stoves and (4) increased competitiveness of substitute fuels.

FIGURE 22:
IMPACT OF REGULATION
AND LAW ENFORCEMENT
MEASURES



Source: [62, modified]

Finally, regulation and law enforcement would yield the following benefits:

- More responsible and efficient resource use
- Revenue generation that creates leeway for strategic investment
- Market incentives for tree planting and forest management by a wide range of stakeholders
- Highlighting the status of tree resources as a renewable resource
- Rural employment
- Foreign exchange savings.

In any case, continuous **monitoring is a key factor of success**. To make the system work, the impact of market demand for wood-based fuels on forest resources must be observed and timely responses devised, to ensure sustainability under changing framework conditions (cf. section E.6.6).

E.6.3 IMPLEMENTATION OF A TRACEABILITY SYSTEM

On-going concerns about the environmental and socio-economic effects of increased charcoal use create – not only in Rwanda — obstacles to clear commitment from decision-makers. To overcome such concerns, **third-party certification** has become an increasingly accepted tool for proving that forest products such as lumber, paper and panel board originate from sustainably managed forests. Over the past decades, various forest standard initiatives have emerged globally, aimed at improving forest and land management, reducing deforestation and preventing forest and land degradation. Some of these voluntary initiatives address issues in the forestry sector directly while others have been developed around different agricultural commodities [65].

Forest certification has the purpose of providing an independent, third-party audit of forest management systems – often more broadly termed “Environmental Management System” (EMS) – with respect to stated management objectives, including environmental soundness and sustainability. The evaluation is provided through private organizations such as the American Forest and Paper Association (AF&PA), ISO or FSC. **Adherence to such schemes has been voluntary rather than government-enforced**, and is increasingly seen as a marketing strategy and eco-labelling process. In addition, these schemes lead to enhanced public acceptance of “green” forest products that are independently certified as coming from environmentally-sustainable management of forest lands [67].

Existing forest certification schemes vary in their details. The Forest Stewardship Council (FSC) led the introduction of forest certification. The FSC is performance-based and was formed in 1993. FSC does not certify forests themselves but accredits other organizations (so-called certification bodies) to do so. FSC certification covers over 100 million hectares of forestland in over 82 countries.

FSC certification standards are based on ten primary principles (cf. Box 7) with strong chain-of-custody procedures. FSC forest management certification involves the on-the-ground assessment of landowners’ forestry practices and indicates that the forest is “well-managed”. Principle 10 deals with criteria and indicators for plantation forestry (cf. Box 8). The chain-of-custody (CoC) certification assures the consumer that certified products are produced from wood originated in a certified forest. In this case, each step that the wood product goes through, from harvest to processing, is monitored. FSC concentrates on wood products. Charcoal is a derived product, eligible to carry the FSC logo if derived from wood from an FSC certified forest.

BOX 7:
FSC PRINCIPLES

Principle 1: Compliance with laws and FSC Principles

Forest management shall respect all applicable laws of the country in which they occur, and international treaties and agreements to which the country is a signatory, and comply with all FSC principles and criteria.

Principle 2: Tenure and use rights and responsibilities

Long-term tenure and use rights to the land and forest resources shall be clearly defined, documented and legally established.

Principle 3: Indigenous peoples' rights

The legal and customary rights of indigenous peoples to own, use and manage their lands, territories and resources shall be recognized and respected.

Principle 4: Community relations and worker's rights

Forest management operations shall maintain or enhance the long-term social and economic well-being of forest workers and local communities.

Principle 5: Benefits from the forest

Forest management operations shall encourage the efficient use of the forest's multiple products and services to ensure economic viability and a wide range of environmental and social benefits.

Principle 6: Environmental impact

Forest management shall conserve biological diversity and its associated values, water resources, soils, and unique and fragile ecosystems and landscapes. By so doing, it will maintain the ecological functions and integrity of the forest.

Principle 7: Management plan

A management plan – appropriate to the scale and intensity of the operations – shall be written, implemented and kept up-to-date. The long-term objectives of management, and the means of achieving them, shall be clearly stated.

Principle 8: Monitoring and assessment

Monitoring shall be conducted – appropriate to the scale and intensity of forest management – to assess the condition of the forest, yields of forest products, chain of custody, management activities and their social and environmental impacts.

Principle 9: Maintenance of high conservation value forests

Management activities in high conservation value forests shall maintain or enhance the attributes that define such forests. Decisions regarding high conservation value forests shall always be considered in the context of a precautionary approach.

Principle 10: Plantations

Plantations shall be planned and managed in accordance with principles and criteria 1-9, as well as Principle 10 and its criteria. While plantations can provide an array of social and economic benefits and can contribute to satisfying the world's needs for forest products, they should complement the management of, reduce pressures on, and promote the restoration and conservation of natural forests.

Source: [63]

In 1999, the Programme for the **Endorsement of Forest Certification (PEFC)** was established as an independent non-governmental third-party umbrella organization that recognizes local forest certification schemes. Originally, it was developed by the European forest industry as an alternative to FSC. While programs are developed locally, they must meet internationally-recognized sustainable forestry management requirements. Initially it had a European focus, but now it is global and covers 200 million hectares of forestland. A fundamental difference between FSC and PEFC are the stakeholders. While mainly environmental groups founded FSC, PEFC had strong forest industry and trade groups among its founders. This is one of the reasons why FSC is not a member of PEFC [73].

Where applied in certification schemes, **CoC tracking follows forest products through each stage of manufacturing and distribution to the final consumer.** A CoC system is the chronological physical or electronic documentation – and/or paper trail – showing the acceptance/purchase, custody, control, transfer and disposition of a product or associated sustainable attributes [66]. **The following three CoC systems are the most common:**

- **Physical segregation:** Certified products are physically segregated from non-certified products at every facility along the supply chain.
- **Mass balance:** The amount of certified product sourced and sold by each supply chain actor is tracked. However, the certified product and associated documentation do not need to be sold together. The certified product can either be segregated (site or tank level mass balance) or not (company level mass balance).
- **Book-and-claim:** The certified product is completely decoupled from sustainability certificates, and both certified and noncertified products flow freely through the supply chain. An independent issuing body would issue sustainability certificates.

However, the EMS certification schemes do not necessarily include CoC provisions. Such systems are more appropriately applied to forest products sold by wholesale or retail outlets where merchants believe “green” product labelling has important market benefits [67].

Forest certification, which has evolved since 1989, can contribute to transparency and accountability. Indirectly, accountability may serve as an incentive to improve performance, and it may result in customers making a preference in favour of the certified operation. **For different forest stakeholders, the possibility of these potential impacts has led to varied hopes for certification** [64].

The main (and original) expectation of most NGOs involved is to:

- Improve forest management and enhance multiple values from forests
- Improve mechanisms for producer accountability
- Challenge policy and legal frameworks to improve government roles
- Reduce government’s forest monitoring burdens by bringing in independent certifiers.

Some expectations are more directly in the interests of producers and the trade such as:

- Maintaining or improving market access and share
- Obtaining a price premium for certified products
- Obtaining or defending the producer's access to forests, resources and capital
- Reducing the producer's environmental and social risk
- Improving the awareness, skills or morale of staff and shareholders.

The costs of certification must be distinguished from the costs of improving management to a level where a certificate may be awarded. In this context, production costs can sometimes increase by up to 25% [73]. However, there is a broad range of cost estimates on a per hectare basis, ranging from 1 to 5% of total annual management costs [64]. Contemporarily, most certified forests have been industrial and investment ownerships. In general, owners and managers of larger woodlands (> 100 ha) use certification schemes as they are more able to bear the cost of certification than owners of small woodlots.

BOX 8:
CRITERIA FOR PRINCIPLE 10:
PLANTATIONS

- The management objectives of the plantation, including natural forest conservation and restoration objectives, shall be explicitly stated in the management plan, and clearly demonstrated in the implementation of the plan.
- The design and layout of plantations should promote the protection, restoration and conservation of natural forests, and not increase pressures on natural forests. Wildlife corridors, streamside zones and a mosaic of stands of different ages and rotation periods shall be used in the layout of the plantation, consistent with the scale of the operation. The scale and layout of plantation blocks shall be consistent with the patterns of forest stands found within the natural landscape.
- Diversity in the composition of plantations is preferred, so as to enhance economic, ecological and social stability. Such diversity may include the size and spatial distribution of management units within the landscape, number and genetic composition of species, age classes and structures.
- The selection of species for planting shall be based on their overall suitability for the site and their appropriateness to management objectives. To enhance the conservation of biological diversity, native species are preferred over exotic species in the establishment of plantations and in the restoration of degraded ecosystems. Exotic species, which shall be used only when their performance is greater than that of native species, shall be carefully monitored to detect unusual mortality, disease, or insect outbreaks and adverse ecological impacts.
- A proportion of the overall forest management area, appropriate to the scale of the plantation and to be determined in regional standards, shall be managed so as to restore the site to a natural forest cover.



- Measures shall be taken to maintain or improve soil structure, fertility, and biological activity. The techniques and rate of harvesting, road and trail construction and maintenance, and the choice of species shall not result in long term soil degradation or adverse impacts on water quality, quantity or substantial deviation from stream course drainage patterns.
- Measures shall be taken to prevent and minimize outbreaks of pests, diseases, fire and invasive plant introductions. Integrated pest management shall form an essential part of the management plan, with primary reliance on prevention and biological control methods rather than chemical pesticides and fertilizers. Plantation management should make every effort to move away from chemical pesticides and fertilizers, including their use in nurseries.
- Appropriate to the scale and diversity of the operation, monitoring of plantations shall include regular assessment of potential on-site and off-site ecological and social impacts (e.g. natural re-generation, effects on water resources and soil fertility, and impacts on local welfare and social well-being), in addition to those elements addressed in Principles 8, 6 and 4. No species should be planted on a large scale until local trials and/or experience have shown that they are ecologically well-adapted to the site, are not invasive, and do not have significant negative ecological impacts on other ecosystems. Special attention will be paid to social issues of land acquisition for plantations, especially the protection of local rights of ownership, use or access.
- Plantations established in areas converted from natural forests after November 1994 normally shall not qualify for certification. Certification may be allowed in circumstances where sufficient evidence is submitted to the certification body that the managers and owner are not responsible directly or indirectly for such conversion.

Source: [63]

The reliable achievement of most of the purposes of certification is unproven, at least on a significant scale. A recently published study, evaluating the impacts of certification schemes, concluded that the overall situation of tropical forests has not improved significantly [65]. Although forest certification has achieved major progress by enabling certified forest products to penetrate some environmentally sensitive market niches and by maintaining and enhancing the public image of forestry companies, the **price premium has proved difficult to realize**. When considering the actual purchasing behaviour of consumers in developed countries, there is little evidence that the expressed willingness to pay a price premium will materialize in the market place. Considerable uncertainty exists as to why this might be the case, and the presence of a too high premium **could drive consumers towards cheaper products derived from unsustainable or illegal forestry activities** [68].

As outlined above, **certification primarily addresses actors who are able to link into global markets** that recognize, appreciate and sometimes reward social and environmental compliance. Nevertheless, it is obvious that market based initiatives suffer from a lack of opportunities for local and small actors [65]. Actually, certification favours those who are exporting large quantities, operating large forest operations and who can pay the cost. A number of certifiers have developed ways to assist small groups (e.g. by forming self-policing associations), which are certified as a single management unit. In return, **many smallholder forest management systems in Rwanda are akin to agro-forestry, which presents problems with certification standards** [64]. Also, compliance with several criteria, especially those fixed for forest plantations (cf. Box 8), will be difficult.

Having said this, it seems that neither forest management certification alone, nor in combination with a CoC, seems to be a realistic option for Rwanda.

Small-scale woodlot owners or charcoal producers sell wood-energy to one of many collectors or transporters and/or at local markets. Wood-energy from many sources may be mixed at multiple stages and traceability is limited in some locations. **Given the small-scale wood production setting and a highly aggregated supply chain, it appears difficult to introduce certification schemes without exorbitant administrative cost.** Again, it should be noted that the Rwandan “green” revolution is mainly driven by small-scale landowners. Most probably, with certification directly or indirectly increasing management cost, it will be an adverse incentive for Rwandan farmers. In addition, **a potential price premium for certified charcoal or fuelwood may be paid by a minority of upper class representatives in Kigali.** The broad mass of consumers will revert to the cheapest available products, even if they were derived from unsustainable or even illegal forestry activities.

Instead, it is proposed to develop and implement a simple traceability system, allowing for the tracking of charcoal from the forest through each stage of distribution to the final consumer. The focus should be on tracking and not on judgment of the compliance with environmental or social standards. An option may be the introduction of a barcode system, replacing the generally used “paper permits”.

The barcode is the ultimate symbol of commercialism in the modern world. **Tracking of forest products is a process similar to checking out at a supermarket.** Using a barcoding system to track forestry products involves printing and attaching labels to the items, scanning the labels, entering the updated information into a computer, and using software to track and run reports on the inventory. At the

heart of each barcoding system is the unique identification (ID) number assigned to every item being tracked (cf. Box 9). An ID number (in the form of a barcode label) is attached to each item in the inventory. When a labelled item is moved, shipped, used, disposed of or modified in any way, the item's barcode is scanned and the information goes into the information tracking system [69].

BOX 9: BARCODES

The series of vertical black lines and spaces known as a barcode is a simple, compact, graphical way to record data. A serial number, ID code, or other data can be turned into a barcode using a set standard, called symbology. More than 250 barcode symbologies are in use today. The uniform product code (UPC) symbology used in the retail industry is one type of symbology.

Barcode symbology code 128 is recommended for Forest Service use. Code 128 is the standard in the shipping industry and is widely used in other areas. The advantages of code 128 include the ability to encode all 128 ASCII characters (e.g. lowercase and capital letters, numbers, punctuation marks, and other symbols), the ability to create high-, medium-, and low-density barcodes, compatibility with numerous hardware and software packages, and widespread product and software support.



Barcodes can be printed in different densities. Density describes how closely the vertical lines are spaced. High-density label lines are closely spaced. Low-density lines are spread farther apart. Some types of scanners cannot read high-density barcodes. Low-density barcodes are less affected by printing imperfections and can be read more reliably, especially if the barcode label is damaged. Nevertheless, low-density barcodes require larger labels than medium- or high-density barcodes with the same amount of information.

Source: [69]

Barcodes have been incorporated into supply chain management for decades because they first identify products and then trace their movement and sale right until they have to be transported to customers. Recently, they have been applied for CoC tracking, e.g. in Guyana or in Malaysia (cf. Box 10). Barcode systems include mobile devices that can be used at every point due to their ease of use and time saving advantages. Once a product enters the materials inventory, barcodes help in identifying the product, its location and tracking its movement. In short, barcodes assist effective traceability of charcoal in the following ways:

- Time saving, by reducing data entry and processing times
- Cost efficiency
- Improved data quality
- Reduced paper work
- Access to accurate information

- Timely action
- Improved efficiency levels in all aspects.

BOX 10: GUYANA'S LOG TRACKING SYSTEM

In 2001, the national log tracking system was implemented using manual means of verification. Under this system, cut logs and stumps are identified using a plastic barcode tag that is attached immediately after logging or when logs are converted into pieces at timber collection points. The manual implementation of this system, however, did not allow for the full benefits of traceability and verification of origin. An ITTO project aimed at helping to prevent illegal logging and trade in illegally harvested timber by expanding the timber tracking system to the harvesting of tropical forests, shipment and exporting stages.

Timber tracking was based on a barcode system utilizing wide-area computer networks. By connecting to a central database, this system enables distribution systems to be managed from the origin of the timber that was harvested through to the point where it is distributed, processed and exported. This system collects several key pieces of information including: concession identification (name and number), type of produce being removed, timber species, tag number, date of expiry and block number identifying the specific approved location in the case of large concessions. The information collected by the Guyana Forestry Commission's (GFC) field offices is linked via a wide-area network to a central database at GFC's head office. Both the WAN and the central database have been developed as a part of the ITTO project.

The improved national log tracking system allows for an overall enhancement of detection and prevention of illegal logging and wood product trading by using an existing national system and filling gaps in its operation. Additionally, the necessary database infrastructure, networking and communication linkages were also created to allow for a comprehensive effort in detection and prevention in a timely, coordinated and effective manner.

Source: [70]

Practically, this will require some adaptations of the actual regulatory framework. Figure 23 gives an idea of the potential elements of a future Rwandan traceability system for charcoal.

FIGURE 23:
ELEMENTS OF A CHARCOAL
TRACKING SYSTEM

LEVEL 1 - Source of wood-energy

- Simple management plan to regulate permissible harvests only for forests/ plantations > 10 ha, approved by District, with NAFA oversight
- For private plantations < 10 ha, no permits required; plantation owners have to comply with standardized silvicultural management regulations
- Replaces existing permit system, no fees charged
- Charcoal producers have to be registered
- Charcoal producers have to use improved kilns
- Control of charcoal production quantities at the production site and direct barcoding at the site

LEVEL 2 - Primary market

- Only approved actors may participate in the system
- Tax and accounting obligations at the rural wood-energy market (RWEM)
- Barcoding of all bags handled at the RWEM

LEVEL 3 - Transportation system

- Only accredited transporters (with a registration number) are authorized to pick up charcoal from RWEM and UWEM
- One unique transport tax is paid by transporters at the rural wood-energy market (RWEM), proof of payment stored in the barcode
- Required to obtain tracking number/barcode from RWEM location
- Transporter must verify accuracy of form contents and sign prior to transport
- Transporter must produce bar-code upon request to any authorized enforcement/inspection agent
- Transport of charcoal during the night is prohibited
- Fixed and ambulant control posts equipped with mobile scanners, allowing the checking of barcodes

LEVEL 4 - Secondary market

- Only approved actors may participate in the system
- Required to obtain tracking number/barcode from transporter
- Must verify accuracy of form contents and sign prior to accepting delivery
- Must maintain permanent record of all transactions and produce upon request

LEVEL 5 - End user

- May purchase at any authorized location
- Liability for purchase, transportation, possession of unauthorized product
- Liability for purchase at unauthorized location

Source: [72, modified]

E.6.4 PROMOTION OF INNOVATIVE FINANCING MECHANISMS

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

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

Various global and regional initiatives to combat climate change and promote carbon-neutral energy consumption offer 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 for promoting carbon-sequestration and safeguarding sustainable supplies of forest products (CDM-Afforestation/Reforestation). This happens by giving an economic value to emission reductions measured in units of metric carbon.

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 [49]. 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 implemented during the last two years [78]. CDM-A/R, being exclusively focused on plantation establishment (through artificial planting or through natural regeneration) on hitherto unforested lands, also excludes existing forests (e.g. natural or secondary) from its purview [49].

CDM comprises different sectors linked to wood-fuels: energy production, energy efficiency and A/R. In principle, emission reductions from the use of biomass can be claimed if the biomass is (1) renewable and (2) replacing fossil fuels. According to the register of CDM projects (2011), 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) direct combustion of woody biomass, (4) switch from fossil fuels to biomass, (5) ethanol production and (6) increases in efficiency to reduce the consumption of non-renewable biomass. The great majority of these projects are in Asia or Latin America [74].

Especially 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 [74]. Decision makers have recognized this problem and adopted simplified procedures for qualifying small-scale projects (cf. Box 11). These procedures reduce the burden on the project developer and facilitate faster implementation of the project.

BOX 11: 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 ktonnes CO₂ annually
- Small-scale afforestation and reforestation projects removing up to 16 ktonnes of CO₂ per year

Source: [77]

Even with 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. This is because fixed costs form

a significant part of transaction costs. Further evidence from CDM projects shows that transaction costs can account for a significant share of their total cost. Smaller projects are at a disadvantage because fixed costs become a major factor [75]. Costs can be reduced by bundling similar small projects into a single project that is still eligible for the simplified procedures [74].

After the 2010 Conference of the Parties held in Cancun (UNFCCC COP 16), a new instrument is emerging for the post-Kyoto period (after 2012), which explicitly promotes policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries.

REDD+ provides a framework for compensating carbon-sequestration services of existing forests. The mechanism also encourages developing countries to contribute to mitigation actions in the forest sector by: (1) reducing emissions from deforestation, (2) reducing emissions from forest degradation, (3) conservation of forest carbon stocks, (4) sustainable management of forests and (5) enhancement of forest carbon stocks [88]. 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 existing forests [49].

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 those stipulated under CDM, **VCM is widely regarded as a more flexible instrument, one that is also more accessible to decentralized as well as small-scale implementation** [49].

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, voluntary markets have shown a preference for forestry credits in many instances. The VCM enables the development of innovative forestry projects that are exemplary in terms of environmental and social development co-benefits. 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 VCM to provide a global standard for voluntary offset projects [89]. VCS is the dominant standard for forest carbon accounting, especially for projects in developing countries. The Climate Group, the International Emissions Trading Association and the World Business Council for Sustainable Development founded the Standard. VCS offsets must be real, additional, measurable, permanent, independently verified and unique. All 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) under which all wood-based energy projects fall [74].

Standards development is quickly evolving, and there are a number beyond the VCS: (1) American Carbon Registry (ACR) Forest Project Standard, (2) Carbon Fix Standard, (3) Climate Action Reserve (CAR), (4) Plan Vivo Standards, among several others. However, the geographical applicability and eligible project types are limited for some standards. For example, CAR credits are favourably positioned in the US market but CAR forestry protocols currently only cover projects within the United States [89].

Some projects have the merit of proposing 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 the Biocarbon Fund, Forest Carbon Partnership Facility (FCPF) of the World Bank, the UNEP program CASCADE (UNEP, FFEM), and UN-REDD. A possible expansion of carbon markets to include new market mechanisms would drastically change the carbon forest market landscape, stimulating investment and professionalizing this still nascent market [79].

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

- **Wood production:** Sustainable wood-fuel production, improved silvicultural treatments or AF/RF activities, will increase the carbon sinks. Efficient biomass harvesting helps reduce wood residues and wastes.
- **Improved carbonization technologies:** The levels of CO₂ emissions from traditional charcoal production in several African countries range from 450 to 550 g per kg of charcoal produced, while the emission of CH₄ about 700 g, CO₂ 450 to 650 g and NMHC 10 to 700 g per kg of charcoal produced [76]. In summary, total emissions range between 1.6 to 2.7 kg CO₂ equivalents per kg of charcoal produced. These figures are even low when compared to estimates given by other authors, ranging from 7.2 to 9.0 kg CO₂ equivalents per kg of charcoal produced [82, 83].
- 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 to the application of GHG reducing technologies. A coupled effect of enhanced transforming efficiency and better GHG management reduces GHGs significantly. For example, current industrial kilns have only less than 10% of methane emissions as compared to traditional kilns (cf. section E.3.4). In addition, the carbon sink potential of forests is preserved by avoiding tree cutting and less 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 [80]. Emissions from transport are estimated at 1.1 kg CO₂ equivalents per kilometre. It is estimated that 10 to 15% of transport emissions could be saved through optimized loading capacity, for instance via bulk transport of charcoal or the utilization of suitable plastic boxes.
- **Increased combustion technologies:** Improved charcoal cook stoves are also vital for reducing GHG emissions. They improve fuel efficiency and reduce GHG emissions by 20 to 30% through an enhanced combustion process.

According to the proposed interventions, Table 17 gives an idea of potential GHG emission reductions in Rwanda at different links in the charcoal value chain. **The total annual emission reduction potential comes to 4.4 million tonnes. At the voluntary market, this is equivalent to a value of 22.3 million USD.**

TABLE 17:
SUMMARY OF POTENTIAL
GHG EMISSION REDUCTIONS
AT DIFFERENT LINKS IN THE
CHARCOAL VALUE CHAIN

Activity		GHG emission reductions (t C-CO ₂ /yr)
1	Rehabilitation and better management of public forest plantations	1,470,314
2	Increasing productivity of existing private forest and agro-forestry resources	791,689
3	Increasing private forest and agro-forestry resources	1,621,569
4	Improvement of carbonization technologies	331,776
5	Test and introduction of semi-industrial kilns	80,006
6	Introduction of new technologies allowing the utilization of charcoal dust	86,400
7	Improvement of transport efficiency	420
8	Increasing combustion technology	87,071
TOTAL		4,469,245

Explanations:

1. Based on an increment in forest productivity from MAI 5.5 to 11.0 m³/ha/yr; rotation period of 7 years, total area = 74,644 ha; average CO₂ stock (aboveground biomass) = 30.7 t/ha (MAI=5.5) and 50.4 t/ha (MAI=11.0)
2. Based on an increment in forest productivity from MAI 5.5 to 11.0 m³/ha/yr; rotation period of 7 years, total area = 40,192 ha; average CO₂ stock (aboveground biomass) = 30.7 t/ha (MAI=5.5) and 50.4 t/ha (MAI=11.0)
3. Based on an estimation that 50% of the potential land is reforested (37,500 ha); MAI = 11.0 m³/ha/yr; rotation period of 7 years; average CO₂ stock (aboveground biomass) = 50.4 t/ha
4. Assumption that 80% of actual charcoal consumption is produced with improved kilns (96,000 t); GHG emissions = 7.2 t CO₂ equivalents /t charcoal produced; efficiency of traditional kiln = 13%, efficiency of improved kiln = 25%
5. Assumption that 10% of actual charcoal consumption is produced with semi-industrial kilns (12,000 t); GHG emissions of traditional kiln = 7.2 t CO₂ equivalents /t charcoal produced; GHG emissions of semi-industrial kiln = 1.44 t CO₂ equivalents /t charcoal produced efficiency of traditional kiln = 13%, efficiency of improved kiln = 35%
6. Based on a production of 12,000 t of charcoal briquettes
7. Based on an average transport distance of 154 km (= 2*77 km); a truck load of 240 standard charcoal bags of 33 kg (= 7.9 t/truck); GHG emissions of 1.2 kg CO₂ equivalents per km
8. Assumption that 75% of charcoal users are using improved stoves; GHG emissions of traditional charcoal stoves = 3.87 t CO₂ equivalents /t charcoal consumed; economy of improved stoves = 25%

E.6.5 IMPROVEMENT OF GOVERNANCE CAPACITY TO REORGANIZE THE CHARCOAL PRODUCTION SECTOR

Following up on the foregoing observation that targeted modernization of the wood-fuel supply chain and establishment of vibrant wood-fuel markets are foremost governance challenges, the issue of governance capacity comes into focus. Governance, in this context, must be understood in the broadest possible sense, i.e. definition of frameworks for planning and monitoring, education and training, cross-sectoral coordination and inter-agency collaboration, law enforcement, provision of targeted public support, and encouragement of civil society participation and private entrepreneurship. These aspects reflect an integrated and comprehensive approach, one that would probably overtax the capabilities of a single sector-administration.

One obvious example would be the more prominent inclusion of forest sector administrations and stakeholders in energy-policy making and strategic programming. On the other hand, however, forest sector administrations in many countries are either weak or forced to prioritize other forest management goals.

A possible solution to currently weak and dispersed governance capacities and mandates may lie in the creation of institutions (e.g. parastatal bodies or an Inter-Ministerial Working Group) specifically tasked with cross-cutting wood-fuel planning, strategy development, resource monitoring and evaluation on all levels, and operational support (cf. Box 12). The latter function would further include a wide range of public relations/awareness building, training and extension, and lobbying for policy support and high-level attention to the goal of sustainable wood-fuel production.

**BOX 12:
EXAMPLE OF A PARASTATAL
BODY COMBINING THE
RESPONSIBILITIES FOR
MANAGING THE DOMESTIC
ENERGY SUB-SECTOR**

After having experienced substantial efficiency losses in managing the domestic energy sector by various stakeholders, the Government of Mali decided in 2003 to create a rural energy services agency (AMADER) with the mandate to promote household energy nation-wide. The main responsibilities are to: (1) expand rural markets for wood-based fuels; (2) improve the regulatory and fiscal framework as well as enforcement; (3) encourage the manufacture, promotion, and use of low cost equipment for wood-based fuels; (4) encourage fuel substitution where appropriate; and, (5) consolidate planning, monitoring, and evaluation tools in the sector.

Source: [45]

While improved governance is indispensable in promoting sustainable wood-fuel supplies, multi-stakeholder participation and involvement of the private sector are crucial preconditions. Institutions would thus face the task of catering to various stakeholder needs, e.g. coordinating their respective contributions and activities, administering public support schemes, and providing information and knowledge management (IKM) services. Capacity building efforts must ensure that public institutions are properly prepared to assume their specific relay function and increasingly act as service providers.

The foregoing observations underscore that enhanced governance support needs to emphasize participation, partnership, cross-cutting interaction/coordination over centralized planning, command and control approaches, and single-sector administration.

Policy-making should be improved through: raising the effectiveness of public participation, inter-ministerial co-ordination and multidisciplinary collaboration, participation of affected stakeholders including the poor, marginalized groups and the private sector, whose investment would bring in scarce financial resources. There is also the need for transparency, accountability and easy access to information to build confidence in the whole process.

E.6.6 IMPROVEMENT OF MONITORING AND EVALUATION SYSTEM

Shaping energy policies presupposes reliable baseline information as a precondition for rational decisions. Past assumptions and predictions by

national and international organizations regarding wood-fuels have in many instances been disproven (Box 13). In the early 1980s, simple scenarios for many Sahel countries forecast near-complete deforestation within 20 years. Population growth and the shift from firewood to charcoal were highlighted as the main driving factors. In reality, natural woody vegetation in the Sahel proved much more resilient than expected. Wood-fuel exploitation alone clearly does not provide a summary explanation for deforestation on a national scale. It may, however, create problems locally, even though these cannot always be reduced to a simple demand and supply gap. Wood-fuel problems are increasingly regarded as being rooted in more systemic – however site-specific – deficits in land tenure, fiscal and incentive policies, urban energy markets, and misallocation of forests and crop-land [48].

The country analyses undertaken by The World Bank reveal that national forest inventories are either out-dated or lacking, and the commitment to value forest resources for their economic, environmental and social significance is still in its infancy.

It is also noteworthy that many studies describing results and impacts apply different assumptions, conversion figures etc., thus making it difficult to appreciate the statements. For example, the figures on the wood-to-charcoal conversion efficiency of improved kilns vary significantly according to different reports: 25% (World Bank 2005) vs. 36% (PROGEDE, 2009, Global Environment Facility 2004), a gap of more than 40 per cent.

Source: [48, modified]

**BOX 13:
LACK OF SOUND
DATA FOSTERS FALSE
PREDICTIONS**

The foregoing problems arise all along the charcoal value chain. Therefore, precise data on each link of the value chain provide an excellent entry-point for shaping sound policy frameworks (cf. Figure 24). They offer an opportunity to the various stakeholders to add knowledge, innovation capital and technology at each step or link in the value chain. On this basis, checks and balances may be introduced to assure a more balanced development within and between the sectors, with a view to achieving the intended overarching goals.

Furthermore, evidence-based analyses of the charcoal value chain provide the opportunity to demonstrate the regional added value of charcoal production and thus help **to sensitize policy-makers** for a source of energy hitherto neglected and left to the informal sector.

This does not mean that data-collection and subsequent analyses have to commence from scratch. A considerable part of the information required already exists at different locations within the institutional structures of the relevant agencies and institutions. Database formats may vary, though, and government statistics may be out-dated to some degree. Other aspects may either be missing or worked on by stakeholders outside governmental structures (e.g., civil society, the private sector, or donor-supported interventions).

The process of collecting and verifying facts and figures is laborious, costly and time-consuming, requiring properly trained and qualified personnel.

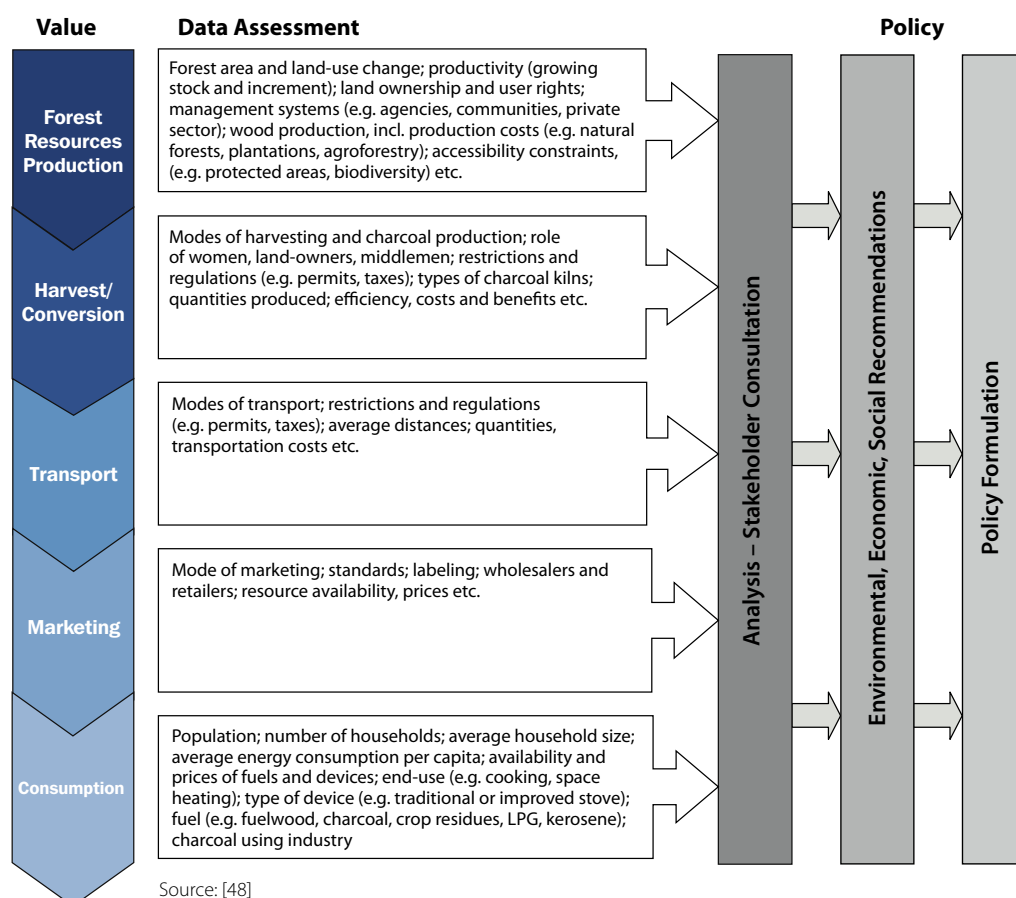
FAO likewise developed and introduced the WISDOM methodology in Rwanda as a tool to support national wood energy planning. WISDOM is a GIS-based tool

that allows the user to understand, in detail, the current spatial patterns of biomass demand and supply in a country, and to assess the sustainability of wood-fuel as a renewable and prolific energy carrier. **WISDOM forms an excellent basis on which future monitoring systems can build.**

Efforts to improve the basis of decision-making and subsequent implementation should focus on:

- **Identifying information gaps** as well as the specific needs and potential contributions of relevant stakeholders (e.g. stakeholder analysis, needs assessment)
- **Measures to improve IKM**, including harmonization of statistics and management information systems (MIS), documentation and up-scaling of experience and lessons learnt, and information sharing among stakeholders
- **Capacity development and pilot-interventions** with a view to collecting supplementary data (e.g. introduction and dissemination of forest inventory protocols and instruments), and targeted supply of novel/advanced methods and technologies (e.g. GIS applications, resource monitoring etc.).

FIGURE 24:
MONITORING THE
CHARCOAL VALUE
CHAIN



Source: [48]

It would be ideal to set up a kind of “observatory” that allows for the monitoring of the proposed interventions (cf. Figure 24). In this context it is essential to set up observation points in the various links of the charcoal value chain:

- **Production of wood energy:** The inventory of different types of forest formations, including regular biometric inventories, to get some statistically

reliable data on forest productivity under different management regimes. The production module should also include a monitoring of exploitation modes and quantities

- **Transformation:** Estimation of the distribution of different types of kilns and their efficiency
- **Transport products:** Setting up observation points at the main transportation axes
- **Marketing of products:** Setting up observation points at wholesale and retail points
- **Consumption:** Setting up household panels in rural and urban areas.

The described procedures within the proposed traceability system (cf. section E.6.3) would simplify data collection along the charcoal value chain. Information could be accessible about the availability of charcoal at different locations. This could be the start of an MIS system, linking wood owners and charcoal burners. Statistics will be collected about the flow of charcoal, including its origin, its destination and who transports it (cf. section C.4.).

For data collection, it is important to intensify cooperation with legal actors and organized players in the wood energy sector. This can be achieved by promoting partnerships between the main entities concerned, supporting the dissemination of a wide range of relevant information, combining the efforts of training and capacity building and using the observatory to promote participation and accountability in local communities and decentralized authorities.

E.6.7 LOBBYING AND PR MEASURES

Wood-based fuels have an image problem. Awareness building, lobbying and PR are indispensable to ensure that support to charcoal production or, more generally, to wood-fuel production, generates lasting and self-sustaining impact. This seems advisable particularly in the following respects:

- Public education programs to sensitize people to the harmful ecological and socioeconomic consequences of unregulated and wasteful wood fuel consumption and, in turn, the benefits of continued biomass utilization in a modernized wood fuel sector
- PR programs to inform concerned segments of society about on-going programs and initiatives, and to capacitate them for equitable participation as stakeholders
- Technical information to disseminate knowledge and innovative approaches
- Policy and legal-regulatory information campaigns to educate concerned segments of society about legal-regulatory amendments, incentive schemes, and economic policies
- Establishment and promotion of feedback by stakeholders to facilitate monitoring of charcoal support programs and interventions.

Engaging leaders and policy-makers on the benefits of biomass energy needs to be an important component of any initiative to promote renewable energy in Rwanda. In this context, the setting-up of an “Inter-Ministerial Working Group” (cf. section E.5.) will strengthen cross-sectoral collaboration between different sectors such as energy and natural resources, and may facilitate lobbying on behalf of a green charcoal value chain in Rwanda.

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in a ventilated space

F INDICATIVE INVESTMENT NEEDS TO REALIZE A “GREEN” CHARCOAL CHAIN

It is proposed that the modernization of the charcoal value chain starts with a pilot phase of three years in three conjoined districts and the capital city of Kigali.

As a first recommendation, the activities during the pilot phase should focus on the districts of Nyanza, Huye and Nyaruguru. The total cost of the pilot phase comes to 4.9 million USD. The cost of the subsequent phase(s), totalling 20.6 million USD, cover interventions in the remaining 27 districts of Rwanda. Table 18 summarizes the investment costs to realize a “green” charcoal chain.

Activity	Pilot phase (USD)	Total (USD)
Sustainable wood production		
Elaboration of wood-energy supply plans	500,000	0
Updating and adaptation of district forestry plans	250,000	1,400,000
Guarantee of adequate user rights for wood-fuel production	200,000	750,000
Rehabilitation and better management of public forest plantations	100,000	915,000
Increasing productivity of existing private forest and agro-forestry resources	510,000	4,600,000
Increasing private forest and agro-forestry resources	390,000	3,480,000
Testing short rotation coppice	50,000	300,000
Sub-total	2,000,000	11,445,000
Exploitation and transformation of wood-fuels		
Improvement of carbonization technologies	180,000	1,500,000
Test and introduction of semi-industrial kilns	100,000	700,000
Development of concepts for the grading and packaging of charcoal	50,000	280,000
Introduction of technologies allowing the utilization of charcoal dust	100,000	280,000
Sub-total	430,000	2,760,000
Transport and commercialization of charcoal		
Improvement of transport efficiency	50,000	280,000
Organization of commercial networks	175,000	1,220,000
Development of a market information system	500,000	500,000
Sub-total	725,000	2,000,000

TABLE 18:
SUMMARY OF COSTS
RELATED TO DIFFERENT
AVENUES OF INTERVENTION

Utilization of wood-fuels		
Increasing the efficiency of energy use	220,000	440,000
Sub-total	220,000	440,000
Framework conditions		
Introduction of adequate forest taxation procedures and law enforcement	100,000	560,000
Implementation of a traceability system	500,000	500,000
Promotion of innovative financing mechanisms	150,000	50,000
Improvement of governance capacity to reorganize the charcoal production sector	250,000	750,000
Setting up a monitoring and evaluation system	467,500	1,910,500
Lobbying and PR measures	300,000	600,000
Sub-total	1,767,500	4,370,500
Total	4,922,500	20,575,500

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PARTICIPANTS LIST OF VALIDATION WORKSHOP

Date September 12, 2012

Venue Umubano Hotel

Location Kigali, Rwanda

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